Research Corner
Outcome Measures in Cardiopulmonary Physical Therapy: Short Physical Performance Battery

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INTRODUCTION

In the last edition of the *Research Corner*, gait speed was presented as a functional assessment tool for patients with cardiovascular and pulmonary (CVP) disease. The benefits of this assessment tool included good reliability, validity, and responsiveness, making it a useful tool for measuring outcomes in patients with cardiovascular and/or pulmonary conditions. Additionally, gait speed is easy to measure, takes less than 2 minutes to complete, and requires minimal training for the tester. Outcomes of physical function may be enhanced by the use of tools that address other aspects of lower extremity performance, such as the Short Physical Performance Battery (SPPB). The SPPB is a simple test to measure lower extremity function using tasks that mimic daily activities. The SPPB examines 3 areas of lower extremity function; static balance, gait speed, and getting in and out of a chair. These areas represent essential tasks important for independent living and are thus an important outcome measure for patients with CVP disease.

Detailed instructions for the SPPB are listed in Appendix 1 and a sample score sheet is given in Appendix 2. To assess static balance, the patient is asked to maintain up to 3 hierarchical standing postures for up to 10 seconds. First, the patient stands with feet together. If the patient can maintain this posture for 10 seconds, he or she then performs a semi-tandem stance position. If semi-tandem is held for 10 seconds, it is followed by a tandem stance posture. For the 4 meter walk test, the patient is asked to walk at his or her comfortable speed across a 4 meter distance. Timing starts on the "begin" command and ceases when one foot crosses the end of the course. No room is provided for acceleration. After assessment of gait speed, the patient is asked to stand from a standard chair without upper extremity assistance. If the patient can stand 1 time, then he or she is instructed to complete 5 sit to stands as quickly as possible without upper extremity assistance. The time taken to complete the 5 sit to stands is recorded.

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Each subscale is scored 0-4 with 0 being "unable to complete the task" and 4 being the "highest level of performance." Scores from each subscale are added to create a summary score between 0 and 12. Table 1 lists how patients can be classified with severe, moderate, mild, or minimal limitations based on their SPPB scores.[1]

Subscale scores can also be used separately. Balance subscale performance can provide a quick screen of balance abilities. Performance on the 4 meter walk test can be used to calculate gait speed. The time in seconds to complete the 5 sit to stands can be used to assess lower extremity strength and power.[2-4] As part of the Women's Health and Aging Study, normative data on subscale performance for the SPPB has been published and is available at http://www.grc.nia.nih.gov/branches/ledb/whasbook/chap4/chap4.htm. Therapists can use this information to gain more insight on their patients' performance and to assist in writing goals.

Table 1. Classification of Limitations Based on Short Physical Performance Score

Score	Classification
0-3	Severe limitations
4-6	Moderate limitations
7-9	Mild limitations
10-12	Minimal limitations

Classification from Guralnik JM, Ferrucci L, Simonsick EM, Salive ME, Wallace RB. Lower-extremity function in persons over the age of 70 years as a predictor of subsequent disability. *N Engl J Med.* 1995;332:556-561.

Intended Population

The populations used to create and establish the SPPB were community dwelling older adults who participated in the Established Populations for Epidemiologic Studies of the Elderly (EPESE). The subjects involved in this longitudinal study were described as mostly Caucasian with higher than average education and income levels.[1] However since the inception of the SPPB, it has been used successfully in more diverse populations.[5-7] Investigators primarily have used community dwelling individuals when study-

ing the SPPB.[1,8,9] Only 1 article was found that involved patients in the acute care setting.[10]

To this author's knowledge, there are no published studies that have examined the psychometric properties of the SPPB in a specific population of patients with CVP diseases. However, subjects with histories of CVP disease were included in many of the studies that established the psychometric properties of the SPPB.[5,8,11] One example is in a study of 1002 women, 14.6% had a history of myocardial infarction, 10.5% had a history of heart failure, and 7% a history of a stroke.[5] Another study was found that used SPPB to examine differences in function between individuals with peripheral arterial disease (PAD) and those without PAD.[12] Based on this information readers should feel comfortable using the SPPB as an outcome measure for their patients with CVP disease, especially if the patients are community dwelling and/or older adults.

Reliability

Across numerous studies, investigators have found the SPPB is a reliable tool. In a group of 487 community dwelling older adults the Intraclass Correlation Coefficient (ICC) was equal to 0.82 across 2 sessions, 2 weeks apart,[11] Ostir et al[5] found an ICC = 0.88-0.92 for 1002 older women. The reliability of the subscale scores has also been examined. Acceptable reliability has been shown for both the 4 meter walk time (ICC = 0.79)[13]and the 5 sit to stands subscale (r = 0.80)[14] The reliability of the tandem stance, which is the most difficult balance posture of the SPPB, has been shown to have low reliability in 203 community dwelling Japanese Americans (r = 0.22).[14] Since the balance subscale may have questionable reliability, therapists should be cautious in using only this score as an outcome measure. A better choice would be to use the summary SPPB score or a different balance assessment tool if a specific measure of balance is required.

Minimal Detectable Change

The SPPB can be a very useful tool for clinicians because investigators have determined its minimal detectable change, responsiveness and minimal clinically important difference (MCID). Perera et al[15] combined information from 3 data sets of older adults (n = 692) to calculate standard error of the mean (SEM) for the SPPB. The SEM for the SPPB was 1.42 points. Guralnik et al[9] examined how SPPB score related to self- report disability, future nursing home admission, and mortality as part of the EPESE. Their conclusion was that a 1 point change in SPPB score led to meaningful differences in the risk for future mortality and nursing home admissions.

Responsiveness to Change

The SPPB has high predictive abilities in identifying those community dwelling older adults at greater risk for mortality, nursing home admission, hospitalization, and incidence of disability.[6-8,16,17] Guralnik et al[1] found that after adjusting for age, sex, and chronic health conditions, subjects with a SPPB score of 4-6 had a relative risk of 4.2 to develop an activity of daily living (ADL) disability over a 4-year period in comparison to subjects who scored 10-12 points. Subjects with a score of 7-9, had a relative risk of 1.6 to develop an ADL disability over a 4 year period in comparison to subjects who scored 10-12 points.[1] The SPPB score has also shown a relationship to compensatory strategies for mobility such as behavioral changes (walking less often, holding onto furniture), use of assistive devices (cane, walker, wheelchair), and human assistance.[18]

Not only should a tool be able to distinguish between individuals with different levels of function and predict the risk for future adverse events, but it should also be able to measure improvements following an intervention. Various investigators have demonstrated that the SPPB is responsive to changes following an exercise-based intervention.[19-21] In a randomized control study of 424 older subjects at risk for disability, individuals assigned to an exercise intervention of aerobic, strength, balance, and flexibility training increased their SPPB by 0.7 points more than the individuals who completed a educational intervention alone.[19] The SPPB is also responsive to changes that may take place following a medical event. In a group of older females, those who experienced a myocardial infarction, stroke, or a hip fracture during a 3-year period had a greater decline in SPPB than those who did not experience these events.[5]

One drawback of the SPPB is it may not be able to distinguish performance in high functioning patients. In a study of 101 older adults, the SPPB and the 400 meter walk test were compared in their ability to discriminate physical performance.[22] Thirty-six subjects scored in the minimal limitations range (10-12) of the SPPB. When the 400 meter walk test results of these 36 were examined, there was a wide range of performance with three being unable to complete the walk test and another 17 subjects with times greater than the median time of all 101 subjects. The investigators concluded that the 400 meter walk test may be a better test for high functioning patients and that the SPPB may have a ceiling effect.

Validity

The validity of the SPPB was established as part of the EPESE.[1,9] A decline in performance on the SPPB was found with age. Participants age 90 or higher scored 2.11 points lower on the SPPB in comparison to participants in 71 to 74 age range.[9] Investigators also found that SPPB score shows a significant association with self reported mobility related and ADL related disability.[1] The SPPB shows a relationship to other functional assessment tools such as the 400 meter walk test.[23] These studies validate that the SPPB measures important aspects of function in older adults.

Minimal Clinically Important Difference

An anchor-based method was used by Perera et al[15] to examine MCID for SPPB. The investigators asked subjects, "Since your last quarterly visit, has there been any change in your mobility?" Subjects responded using a 15 point scale with a range of -7 being a "very great deal worse," 0 being "no change," and 7 being a "very great deal better." If subjects reported a 2-3 point change in their mobility, this was considered a small change. A self reported change

of 4-7 points was classified as a substantial change in mobility. A change in the subject's SPPB score of 0.54 was related to a small change in mobility and a change of 1.34 was related to a substantial change in mobility.

Suggestion for Use in the Clinic

The SPPB has many desirable qualities and should be an appealing outcome measure to physical therapists who manage patients with CVP disease. The SPPB examines 3 important and separate aspects of lower extremity function.[9] The test's reliability and validity are high. It is responsive to change and its MCID has been established. The SPPB only requires 5 to 10 minutes to complete[9,11] so it can integrated into patient management without a high cost in time.

Integration of the SPPB into clinical practice can be a simple process. An established area of the clinic with 15 to 20 feet of open space can be used to test the 4 meter (13.12 feet) walk time. If a therapist practices in the home health setting, enough room can be found in most rooms to complete the 4-meter walk test. Any standard chair can be used to assess sit to stand performance. To this author's knowledge, no where in the literature has it been clarified what chair height should be used to test sit to stand performance. For consistency and reliability, only 1 type of chair should be used when testing sit to stand performance. If the therapist is in the home health setting, then the same chair in the patient's home should be used during each testing session. The balance subscale testing requires little space and can be performed almost anywhere. For safety reasons, this author prefers to test the balance with the patient in front of a chair and requires the patient to wear a gait belt.

Using the score sheet in Box 2, or a similar score, has benefits. First, therapists can record test results from 2 different sessions on 1 sheet of paper making it simple to track progress. This score sheet can also help remind therapists to reassess SPPB performance when they see the bottom half of the page blank. Second, the calculations to determine gait speed are listed on the score sheet giving therapists even more meaningful information on their patient's performance. Finally, space is provided to record the time in seconds the patient required to complete 5 sit to stands.

In the last edition of the *Research Corner*, the benefits and ease of gait speed were highlighted. One may ask if there are any additional benefits of completing the SPPB when gait speed can be measured in half the time. As part of the EPESE, both gait speed and SPPB were found to predict future disability over 1 and 4 year periods. The SPPB had better predictive abilities over the 1 year period, but the differences between SPPB and gait speed were minimal over the 4-year period.[8] Studenski et al[11] found that both SPPB and gait speed had strong predictive abilities for decline in health status and function, but for one cohort of older adults in their study (individuals recruited from Veterans Administration Network), the SPPB did a better job of predicting future hospitalizations than gait speed alone. In a group of 316 older Mexican Americans the SPPB did not provide any additional information over gait speed in predicting death during a 7-year period.[24] The literature supports both SPPB and gait speed, but seems to indicate that the SPPB is more informative than gait speed alone. Considering the fact that the SPPB can be completed in about 5 to 10 minutes, in general this author would recommend completing the full SPPB over gait speed alone, especially when the therapist suspects deficits in lower extremity strength and power or balance.

The SEM for SPPB is 1.42 points and the MCID ranges from 0.54-1.34 points.[15] Using this information, therapists should feel confident that if a patient has a change in their performance by 1-2 points, this is a meaningful change. Tracking performance on the SPPB over time can provide a great way to measure progress with interventions or decline in lower extremity performance due to a change in health status. This information can also be helpful to therapists in writing goals.

While the SPPB has many benefits, there are limitations that need to be addressed. The psychometric properties of the SPPB have not been well established beyond the community dwelling older adult population. Therapists who practice in areas other than the outpatient setting will have to make their own decision on whether the test is appropriate for their patients. In this author's experience the SPPB can be useful in the skilled nursing and acute care setting for patients that are independent ambulators. The SPPB appears to have a ceiling effect for individuals who have high functional abilities. This will limit the SPPB usefulness for individuals who are active and independent. The ceiling effect may also give these patients and their therapists a false sense of good health when in fact the patient may be beginning to have some functional declines that were not detected by the SPPB. Therapists need to keep all these limitations in mind when deciding whether the SPPB is appropriate for their patients.

CONCLUSION

In conclusion the SPPB offered many benefits such as being an inexpensive, reliable, valid, and sensitive tool with established MCID. It has been used primarily in community dwelling older adults, but can be a beneficial tool to use in the management of patients with CVP disease.

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Appendix 1. Directions for the Short Physical Performance Battery

Balance Subscale

Side by side – Patient will stand with feet together, side by side for up to 10 seconds. Patient may use arms, bend knees or move body to maintain balance, but may not move feet. First demonstrate the position to the patient. Then stand next to the patient to help him or her into the side-by-side position. Supply just enough support to the patient's arm to prevent loss of balance. When the patient has his or her feet together and is ready, let go and begin timing as you say, "Ready, begin." Stop the stopwatch and say "stop" after 10 seconds or when the patient steps out of position or grabs your arm. If patient is unable to hold the position for 10 seconds, record results, and go to the next subscale. If patient can maintain for 10 seconds, go onto the next posture.

Semi-tandem – Patient will stand with feet together, the toes of one foot aligned with the midpoint of the other foot. Follow the same directions as in the side by side stand. If patient is unable to hold the position for 10 seconds, record results, and go to the next subscale. If patient can maintain for 10 seconds, go onto the next posture.

Tandem – Patient will stand with one foot in front of the other with the heel of the front foot in contact with the toes of the back foot. Follow the same directions as in the side by side stand. Record results, and go to the next subscale.

Four Meter Walk Subscale

Mark off a four meter (13.12 foot) course with two cones or pieces of tape. The patient will start at one end of the course. Instruct the patient to walk at their normal pace as if they are walking down the street or going to the store. The patient will begin walking on the command "begin". Patient should walk past the other end of the course and not slow down until outside the four meter marker. Start on "begin" and stop timing when one of the patient's feet is all the way across the four meter marker. Walk behind and to the side of the patient. Patients are allowed to use a cane or any other walking device they normally use. Patient should repeat this walk twice, with the best time used for scoring.

Sit to Stand Subscale

Single Chair Stand – The patient should be seated in a standard height chair. The patient should fold arms across chest and sit so feet are resting on the floor. Ask the patient to stand while keeping arms folded across the chest. If patient cannot stand without using arms, the test is over. Record results on the score sheet. If patient can complete the stand, go onto the five chair stands.

Five Chair Stands – Instruct patient that you will now time how long it takes to complete five chair stands. Patient starts with arms folded across chest and sits so feet are resting on the floor. On the command "begin", patient should stand up straight as quickly as possible, sit back down and repeat for a total of five times. Count out loud as the patient completes each stand. Start timing on "begin" and stop the stopwatch when the patient has straightened up completely for the fifth time. Stop the test if the patient becomes tired, short of breath, uses arms, or one minute has passed without all five stands completed.

Directions adapted from Guralnik JM, Ferrucci L, Pieper CF, et al. Lower extremity function and subsequent disability: consistency across studies, predictive models, and value of gait speed alone compared with the short physical performance battery. *J. Gerontol A Biol Sci Med Sci.* 2000;55:M221-231.

Appendix 1. Score Sheet for the Short Physical Performance Battery

Patient Name: _____

Date : _____

Balance Score

Unable to hold side by side stance for > 9 seconds		0 points
Side by side stance for 10 sec, but unable to hold semitandem for 10 sec		1 point
Semitandem for 10 sec, unable to hold full tandem for > 2 sec		2 points
Full tandem for 3-9 sec		3 points
Full tandem for 10 sec		4 points

Walk Score (4 Meter or 13.12 feet)

Unable to walk		0 points
If time is more than 8.70 seconds		1 point
If time is 6.21 to 8.70 seconds	Time 1: _____	2 points
If time is 4.82 to 6.20 seconds		3 points
If time is less than 4.82 seconds	Time 2: _____	4 points

Chair Stand Score

If the participant was unable to complete the 5 chair stands		0 points
If chair stand time is 16.7 seconds or more		1 point
If chair stand time is 13.7 to 16.6 seconds		2 points
If chair stand time is 11.2 to 13.6 seconds		3 points
If chair stand time is 11.1 seconds or less	Time: _____	4 points

Total Score _____

Converted Gait Velocity (13.12/time in seconds)*0.68 = mph) _____

Date : _____

Balance Score

Unable to hold side by side stance for > 9 seconds		0 points
Side by side stance for 10 sec, but unable to hold semitandem for 10 sec		1 point
Semitandem for 10 sec, unable to hold full tandem for > 2 sec		2 points
Full tandem for 3-9 sec		3 points
Full tandem for 10 sec		4 points

Walk Score (4 Meter or 13.12 feet)

Unable to walk		0 points
If time is more than 8.70 seconds		1 point
If time is 6.21 to 8.70 seconds	Time 1: _____	2 points
If time is 4.82 to 6.20 seconds		3 points
If time is less than 4.82 seconds	Time 2: _____	4 points

Chair Stand Score

If the participant was unable to complete the 5 chair stands		0 points
If chair stand time is 16.7 seconds or more		1 point
If chair stand time is 13.7 to 16.6 seconds		2 points
If chair stand time is 11.2 to 13.6 seconds		3 points
If chair stand time is 11.1 seconds or less	Time: _____	4 points

Total Score _____

Converted Gait Velocity (13.12/time in seconds)*0.68 = mph) _____