WHITEPAPER

Mobility Lab by APDM
Mobility Lab provides sensitive, valid and reliable outcome measures.

With hundreds of universities and hospitals using this system worldwide, Mobility Lab is the most trusted wearable gait and balance system on the market.

Using APDM’s advanced wearable monitors (Opals), Mobility Lab makes it easy to collect, analyze, and store outcome measures. Attach monitors to your subject, and instruct them to perform a standardized test. A report is then automatically generated to compare against normative values. This process takes less than five minutes.

What Can We Measure?

**GAIT**

- **Lower Limb**
  - Cadence
  - Foot Clearance
  - Gait Cycle Duration
  - Gait Speed
  - Double Limb Support
  - Lateral Step Variability
  - Lateral Swing Max
  - Pitch at Initial Contact
  - Pitch at Toe Off
  - Stance
  - Step Duration
  - Stride Length
  - Swing
  - Toe Out Angle

- **Upper Limb**
  - Maximum Velocity
  - Range of Motion

**BALANCE**

- **Trunk**
  - Coronal Range of Motion
  - Sagittal Range of Motion
  - Transverse Range of Motion

- **Lumbar**
  - Coronal Range of Motion
  - Sagittal Range of Motion
  - Transverse Range of Motion

- **Head**
  - Coronal Range of Motion
  - Sagittal Range of Motion
  - Transverse Range of Motion

- **Postural Sway**
  - 95% Ellipse Sway Area
  - RMS Sway
  - Coronal RMS Sway
  - Sagittal RMS Sway

**Turning**

- Angle
- Duration
- Maximum Velocity

**Sit to Stand**

- Lean Angle
- Duration

**Stand to Sit**

- Lean Angle
- Duration
PORTABLE
Set up in any location with our lightweight, wireless system

RELIABLE
Numerous clinical studies have proven high test-retest reliability

SENSITIVE
Accurately measure minimally detectable changes

VALID
Algorithms validated against video motion capture and force plate systems
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MONITOR CONFIGURATIONS AND MEASURES

BALANCE

1 OPAL

BALANCE, LOWER LIMB GAIT, TURNING

3 OPALS

BALANCE, LOWER LIMB GAIT, UPPER LIMB GAIT, TURNING, SIT TO STAND

6 OPALS
## MOBILITY LAB TEST MEASURES

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<td>Sit to Stand</td>
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### Lower Limb

- Cadence
- Gait Cycle Duration
- Gait Speed
- Foot Clearance
- Double Support
- Lateral Step Variability
- Lateral Swing Max
- Pitch at Initial Contact
- Pitch at Toe Off
- Stance
- Step Duration
- Stride Length
- Swing
- Toe Out Angle

### Upper Limb

- Maximum Velocity
- Range of Motion

### Sternum Range of Motion

- Coronal
- Sagittal
- Transverse

### Lumbar Range of Motion

- Coronal
- Sagittal
- Transverse

### Sit To Stand

- Duration
- Lean Angle

### Stand To Sit

- Duration
- Lean Angle

### Turning

- Angle
- Duration
- Velocity

### Postural Sway

- 95% Ellipse Sway Area
- RMS Sway
- Coronal RMS Sway
- Sagittal RMS Sway
FULL BODY GAIT MEASURES

Gait measures are detected, analyzed, and averaged over the extent of the walking duration of the subject. All measures are assessed for asymmetry and variability.
POSTURAL TRANSITION MEASURES

Postural transitions are detected, analyzed, and averaged over the extent of the walking duration of the subject.
TURN TO SIT
ANALYSIS

Turn Duration
seconds

Turn Velocity
deg/s

Sagittal Range of Motion
degrees

Transverse Range of Motion
degrees

Coronal Range of Motion
degrees

TRUNK RANGE
OF MOTION
POSTURAL SWAY MEASURES

All postural sway measures are assessed using the Opal movement monitor placed on a subject’s lumbar. All metrics are reported in Coronal, Sagittal and Transverse planes.

POSTURAL SWAY

95% Ellipse Sway Area
degrees²

95% Ellipse Rotation
degrees

RMS Sway
m/s²

Mean Velocity
m/s³
FOOTPLATE

The Mobility Lab Footplate is designed to standardize stance width for each Mobility Lab test. All norms are derived from subjects using the standardized stance width measured by the Footplate. Standard instructions for some tests instruct the subject to stand with their feet together to induce instability, but research has shown that using Mobility Lab with a wider stance is equivalently as sensitive and puts the subject at less of a risk of falling during the tests.
WALK TEST

The Walk test is the most comprehensive test to measure a subject’s gait. We recommend that your subject walks for at least 2 minutes in order to collect a sufficient amount of gait cycles to accurately measure variability and asymmetry.

TEST MEASURES:
Full body gait (legs, arms, and trunk), asymmetry, variability and turning

NUMBER OF MONITORS: 3 or 6

SETUP:
1. Walking corridor must be at least 7 meters in length

PROTOCOL:
1. Select Walk and press start trial.
2. Subject should stand comfortably and wait for instruction to begin walking.
3. When the subject is ready, press record and instruct the subject to walk.
4. The subject can walk freely in a straight path and perform 180 degree turns when necessary.
5. Terminate the trial at any point.

NORMATIVE VALUES:
Normative values were collected using a 2 minute walk in a corridor 7 meters or longer with 180 degree turns at both ends.
Timed Up and Go (TUG) is a common test to assess a subject's mobility, and APDM has made it more valuable by giving you the ability to precisely measure all of the components of mobility, rather than just duration.

**TEST MEASURES:**
Full body gait (legs, arms, and trunk) and postural transitions (sit, stand, and turning)

**NUMBER OF MONITORS:** 3 or 6

**SETUP:**
1. Measure 7 meters, placing tape at the two ends.
2. Place an armless chair at the start before the tape.

**PROTOCOL:**
1. Select TUG and press start test.
2. Subject should sit comfortably in the chair with their arms on their legs, and back against the seat.
3. When the subject is ready, press record and the test will begin to count down from 3 seconds.
4. The subject should rise from the chair without using their arms and begin walking. If the subject is unable to rise from the chair with arms, reset the test and allow them to use their arms to stand.
5. After the subject walks passed the 7m end tape, they should turn 180 degrees and walk back.
6. Once they arrive at the chair they should turn 180 degrees, and sit down.
7. Terminate the trial when the subject rests their back against the back of the seat.

**NORMATIVE VALUES:**
Normative values were collected using the protocol listed above.
The instrumented Postural Sway (Sway) test is a common test of quiet stance balance. It is a very simple test comprising of only one monitor around the waist. The test takes only 30 seconds to administer.

**TEST MEASURES:**
Postural sway

**NUMBER OF MONITORS:** 1 or 3 or 6

**SETUP:**
1. Have the subject fit their feet around the foot template provided with the Mobility Lab system (to normalize foot placement).

**PROTOCOL:**
1. Select Sway and press start test.
2. Subject should stand comfortably with their hands at their side or across their chest.
3. Press start and wait for the test to count down from 30 seconds.

**NORMATIVE VALUES:**
Normative values were collected with eyes open on a hard surface with arms crossed.
The modified Clinical Test of Sensory Interaction and Balance (mCTSIB) is a composite test to assess a subject’s balance under different test conditions.

**TEST MEASURES:**
Postural sway, visual dependence, proprioceptive dependence, and vestibular loss

**NUMBER OF MONITORS:** 1 or 3 or 6

**SETUP:**
1. Have the subject fit their feet around the foot template provided with the Mobility Lab system (to normalize foot placement). *

**PROTOCOL:**
1. Select CTSIB and press start test.
2. Subject should stand comfortably with their feet together and hands at their side.
3. Follow the conditions outlined in the test description.
4. Press start and wait for the test to count down from 30 seconds. Move on to the next test condition.

**TEST CONDITIONS:**
1. Eyes Open, Hard Surface
2. Eyes Closed, Hard Surface
3. Eyes Open, Foam Surface
4. Eyes Closed, Foam Surface

**NORMATIVE VALUES:**
Normative values were collected following the protocol listed above.
The Balance Error Scoring System (BESS) test is a measure of assessing static postural stability. It is designed for the mild head injury population, and to assist in return to sports play decisions.

**TEST MEASURES:**

Postural stability in varying conditions

**NUMBER OF MONITORS:** 1 or 3 or 6

**SETUP:**

1. Have the subject fit their feet around the foot template provided with the Mobility Lab system (to normalize foot placement). *

**PROTOCOL:**

1. Select BESS and press start test.
2. Subject should stand according to the test condition with their hands on their hips, and their eyes closed.
3. Follow the conditions outlined in the test description.
4. Press start and wait for the test to count down from 30 seconds. Move on to the next test condition.

**TEST CONDITIONS:**

1. Eyes Closed, Double Support, Hard Surface
2. Eyes Closed, One Leg, Hard Surface
3. Eyes Closed, Tandem Stance, Hard Surface
4. Eyes Closed, Double Support, Foam Surface
5. Eyes Closed, One Leg, Foam Surface
6. Eyes Closed, Tandem Stance, Foam Surface

**NORMATIVE VALUES:**
Normative values were collected following the protocol listed above.
The modified Balance Error Scoring System (mBESS) test is a shortened version of the BESS test. It is a measure of assessing static postural stability, designed for the mild head injury population, and to assist in return to sports play decisions.

TEST MEASURES:
Postural stability in varying conditions

NUMBER OF MONITORS: 1 or 3 or 6

SETUP:
1. Have the subject fit their feet around the foot template provided with the Mobility Lab system (to normalize foot placement). *

PROTOCOL:
1. Select mBESS and press start test.
2. Subject should stand according to the test condition with their hands on their hips, and their eyes closed.
3. Follow the conditions outlined in the test description.
4. Press start and wait for the test to count down from 30 seconds. Move on to the next test condition.

TEST CONDITIONS:
1. Eyes Closed, Double Support, Hard Surface
2. Eyes Closed, One Leg, Hard Surface
3. Eyes Closed, Tandem Stance, Hard Surface

NORMATIVE VALUES:
Normative values were collected following the protocol listed above.
The 360 degree Turn Test is a measure of dynamic balance. The subject turns in a complete circle (360 degrees) while time to complete and/or number of steps to complete the turn are recorded.

**TEST MEASURES:**
Turn velocity, time, number of steps

**NUMBER OF MONITORS:** 6

**SETUP:**
1. Place a piece of masking tape on the floor to mark the start/stop position. Have the subject fit their feet around the foot template provided with the Mobility Lab system (to normalize foot placement). *

**PROTOCOL:**
1. Select 360° Turn and press start test.
2. Subject should stand with their toes aligned with the tape.
3. Press start and wait for the subject to complete a full turn. Press stop when the subject’s shoulders are back in the start position.

**NORMATIVE VALUES:**
Normative values were collected following the protocol listed above.
The 5 Times Sit to Stand (5xSST) test is a measure of functional lower limb muscle strength. It is useful in quantifying functional change of transitional movements.

**TEST MEASURES:**
Trunk excursion, stand time, cadence, total time

**NUMBER OF MONITORS:** 6

**SETUP:**
1. It is preferable to use a chair with no armrests, to ensure that subjects stand without assistance.

**PROTOCOL:**
1. Select 5x Sit to Stand and press start test.
2. Subject should sit with their back against the back of the chair.
3. Press start and wait for the subject to stand up completely, then return to the sitting position. Press stop when the subject has returned to the sitting position the 5th time.

**NORMATIVE VALUES:**
Normative values were collected following the protocol listed above.