

NEUROMUSCULAR FUNCTION

1. Background and Rationale

Direct assessments of physical performance have become standard measurements in epidemiological studies in the elderly. These assessments generally tap multiple domains of physiological performance, including lower extremity strength, balance, coordination, and flexibility. The assessment techniques used in Mr.OS have been derived from several previous studies, are reliable when performed in a standardized fashion, and are well tolerated by elderly participants. The following assessments are included in the Mr.OS performance battery: single and multiple chair stands and short walk tests with narrowed base of support.

2. Equipment and Supplies

- Digital stopwatch (repeated chair stands, standing balance, short walk test)
- Standard chair: straight back, flat, level, firm seat; seat height 45 cm at front (single and repeated chair stands).
- Walking course (See drawing included in description of narrow walk)

2.1 Stopwatch Use



The stopwatch will be used to measure the time it takes to complete a task from the beginning of the activity until the conclusion. Press the middle (mode) button to make sure you are in stopwatch mode. The display should read **0:0000**. To time the task, just press the right-hand button (labeled STA/STP) at the top of the stopwatch to begin, and press again when the task is completed. The time is digitally displayed on the stopwatch. To get the display to read **0:0000** again, press the left (lap) button.

3. Safety Issues and Exclusions

Walking aids may not be used in the chair stand and standing balance tests. The vast majority of participants should be able to attempt the performance tests. Exclusion from the performance tests will be based on an individualized assessment of impairments and safety concerns. The examiner will describe each test, and then discuss with the participant whether they should attempt that test given any physical problems or disabilities present. Refusal, or inability to perform a test will be recorded on the data form.

Obstructions in the exam area that could cause accidents should be removed. The detailed protocols describe how to administer the tests safely, including instructions on how to support the participant if required. For all test items where loss of balance is a possibility, you should use the following safety precautions. Position yourself standing at the participant's side, slightly behind them. Your hands should be positioned very close to either side of the participant's trunk at the hip or waist level but not touching the participant. Be ready to place both hands on the participant to stabilize them if necessary. If the participant loses balance, immediately hold onto the participant with both hands at the trunk and stabilize them. If the participant begins to fall do not try to catch them; reach under the participant's shoulders from behind and slowly ease them down to the floor. This will protect the participant and examiner from injury.

If the participant falls and is not injured, help them up by first having the participant get on their knees or on all fours, place a chair next to the participant, and have the participant support themselves on the chair as you help lift under the shoulders. Do not try to lift the participant from the floor by yourself.

4. Participant and Exam Room Preparations

- Footwear: To eliminate the effect of different footwear on test performance, these tests should be performed in tennis shoes or comfortable walking shoes with minimal or no heels. The participant may perform the tests in socks / stocking or bare feet if appropriate footwear is not available. Clinics may want to purchase a few sizes of inexpensive tennis shoes to have available.
- The standard chair should be placed on a nonslip surface (low pile carpeting works well) with the back of the chair against a wall for stability. There should be adequate room in front and on the sides of the chair for the examiner and the participant to maneuver freely.
- Walking course layout: The walk will be conducted on a six-meter path in a corridor at least 122 cm wide, without obstructions or irregularities in the floor. The start and finish lines will be marked by tape on the floor. The narrowed path will be marked at 20 cm, using tape. (See figure under 5.6 Six Meter Usual Pace and Balance Walk: Administration)

5. Measurement Procedures

5.1 Approach to Standardization

The Performance Based Measurements are administered by a certified examiner. Since motivation and level of understanding can have large impacts on performance, each component of the exam should be administered strictly according to the protocol and in the following sequence:

- Explain the procedure to the study participant making sure that key points from the suggested script are conveyed.
- Demonstrate the procedure using suggested script.
- Ask the participant if they have any questions.
- Re-explain the procedure briefly using suggested script.
- Ask the participant to perform the procedure.
- Begin all timed procedures with the words, "Ready? Go!"

Instructions and encouragement: Use the script provided to make sure that all key points are covered when you describe the test and how to perform it properly. You should not provide additional description or encouragement beyond the key points provided by the standard scripts.

If a participant questions the need for detailed verbal instruction, respond that you explain each test in detail since this is the best way to make sure that everyone does the test in a similar manner.

Demonstration: Demonstrate each maneuver for the participant. Remind the participant not to begin to do the maneuver until after you have demonstrated it.

It is very important that the examiner demonstrate each exercise correctly. Experience has shown that participants follow more closely what the examiner does rather than what they say. If the position or exercise is demonstrated incorrectly, the participant following the example will do the exercise incorrectly and be scored as "Unable" even though they may actually have been able to perform it correctly.

If the participant indicates that they do not understand the exercise, demonstrate it again rather than relying on repeated verbal instructions. Repeat the demonstration only once. If the participant still does not understand, go on to the next component of the test.

Practice trial: Practice trials for each test should be limited to those described in the individual measurement procedures.

Rest: The participant should be allowed to rest between tasks if out of breath or fatigued during the assessments.

5.2 General Scoring Issues

Not attempted/refused: If a test is not attempted because the participant refuses or the examiner deems the test unsafe for the participant, for whatever reason, record “not attempted/refused” on the scoring form. Where indicated, record a reason for the refusal.

Unable: If a test is attempted but cannot be completed or scored, record “unable” on the scoring form. Again, where indicated, record a reason.

5.3 Introductory Script and Exclusions for Performance Tests

The participant should be encouraged to perform each test if possible. However, they should also be instructed not to attempt a test if they feel it would be unsafe.

Script: “I’m going to ask you to try to do several different movements of your body. I will first describe and show each movement to you. Then I’d like you to try to do it. If you cannot do a particular movement or you feel it would be unsafe to try to do it, tell me and we’ll move on to the next one. Let me emphasize that I would like you to try each exercise. But I don’t want you to try to do any exercise that you feel might be unsafe.”

Record Impairments/Appliances: Record use of aids on the form.

Script: “Do you use any walking aids, such as a cane?”

Identify if the participant has any of the following. Record it on the form.

1) *Participant use of a lower extremity orthosis*

Orthosis - an orthopedic appliance or apparatus used to support, align, prevent or correct deformities or to improve the function of moveable parts of the body. In this exam we are specifically checking for lower extremity orthoses; plastic or metal leg braces at or above the ankle.

This refers to the participant's current use of such an aid. They will be wearing the device at the clinic for the exam. An orthosis used at other times (at night, for instance) is not recorded here.

An orthosis worn below the ankle (for example, a device worn in the shoes for fallen arches) does not qualify in this definition. If you cannot determine whether the participant uses an orthosis ask them.

2) *Missing limb*

Major limbs only are considered here: arms (including hands) and legs (including feet). A missing finger or other digit does not constitute a missing limb. A limb is considered missing whether or not an artificial limb is replacing the natural body part.

3) *Participant use of a prosthesis*

Prosthesis - an artificial substitute for a missing body part, such as an arm or leg, used for functional or cosmetic purposes, or both.

If the participant is missing a limb, the use of an artificial limb or prosthesis is to be recorded here. This refers to the participant's current use of such an aid. They will be wearing the device at the clinic for the exam. If the participant has mentioned owning a prosthesis but is not currently wearing it, it is not to be recorded here. If you cannot determine whether the participant is wearing a prosthesis ask them.

NOTE: Use of appliances or missing limbs are not exclusion criteria for these tests.

4) *Paralysis of an extremity or side of body*

If the participant is unable or has difficulty moving an arm and/or leg due to weakness or spasticity, record this here. Only obvious impairment need be recorded. The examiner is not expected to elicit subtle neurologic signs.

Screen for health status:

Script: “Do you have any problems from recent surgery, injury, or other health conditions that might prevent you from standing up from a chair or walking?”

If the answer is “yes,” record on the form. Tell the participant who says “yes” that after you describe each test to them, you will discuss whether they should attempt the test given their physical problems. If no problems are mentioned by the participant, mark “no”.

5.4 Single Chair Stand: Administration

This is a test of ability to stand up from a standard chair without using arms. This task is also used to screen for the ability to do repeated chair stands. Walking aids such as canes, walker, or crutches may not be used.

- 1) **Participant and Exam Preparation:** A straight-backed chair without arms, with seat height of 45 cm, should be used for this test and placed against a wall for added stability. The participant's feet should be placed squarely on the floor in front of them. The participant should be seated in a position which allows them to place their feet on the floor with knees flexed to slightly greater than 90° so that their heels are somewhat closer to the chair than the back of the knees.

During the test, the examiner may stand in front of the participant (with arms extended, if appropriate) for the participant's safety during the chair stands.

- 2) Describe the test:

Script: "This is a test of strength in your legs in which you stand up from sitting without using your arms."

- 3) Demonstrate the procedure:

Script: "Fold your arms across your chest, like this, and stand, keeping your arms in this position. Do you understand?"

- 4) Ask the participant to stand:

Script: "Can you stand and sit one time for practice? Ready, Go!"

If the arms unfold, or the participant puts one or both hands down on the chair to push up, remind them to keep their arms folded snugly across their chest and ask them to repeat the chair stand.

It is OK for the participant to move part-way forward in the chair before standing, but knees and hips should be flexed to approximately 90° before standing.

- 5) If the participant cannot rise without using arms, say:

Script: "OK. Try to stand up using your arms to push off."

- 6) Answer if the participant could stand up one time unassisted. Score as follows:

If the procedure was not performed for safety reasons or refused for other reasons, score "*Did not attempt/refused.*" Do not perform Repeated Chair Stands!

If participant attempted but was unable to arise even using their arms, score as "*No, unable to stand.*" Do not perform Repeated Chair Stands!

If the participant uses arms to stand up, score as "*No, rises using arms.*" Do not perform Repeated Chair Stands!

If the participant stood up all the way without using arms, score as "*Yes.*" Go on to Repeated Chair Stands.

5.5 Repeated Chair Stands: Administration

This is a test of lower extremity strength in which the participant stands up from a seated position five times as quickly as possible. The time it takes to stand five times is recorded.

- 1) If the participant can arise from the chair without using arms, attempt the five stands.

Script: "This time, I want you to stand up 5 times as quickly as you can keeping your arms folded across your chest."

- 2) Demonstrate the test.

Cross your arms over your chest and then rise while emphasizing “full standing position”, and sit while emphasizing “all the way down.”

Script: “First I will show you. When you stand up, come to a full standing position each time, and when you sit down, sit all the way down each time. I will demonstrate two chair stands to show you how it is done.”

Rise two times as quickly as you can, counting as you stand each time.

- 3) Begin the test

Script: "When I say ‘Go’ stand five times in a row, as quickly as you can, without stopping. Stand up all the way, and sit all the way down each time. Ready, Go!"

Start timing as soon as the examiner says “Go.” Count: "1, 2, 3, 4, 5" as the participant stands each time.

- 4) If the participant is unable to complete the chair stands correctly (e.g. is not coming to a full stand), abort the procedure, repeat the demonstration, wait 1 minute, and begin the procedure again.
- 5) If the participant stops before completing five stands, confirm that they cannot continue by asking:

Optional script: "Can you continue?"

If they say yes, continue timing. Otherwise, stop the stopwatch.

- 6) Score as follows:

When 5 stands weren’t completed:

If the procedure was not performed for safety reasons or refused for other reasons, score *“Did not attempt/refused.”*

If participant attempted and completed at least one stand but was unable to complete five stands, score as *“Completed at least 1 stand, but unable to complete 5 without help.”* Record the number of stands that were completed.

If the participant attempted but was unable to stand once without help, score as *“Attempted, but unable to stand once without help.”* Record that 0 stands were completed.

When 5 stands were completed:

Record the number of seconds, to a hundredth of a second, required to complete five stands. Also, record participant’s arm use during the chair stands.

5.6 Six Meter Usual Pace and Balance Walk: Administration

This is a modification of the short walk test used in many epidemiological and clinical studies. The time to walk 6 m at the participant's usual pace is measured, along with the number of steps.

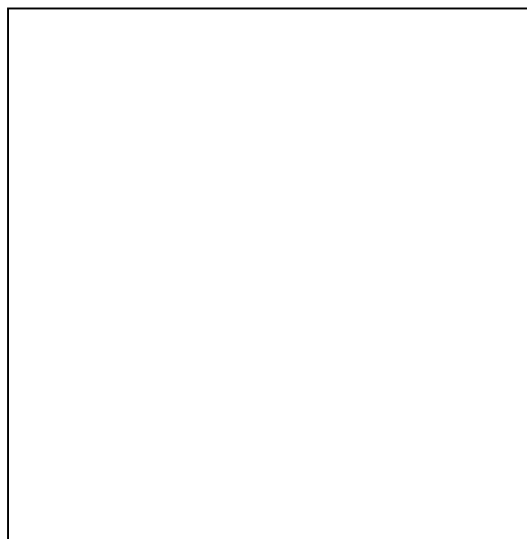
In addition to the standard walk, this test also includes one walk along a narrowed path. The narrowed walk path is designed to make the participant slow down during gait with a narrowed base of support, a situation that requires increased motor control. There will be two scored trials for the narrowed walk.

The 6 m walk tests will be conducted in the following order: usual pace and narrowed to 20 cm.

The 6 m walking course is laid out on the floor as indicated in the figure below. The course must be free of obstacles.

Starting Each Walk Test: The participant should stand with toes just touching the starting line. Hold your arm up, say "Ready, Go," and then drop your arm. Start timing with the first footfall over the starting line (participant's foot touches the floor on the first step).

Scoring the Walks: Stop timing with the first footfall (complete or partial) crosses the finish line. Time is recorded to the nearest 0.01 second. For the usual pace walk, also count all steps. Steps are counted by counting both right and left steps and include the initial starting step and the step that first touches the floor across the finish line.



The narrow path walk is scored for time if there are no more than two deviations from the path. A deviation from the path is defined as stepping on, or going outside of, the colored tape or touching the wall. If there are more than two deviations, the trial is scored as "unable to assess." Each participant will be given up to three chances to perform the narrowed walk with two or fewer deviations. If they successfully perform the walk in the first two trials, a third trial will not be needed.

1) Introduction

Describe the walking tests.

Script: “This is the balance walk test. First I want you to walk down the hall normally, at a comfortable pace, ignoring the colored lines. For the second walk, I will ask you to walk keeping your feet inside the lines. Each walk will be done at least twice.”

2) Usual pace walk

- a) Demonstrate the usual pace test: Say the following, while demonstrating where to place the feet and where to walk.

Script: “Place your feet with your toes behind, but touching the starting line. Wait until I say ‘GO.’ Remember, I want you to walk at a comfortable pace ignoring the colored lines.” (Demonstrate and return.) “Walk a few steps past the finish line each time. Any questions.”

- b) Complete Trial 1. Hold your arm up. To start the test, drop your arm and say,

Script: “Ready, Go.”

Start timing with the participant’s first footfall. Follow along a few paces behind the participant. Count each step (NOT aloud), both left and right. Hit the start button on the stopwatch as you count the first step. Stop timing with the first footfall (complete or partial) crosses the finish line.

- c) Have the participant repeat the usual pace walk.

Script: “OK, fine. Now turn around and when I say go, walk back the other way at a comfortable pace. Ready, GO.”

- d) For each trail, record if the trial was completed. If the trial was completed, record the time and the number of steps. Also record aid use. If the participant wasn’t able to complete a trail, score “*Participant attempted but unable.*” If a trial wasn’t completed, score “*Unable to assess.*”

3) 20 cm narrow walk

- a) Explain the 20 cm narrow walk.

Script: “Now for the second walk, I want to keep your feet inside the lines. It is important that you do your best to keep your feet inside the lines.”

- b) Demonstrate the walk.

Script: “I’ll demonstrate. Keep your feet inside the lines. Be sure to walk a few steps past the finish line. Any questions?”

- c) Begin test. Time as before, but do not count steps. Drop your arm and say,

Script: “Ready, GO.”

- d) Record if the participant was able to successfully stay within the lines during each trial (if they had 2 or less deviations). If the participant was able to successfully stay within the lines, record the time on the form. If the participant deviated from the lines 3 or more times, score “*Unable to complete.*” If the trial wasn’t attempted, mark ‘*Trial not attempted.*”
- e) We would like to obtain two valid times from 2 trails with 2 or fewer deviations. A third trial should be performed if the participant is not able to successfully complete trial 1 or 2 because they deviate from the lines 3 or more times.

6. **Alert Values/Follow-up/Reporting**

These test results have no alert values and are not reported to the participant or physician.

7. **Quality Assurance**

7.1 **Training and Certification**

The examiner requires no special qualifications or experience to perform this assessment. Training should include:

- Read and study manual
- Attend Mr.OS training session on techniques (or observe administration by experienced examiner)
- Practice on other staff or volunteers
- Discuss problems and questions with local expert or QC officer

7.2 **Certification Requirements**

- Complete training requirements
- Recite exclusions
- Conduct exam on 2 volunteers:
 - According to protocol, as demonstrated by completed QC checklist
 - Times within ± 1 s of QC officer, step counts agrees with QC officer
 - Assessment of “deviations” on narrow walk agrees with QC officer

7.3 Quality Assurance Checklist

- Performance tests
- Asks participant about problems which might prevent testing
- Correctly assesses impairments/appliances (records lower-extremity orthosis, prosthesis, missing limb, or paralysis, if present)

Chair stands

- Back of chair against a wall
- Script correctly and clearly delivered for each test
- Correctly demonstrates single stand, emphasizing keeping arms tight across chest
- Correctly demonstrates two stands, emphasizing full stand and return to complete sit
- Says “ready, go.” for each test
- Counts each chair stand, and stops timing after participant STANDS UP on fifth stand
- Records and explains unusual values
- If task was not performed, codes and explains reasons

Short walks

Usual pace

- Script correctly and clearly delivered
- Correctly demonstrates
- Toes touching start line
- Timing started coincident with participant’s first footfall
- Correct number of steps counted, and time stopped with first footfall over the finish line
- Repeat (second trial)

Narrow short walk

- Script correctly and clearly delivered
- Correctly demonstrates
- Toes touching start line
- Timing started coincident with participant’s first footfall
- Timing stopped at with first footfall over the finish line
- Ability to stay “in bounds” on narrowed walk correctly assessed
- Correct number of trials allowed

8. References

1. Ferrucci, Luigi: Unpublished data.

