Assessment of Balance

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In any assessment or management of balance, particularly in standing, the client's safety is your first priority. How can you ensure this?
- remove obstacles, may set up the patient in a harness or use ambulation/transfer belt, be ready to assist, reasonably challenge within the patient's capacity, during perturbations, push patient towards you rather than away, use of a spotter, assess and treat in front of a stable surface

Assessment of Impairments Impacting on Balance

Balance is a composite impairment. The following balance assessment by Horak identifies groups of impairments that have an impact on balance: ROM, strength, pain, muscle tone, coordination and sensation. These are all included in a PT neurological assessment.

We will not go into the details of the assessments in the vision section.

IMPAIRMENTS AFFECTING BALANCE

A. Range of Motion	**Right**	**Left**
Hip		
Knee		
Ankle		
Cervical		
Trunk		
Remarks	e.g. deformities, contractures	
B. Strength	**Right**	**Left**
Gastroc/Soleus		
Tibialis Anterior		
Quads		
Hamstrings		
Hip flexors		
Hip extensors		
Abductors		
Adductors		
Trunk (abdominals (partial sit up), extensors)		
Neck		
Remarks		
C. Pain		
D. Muscle Tone		
Increased resistance to passive stretch		
Clonus / DTR's		
E. Cerebellar coordination		
Finger to nose		
Pronation / supination		
Heel to shin		
Tremor		

F. Sensation

Vision

- central and peripheral visual acuity (by report)
- depth perception (by report)
- acuity at night (by report)
- smooth pursuit eye movements *use 2 targets with eye movement to each i.e. L,R*
- saccadic (fast) eye movements
- eye/head coordination – *2 parts to this: 1) ability to move eyes with the head still as in smooth pursuit, and 2) to gaze during head motion, either a) head and eyes moving together synchronously with no lag, i.e. in phase with head and eyes together (e.g. watching a tennis match) or b) VOR i.e. out of phase with eyes moving opposite to head*
- VOR *The vestibulo-ocular reflex maintains the image of an object stable on the retina during head movement. The vestibular system senses head movement, signals ascend to the oculomotor nuclei, which drives compensatory eye movement in the direction opposite the head movements. The gain, eye movement velocity/head movement velocity should be close to 1:1, i.e. head velocity is the same as eye velocity. Test VOR by shaking head and see if eyes can maintain fixation on an object placed approx. arm's length away.*

Somatosensory (sole of foot, ankle and toes)

- Proprioception
- vibration – *a good indication of the integrity of the receptors and conduction of peripheral nerve and spinal cord*
- Pressure, e.g. Von Frey hairs

Vestibular

- Dizziness (*a patient's misperception that motion is occurring, **not** lightheadedness i.e. postural hypotension) – identify what positions or movements elicits it. Can be rated on a scale of 1-10 or record the time that the sensation lasts*

Other

- Polypharmacology, urgency, fear of falling (perceived limits of stability), impaired cognition (e.g. attention), fatigue and deconditioning

Postural Control Assessment presented by Fay Horak, Rehabilitation of Balance and Dizziness in the Neurologic Patient (1998).

Horak went on in 2009 to develop The Balance Evaluation and Systems Test (BESTest) to more specifically assess deficits in the above groupings.

Accurate assessment is required to determine the contributing factors to the balance deficit.

Motor Strategy Assessment

Sequence for testing balance commonly used in the clinical setting

The motor strategy assessment examines the ability to coordinate motor responses during perturbations to balance. This is assessed in addition to the list of impairments that impact balance covered above.

The motor strategy assessment is a *framework* used by clinicians for assessing postural control. It is a performance-based evaluation usually performed in sitting and standing. It utilizes a series of self-generated and external perturbations that require progressively greater balance control.

It is important to appreciate that postural control is achieved through a **combination** of ongoing anticipatory and reactive control strategies tested within this framework; the brain is computing all necessary postural adjustments before and during the movement.

Framework for Motor Strategy Assessment of Balance

A ***Observe the alignment / posture and stability in an unsupported position***

B ***Anticipatory balance strategies***
Definition: a postural adjustment that is activated before voluntary movements in order to minimize the potential disturbance to balance that the movement may cause (page 188, Shumway-Cook & Woollacott, 2012).

Observe the alignment/stability and motor strategies used during internal perturbations of gradually increasing challenge.

i.) Begin with movement of arms, legs and head
ii.) Perform active weight shifts, gradually progressing the amplitude of the movement closer and closer to the limits of stability

C ***Reactive balance strategies***
Reactive control is essential to recover from unpredictable/external perturbations or correct for errors / limitations in anticipatory strategies.

Observe stability/motor strategies used during external perturbations of gradually increasing force.

Practical Application of the Motor Strategy Assessment
Perform the following evaluation on a partner.

In Sitting

A. Observe the alignment / posture and stability in an unsupported position
Observe at rest

B. Anticipatory balance strategies – a suggested progression
Anticipatory postural adjustments of the core and limbs must be made as COM is perturbed with each of the following test movements. These movements are known as "internal perturbations" because they are self-generated.

- Observe arm movement (e.g. shoulder flexion and/or abduction)
- If performed with ease, increase the speed
- Observe leg movement (e.g. unilateral knee extension or hip flexion (the latter is likely more difficult))
- If performed with ease, increase the speed
- Observe head and trunk rotations
- Observe anterior, posterior and lateral weight shifts, with arms if possible, from small to larger ranges (take note of several students' maximal range of weight shift to begin to establish a typical standard)

For these tasks, ask patient to repeat with more range if appears able/safe so that testing is <u>appropriately challenging</u>

In standing may also include leg movements (e.g. hip abduction or hip flexion with knee flexed)

In standing, try self-initiated sways yourself. Feel what muscles are turning on and off as you sway in the anterior-posterior direction.

Note the *expected ranges for older adults:* 12.5 inches for forward reach, 10 inches for lateral reach (Newton RA. 2001. Validity of the multi-directional reach test: a practical measure for limits of stability in older adults. J Gerontol Med Sci 56A(4):M248)

C. Reactive balance strategies
For external perturbations push client at shoulder or if standing, can push at shoulder or pelvis. PT can be at back or front or towards a side, just be "ready" for loss of balance

- Expected perturbations, just do about two – say "I'm going to give you some nudges to the - - - (Fill in the blanks with the direction), keep your balance"
- Unexpected perturbations – do not warn patient of the direction or time of when he/she will be pushed/perturbed; the "hold and release" method and the reach to max and then perturb are other options (**Note to tutors: show how to guard these**).

In standing, progress to provocation of protective response i.e. stepping strategy (change in support strategy).

Other Research Findings:
Jacobs et al (2005) studied the responses of control subjects who adopted a stooped posture and found that *"… peak center of pressure displacements slowed and decreased, reducing stability margins toward values observed in PD subjects."* The authors concluded that a stooped posture is one contributing factor but does not fully account for abnormal postural responses seen in Parkinson's.

Horak has observed that individuals with the greatest limits of stability (controls, individuals with Parkinson's during on and off phases of medications) demonstrate the best postural responses to perturbations (2009, Current Concepts in Balance, Mobility and Fitness conference, Toronto)

In A, B and C above, how would you increase the challenge for the patient to the appropriate level?

- Assessment must be at the patient's level of skill. Use judgment.
- Evaluate responses in all directions
- Gradually increase amplitude and speed
- May progress from testing with eyes open to closed
- Change from expected to unexpected displacements/external perturbations
- May progress by reducing size of base of support, for example:
  - In sitting, raise seat so feet don't touch the ground
  - In standing, test in tandem or 1-foot stance or use Romberg (eyes closed, feet together, hold x 30 sec), or sharpened Romberg (tandem, eyes closed, arms across chest, hold x 60 sec, do 4 trials and score out of 240)
    - What to look for? First and foremost, stop timing if feet move out of position (for all tasks) or they open eyes (Romberg), but also note use of equilibrium reactions, sway and play at ankles (combines quantitative and qualitative assessment of performance)

How would you document your findings?

Was stability maintained?

What was the range and duration of the test movements?

- As examples: Were the movements held appropriate times, what was the range of weight shifts and head and trunk turns?

What was the strategy used?

- hip, ankle, change in support (stepping and/or arm)

Were the test movements and the strategy coordinated well?

- Consider, as examples: Was there appropriate elongation and shortening during weight shifting, did the limbs collide, and how many steps were taken to recover balance?

Was the strategy used appropriate for the context?

- *Was the strategy used appropriate for* the amount of movement of the COM / degree of displacement in the test? For example, did the patient use a stepping strategy even with a small perturbation?

Consider pros and cons of using technology to evaluate balance control.

-Expense? Ease of interpretation of data? Validity?

Berg Balance Scale

The Berg Balance Scale was developed for use in elderly patients with stroke and it has been shown to be useful in predicting falls in the elderly. It is commonly used in the clinical environment to assess balance and risk of falls. (pg 257, in O'Sullivan & Schmitz 2007)

Review the Berg Balance Scale items on the following pages. Think about: where you would position yourself to ensure patient safety, and in what situations you might decide not to conduct parts of the test.

You can find further information about the normative values and psychometric properties of the Berg Balance Scale (and many other outcome measures) on the **Rehabilitation Measures Database**:
http://www.rehabmeasures.org/rehabweb/allmeasures.aspx?PageView=Shared

ASSESSMENT *Tool 11–3*

Berg Balance Test[a]

1. Sitting to standing

Instruction: Use a chair with arms. Ask the patient to stand up. If the patient stands up using the arms of the chair, ask him or her to stand up without using his or her hands, if possible.

Grading: Mark the lowest category that applies. _____

_____ (4) able to stand, no hands, and stabilize independently
_____ (3) able to stand independently using hands
_____ (2) able to stand using hands after several tries
_____ (1) needs minimal assistance to stand or to stabilize
_____ (0) needs moderate or maximal assistance to stand

2. Standing unsupported

Instruction: Stand for 2 minutes without holding on to any external support.

Grading: Mark the lowest category that applies. _____

_____ (4) able to stand safely for 2 minutes
_____ (3) able to stand for 2 minutes with supervision
_____ (2) able to stand for 30 seconds unsupported
_____ (1) needs several tries to stand for 30 seconds unsupported
_____ (0) unable to stand for 30 seconds unassisted

If subject is able to stand 2 minutes safely, score full marks for sitting unsupported. Proceed to position change from standing to sitting.

3. Sitting unsupported feet on floor

Instruction: Sit with arms folded for 2 minutes.

Grading: Mark the lowest category that applies. _____

_____ (4) able to sit safely and securely for 2 minutes
_____ (3) able to sit for 2 minutes under supervision
_____ (2) able to sit for 30 seconds
_____ (1) able to sit for 10 seconds
_____ (0) unable to sit without support for 10 seconds

4. Standing to sitting

Instruction: Sit down.

Grading: Mark the lowest category that applies. _____

_____ (4) sits safely with minimal use of hands
_____ (3) controls descent by using hands
_____ (2) uses backs of legs against chair to control descent
_____ (1) sits independently but has uncontrolled descent
_____ (0) needs assistance to sit

5. Transfers

Instruction: Move from this chair (chair with arm rests) to this chair (chair without arm rests) and back again.

Grading: Mark the lowest category that applies. _____

_____ (4) able to transfer safely with only minor use of hands
_____ (3) able to transfer safely with definite need for hands
_____ (2) able to transfer with verbal cueing and/or supervision
_____ (1) needs one person to assist
_____ (0) needs two people to assist or supervise to be safe

6. Standing unsupported with eyes closed

Instruction: Close your eyes and stand still for 10 seconds.

Grading: Mark the lowest category that applies. _____

_____ (4) able to stand for 10 seconds safely
_____ (3) able to stand for 10 seconds with supervision
_____ (2) able to stand for 3 seconds
_____ (1) unable to keep eyes closed for 3 seconds but stays steady
_____ (0) needs help to keep from falling

7. Standing unsupported with feet together

Instruction: Place your feet together and stand without holding on to any external support.

Grading: Mark the lowest category that applies. _____

_____ (4) able to place feet together independently and stand for 1 minute safely
_____ (3) able to place feet together independently and stand for 1 minute with supervision
_____ (2) able to place feet together independently but unable to hold for 30 seconds
_____ (1) needs help to attain position but able to stand for 15 seconds feet together
_____ (0) needs help to attain position and unable to hold for 15 seconds

The following items are to be performed while standing unsupported.

8. Reaching forward with outstretched arm

Instruction: Lift arm to 90 degrees. Stretch out your fingers and reach forward as far as you can. Examiner places a ruler at end of fingertips when arm is at 90 degrees. Fingers should not touch the ruler while reaching

(continued)

forward. The recorded measure is the distance forward that the fingers reach while the subject is in the most forward-leaning position.

Grading: Mark the lowest category that applies. _____

_____ (4) can reach forward confidently >10 inches
_____ (3) can reach forward >5 inches safely
_____ (2) can reach forward >2 inches safely
_____ (1) reaches forward but needs supervision
_____ (0) needs help to keep from falling

9. Pick up object from the floor

Instruction: Pick up the shoe/slipper that is placed in front of your feet.

Grading: Mark the lowest category that applies. _____

_____ (4) able to pick up slipper safely and easily
_____ (3) able to pick up slipper, but need supervision
_____ (2) unable to pick up but reaches 1–2 inches from slipper and keeps balance independently
_____ (1) unable to pick up, and needs supervision while trying
_____ (0) unable to try, and needs assistance to keep from falling

10. Turning to look behind over left and right shoulders

Instruction: Turn to look behind you over your left shoulder. Repeat to the right.

Grading: Mark the lowest category which applies. _____

_____ (4) looks behind from both sides and weight shifts well
_____ (3) looks behind one side only, other side shows less weight shift
_____ (2) turns sideways only, but maintains balance
_____ (1) need supervision when turning
_____ (0) needs assist to keep from falling

11. Turn 360 degrees

Instruction: Turn completely around in a full circle. Pause. Then turn a full circle in the other direction.

Grading: Mark the lowest category that applies. _____

_____ (4) able to turn 360 degrees safely in <4 seconds each side
_____ (3) able to turn 360 degrees safely one side only in <4 seconds
_____ (2) able to turn 360 degrees safely but slowly
_____ (1) needs close supervision or verbal cueing
_____ (0) needs assistance while turning

12. Count number of times step stool is touched

Instruction: Place each foot alternately on the stool. Continue until each foot has touched the stool four times for a total of eight steps.

Grading: Mark the lowest category that applies. _____

_____ (4) able to stand independently and safely and complete eight steps in 20 seconds
_____ (3) able to stand independently and complete eight steps in >20 seconds
_____ (2) able to complete four steps without aid with supervision
_____ (1) able to complete less than steps, needs minimal assistance
_____ (0) needs assistance to keep from falling/ unable to try

13. Standing unsupported, one foot in front

Instruction: (Demonstrate to subject) Place one foot directly in front of the other. If you feel that you cannot place your foot directly in front, try to step far enough ahead that the heel of your forward foot is ahead of the toes of the other foot.

Grading: Mark the lowest category that applies. _____

_____ (4) able to place foot tandem independently and hold for 30 seconds
_____ (3) able to place foot ahead of other independently and hold for 30 seconds
_____ (2) able to take small step independently and hold for 30 seconds
_____ (1) needs help to step but can hold for 15 seconds
_____ (0) loses balance while stepping or standing

14. Standing on one leg

Instruction: Stand on one leg as long as you can without holding on to an external support.

Grading: Mark the lowest category that applies. _____

_____ (4) able to lift leg independently and hold for >10 seconds
_____ (3) able to lift leg independently and hold for 5–10 seconds
_____ (2) able to lift leg independently and hold for 3 seconds or more
_____ (1) tries to lift leg, unable to hold for 3 seconds, but remains standing independently
_____ (0) unable to try or needs assistance to prevent fall

[a] *From Berg K. Measuring balance in the elderly: validation of an instrument. Dissertation. Montreal, Que.: McGill University, 1993.*

Functional Performance-based and Self-report Balance Assessments

Review what measures are available and the rationale for choosing one over another
Consider Berg, Functional Reach, Tinetti, CB&M and self-reports (e.g. Falls Efficacy Scale or ABC)
See databases of outcome measures listed in* **Course Documents*

Balance Scale (Berg)*:* has content, concurrent, construct and predictive validity in elderly and older patients with stroke. Declining scores are associated with increasing fall risk in the elderly, in a non-linear relationship: a 1-point drop increases the fall risk differently depending on where the score is on the scale i.e. from 54-56 a 1-point drop is associated with a 3-4% increase in fall risk whereas from 46-54, a 1-point drop leads to a 6-8% increase. **Below 36, fall risk is close to 100%** (Shumway-Cook et al., Physical Therapy Vol. 77 p. 812-819, 1997). The scale can detect statistically significant change in these populations; has demonstrated intrarater and interrater reliability; simple to do with few pieces of equipment

Functional Reach: has content, criterion, concurrent and predictive validity for community dwelling elderly or those in inpatient rehab units; limited sensitivity; demonstrates test-retest and intrarater reliability

Tinetti / Performance Oriented Mobility Assessment POMA: It is a screen for balance and mobility skills in older adults. It determines the likelihood of falls (i.e. <19 = increased risk of falls); has good inter-rater reliability.

Community Balance and Mobility Scale (CB&M): (Howe et al, Clin Rehab 2006; Inness et al, Measuring Balance and Mobility after Traumatic Brain Injury: Validation of the Community Balance and Mobility Scale (CB&M) 2011; and the Centre for Outcome Measurement in Brain Injury (COMBI) http://www.tbims.org/combi/cbm/index.html). The CB&M was originally developed for high functioning young and middle-aged adults with traumatic brain injury; however useful for other conditions as well. Has established content, concurrent and construct validity, and inter-, intra-rater and test-retest reliability.

BESTest (Horak et al), The Balance Evaluation and Systems Test (BESTest) to Differentiate Balance Deficits. Phys Ther 2009 Mar 27: Test consists of 36 items, scored on 4-point scale. It is designed to test the following systems: biomechanical constraints, stability limits / verticality, anticipatory postural adjustments, postural responses, sensory orientation, stability in gait
The BESTest may be useful in highlighting a specific area of impairment where more detailed assessment is warranted. It may also highlight areas for focus in treatment and provide ideas for treatment strategies.

Self-reports: These are important to include because decreased confidence or self-efficacy can confound measures of postural performance and it can limit activities in which the client engages leading to further decrease in physical ability

a) **Falls Efficacy Scale (FES)**: good reliability, adequate for assessing balance in frail seniors, but has ceiling effect for higher functioning seniors
b) **Activities – specific Balance Confidence scale (ABC)**: (Myers et al 1998 J Gerontol A Biol Sci Med Sci,) based on FES but includes more situation specific activities, assesses seniors at various levels of functioning, has discriminative and evaluative properties (< 50 is low level, 50-80 is moderate level; >80 is high functioning)

Community Balance and Mobility Scale (CB&M)

The CB&M was originally developed for high functioning young and middle-aged adults with traumatic brain injury; however useful for other conditions as well.

Find the full scale through the Rehabilitation Measures Database:
http://www.rehabmeasures.org/rehabweb/allmeasures.aspx?PageView=Shared
Good information on the CB&M is found at:
http://www.tbims.org/combi/cbm/index.html

Try to find:
- Purpose of the CB&M
- Measurement properties established to date
- Normative values established to date
- Populations for whom the scale is appropriate

Note:
The performance of a person in their 20's, with a normal neuromusculoskeletal system, is the standard to which the patient's performance is compared.

Think about with whom, and for what purpose you might use the Berg Balance Scale vs. CB&M vs other tests listed here. Do they give you similar information?

Appendix

Sensory Strategy Assessment

There is a sensory strategy assessment called the Clinical Test of Sensory Interaction in Balance (CTSIB). It involves assessing the contribution of the proprioceptive, visual and vestibular systems to balance. The patient is observed under several different sensory conditions. The amount of time before the patient must change position of feet, grab with arms or need support is recorded as is the direction and amount of sway. Consider what you might learn from such an assessment.

Role of Attention in Balance Control

Standing and walking while concurrently performing another task is common-place and underlies the performance of most activities of daily living. However, current clinical assessments often focus on evaluating performance of balance in sitting, standing or walking tasks in isolation.

How is a patient's performance influenced if they stand, walk or recover their balance while in the midst of performing another task? Why do you think a change in performance would or would not occur?

How might you assess this in clinical practice?

Dual-task assessment is used to measure the automaticity or conversely the amount of higher level attentional control required of a postural task such as standing, balance recovery from a perturbation or walking.

A postural or locomotor task and a secondary cognitive task (e.g. reaction time test, neuropsychological test) are evaluated when performed separately (single-task) and concurrently (dual-task). Theoretically, if one or both of the tasks did not require attention or was highly "automatic", no change in performance would be seen. Conversely, a decrement in the cognitive task performance under dual-task conditions as compared to when performed alone, would be considered to be a measure of the attentional demands of the primary standing or walking task. Most studies examine the effects of both postural and cognitive tasks, the extent to which either task declined would indicate interference between the attentional processes controlling the two tasks.

Consider also the "Stops walking while talking (SWWT)" test.
The SWWT - whether an individual stopped walking when the health care professional engaged them in talking - was found to be a good predictor of falls among frail institutionalized elderly patients. The findings were not as strongly replicated in the stroke population. However, this test is easy to use in the clinical

environment and may be used as part of a larger battery of balance assessment; it should not be used as a single indicator of fall risk for those with stroke.

Selected references

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