

FLEX CEUs



Balance Outcome Measures - Analysis of Variety of Balance Tests



Introduction	3
Section 1: The Burden of Falls.....	3
Section 1: Clinical application through a case study.....	10
Section 1: Summary.....	11
Section 1: Key Terms.....	11
Section 1: Personal Reflection Question.....	12
Section 2: Standardized Balance Outcome Measures	12
Section 2: Clinical application through a case study.....	28
Section 2: Summary.....	28
Section 2: Key Terms.....	29
Section 2: Personal Reflection Question.....	30
Section 3: Clinical interpretation of balance outcome measures	31
Section 3: Clinical application through a case study.....	34
Section 3: Summary.....	35
Section 3: Key Terms.....	36
Section 3: Personal Reflection Question.....	36
Section 4: Case Studies Revisited.....	36
Section 1: Clinical application through a case study.....	36
Section 2: Clinical application through a case study.....	38
Section 3: Clinical application through a case study.....	40
Conclusion	43



Introduction

For many individuals, maintaining balance is effortless and requires little-to-no energy or thought. The inherent task of remaining upright is not exposed until injury, inflammation, or a disease process causes a disruption in the balance system and leads to balance dysfunction. Physical therapists can play a pivotal role in the rehabilitation of balance dysfunction but will need the tools to adequately identify, quantify, and assess changes to the balance system. This course will identify the catastrophic and cascading effects of balance dysfunction on individuals and society with corresponding risk factors and preventative measures for injurious falls. Furthermore, this course will introduce a variety of balance outcome measures and pertinent findings that are critical in establishing effective treatment techniques and strategies to improve health outcomes and decrease fall risk.

Section 1: The Burden of Falls

Statistics on falls^{1,3,4,9,10,42}

The burden of falls across the lifespan is a major safety concern that affects people worldwide.

- In 2018, more than one in four adults, ages 65 and older, reported a fall in the past year. 10.2% of those falls resulted in an injury, which is known as an injurious fall.
- More frighteningly, an older adult dies every 19 minutes from a fall-related incident. Falls are considered to be the leading cause of fatal injury, the most common cause of nonfatal trauma-related hospital admissions, and the second leading cause of accidental deaths worldwide among older adults.
- Falls result in more than 2.8 million injuries treated in emergency departments annually, including over 800,000 hospitalizations and more than 27,000 deaths.
- Gender may play a role in determining overall fall risk. Women tend to report more falls than men, however, when stratified by age group, the percentages of adults over the age of 85 who report falls do not differ significantly by gender.
- Those who report difficulties with activities of daily living suffer more falls than those without these difficulties.

- Elderly individuals with multiple health impairments are at the greatest risk for falls, but many healthy older adults, without a history of falls, also fall each year.
- The psychological burden of falls in older adults can be equally detrimental as the physiological effects. Falls can lead to temporary or permanent disability, loss of independence, and poor quality of life. Upon sustaining a fall, many individuals develop a fear of falling, which has been well-documented as a factor to increase one's susceptibility for future falls. Consequently, a fear of falling may lead to avoidance of social behaviors and mobility that can further perpetuate the fall-risk cycle.

Financial cost of falls^{1,3,4,9,10}

- The financial and economic cost from injurious falls is substantial and accounts for almost \$50 billion in direct medical costs annually. Injuries from falls are among the 20 most expensive medical conditions in which government-funded programs, such as Medicare and Medicaid, finance about 75% of these costs. As the population continues to age, it is anticipated that there will be as many as 49 million falls, 12 million fall injuries, and almost 100,000 fall-related deaths per year by 2030. The financial burden of falls also extends to other countries as evidenced by the enormous average health system cost per fall injury which ranges from \$1049 to \$3611 in U.S. dollars.
- Interestingly, patient-related falls can significantly affect reimbursement models within specific healthcare settings.
 - Falls are closely monitored by many acute and inpatient facilities due to the fact that current federal payment policies penalize them for certain hospital-acquired conditions, including falls. Unfortunately, this practice is viewed as a well-intended but drastic consequence that jeopardizes health outcomes, including functional mobility and quality of life, during hospital admission and following discharge.
 - As a result, some hospitals and clinics place a low emphasis on mobility programs in an effort to limit patients' risk for falls. Immobility has dire consequences that places patients at higher risk for further medical and functional decline, adverse medical events, and future readmission. Efforts directed towards implementing system-wide policies include early mobilization as standard of care measures in order to avoid such catastrophic effects on functional and health outcomes.

Personal Reflection Question

Have you ever worked in a facility that utilizes an early mobilization program, especially for those in critical care units? If so, what were the expectations regarding early mobilization and how did they affect your decision-making skills as a therapist?

Risk factors for falls^{2,4,5,6,7,8,9,11,26,32,43}

Definition of a fall

A fall is defined as an unexpected event in which someone comes to rest on the ground, floor, or lower level. It usually results from an initial event that forces the body's center of gravity beyond its base of support.

- Events that may precipitate a fall include intrinsic and extrinsic risk factors (Refer to Table 1). If the body is unable to maintain upright posture by identifying and self-correcting errors, then a fall may result.
- Failure to catch oneself may be caused by other complex intrinsic factors such as changes to the somatosensory system, impaired central processing, and neuromuscular weakness.
- Consequently, it is important to note that most falls are multifactorial and may include a culmination of intrinsic, pharmacologic, environmental (extrinsic), behavioral, and activity-related factors.

Risk factors for falls

A current understanding of the etiology of balance problems and falls is emerging in the literature, and many studies support a number of risk factors that can increase one's risk of sustaining a fall.

- There is a significant amount of research that emphasizes the influence of a fear of falling on older adults. A fear of falling has been correlated with activity restriction, decreased physical performance, cognitive function, and diminished quality of life metrics.
- A division of risk factors for falls, reflected in Table 1, may be categorized according to intrinsic and extrinsic causes, as well as modifiable and non-modifiable factors.

- Modifiable risk factors suggest the possibility that one's risk for falling may be modified through specific interventions that are coordinated with an appropriate healthcare provider. Examples may include:
 - Concerns regarding polypharmacy should be addressed with the prescribing physician and/or pharmacist.
 - Visual changes that may or may not be related to advancing age should be discussed with an optometrist or ophthalmologist.
- Non-modifiable risk factors suggest that certain factors that increase the risk for falls may not be modified through treatment or interventions.
- Susceptibility to falls can result from an interaction between any number of these factors.

Table 1 - Risk factors for falls^{2,4,5,6,7,8,9,11,26,32}

	Intrinsic	Extrinsic
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<p>Modifiable</p>	<p>Those who require assistance with activities of daily living</p> <p>Limb proprioceptive and tactile input, visual input, and vestibular input</p> <p>Postural reflexes</p> <p>Muscle weakness/ decreased ankle range of motion</p> <p>Impaired vision</p> <p>Impaired hearing</p> <p>Impaired cognitive function</p> <p>Polypharmacy and/or medications to impair one's level of alertness</p> <p>Fear of falling</p> <p>Gait impairment and/or</p>	<p>Tripping hazards, like cords or rugs</p> <p>Unsecured floor mats and rugs,</p> <p>Lack of non-skid surfaces in bathtubs</p> <p>Cluttered floors without clear pathways</p> <p>Poorly secured handrails on the stairway</p> <p>Slip on shoes or sandals</p> <p>Home entryway</p> <p>Activity level (sedentary lifestyle)</p>
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Non-modifiable	Age Gender (females are more inclined to fall) History of falls Gait impairment Certain chronic conditions (like arthritis) History of depression Polypharmacy Impaired cognitive function	Poor stairway design Inability to add handrails on the stairway Inadequate lighting Slippery floors Home entryway
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Fall prevention efforts

Efforts to prevent falls are also multifactorial in nature and must address the diversity of causes without compromising quality of life and function.

- One proposed solution is increased levels of physical activity, which is supported by the fact that older, healthy adults who engage in physical activity report less falls as compared to those who do not exercise.
 - Physical activity has been proven to effectively reduce the rate of falls and the risk of falls when compared to usual care, and there is evidence that

exercise in community-dwelling older individuals also reduces the fear of falling. Usual care is typically defined as education regarding fall prevention, such as brochures for home modification and safety checklists. While exposing extrinsic fall risk factors is important, healthcare practitioners should understand that a comprehensive fall prevention program should also identify and address intrinsic fall risk factors.

- Some individuals may feel that engaging in physical activity is an unreasonable and unattainable goal due to pre-existing strength, balance, sensory, and gait impairments. Those individuals should be encouraged to seek skilled therapeutic interventions from allied healthcare professions, like physical therapists, who are qualified to identify, quantify, and assess impairments that may contribute to a heightened fall risk. Physical therapists are well-suited to address reduced postural responses, impaired musculoskeletal or neuromuscular systems, deconditioning associated with sedentary behavior, and impaired integration of sensory input that can affect the balance system and contribute to a heightened fall risk.
- Physical interventions are most effective when combined with other multifactorial approaches to fall prevention in which treatments are actively provided to address modifiable risk factors.
 - Other members of the healthcare team can play a valuable role in addressing physical impairments that can contribute to one's susceptibility for falls. Occupational therapists can attend to visual, cognitive, and functional changes that may inhibit participation in personal and household duties. Speech language pathologists may be able to assist with cognitive impairments and decreased insight into functional abilities that can negatively affect one's level of independence.

Initiatives to prevent falls

Many interventions, initiatives, and programs have been established to assist in decreasing fall risk for healthy, older, and active adults.

- Oftentimes, these programs are based upon modifiable risk factors for falls.
- Depending upon the program, most of these initiatives are designed to prevent falls in community-dwelling individuals and are not appropriate for someone who exhibits multiple risk factors for falls or has sustained a recent fall. Consequently,

they may be recommended at an annual wellness visit or suggested following discharge from physical therapy.

Some of these state and federal initiatives are highlighted below:

1. The Centers for Disease Control and Prevention's Stopping Elderly Accidents, Deaths, and Injuries (STEADI) initiative provides a coordinated approach to fall prevention by involving various healthcare providers. Several components of STEADI, based upon evidence-based interventions, are targeted towards increasing muscular strength, improving balance, and reducing medications that increase fall risk. STEADI also includes a recently published coordinated medication plan, known as STEADI-Rx, that encourages pharmacists to partake in fall prevention efforts by identifying older adults who may be at risk for a fall based on the types of medications filled at the pharmacy.^{2,4,8,11}
2. The National Falls Prevention Resource Center created the Free Falls Initiative which is a national effort to address the growing public health concern related to falls, injurious falls, and fall-related deaths. The initiative includes a coalition of over 70 national organizations which include: A Matter of Balance, Bingocize, CAPABLE, Enhance Fitness, FallsTalk, FallScape, Fit & Strong!, Healthy Steps for Older Adults, Healthy Steps in Motion, The Otago Exercise Program, Stay Active and Independent for Life (SAIL), Stepping On, Tai Chi for Arthritis, Tai Chi Prime, Tai Ji Quan: Moving for Better Balance, YMCA Moving for Better Balance, and Evidence-Based Community Falls Prevention Programs Review Council.^{2,4,8,11}

Section 1: Clinical application through a case study

During a community fall screening event, a woman reports one previous fall, use of sleeping pills, a heightened fear of falling, and use of a cane for outdoor ambulation. She also requires assistance to bathe and uses a shower chair to avoid standing.

1. State the intrinsic risk factors that may be contributing to this woman's high susceptibility for falls.
2. Which non-modifiable risk factors are present in this individual?
3. State how a fear of falling may affect this woman's ability to participate or engage in social events.
4. Would this patient be appropriate for a formal physical therapy evaluation or a federal or state initiative program?

Section 1: Summary

- The cost of falls has several implications on the individual, society, and healthcare system. Falls are a significant burden on the healthcare system and amount to billions of dollars each year. Falls can also have catastrophic effects on one's physical, emotional, and cognitive function.
- The risk for falls can be categorized into intrinsic and extrinsic factors, which are further classified by modifiable and non-modifiable factors.
- Statistics have shown that, while the incidence of injurious falls among older adults is declining, the risk for falls remains unchanged despite several factors being amenable to lifestyle and medical modifications. Physical activity has been proven to effectively reduce the rate of falls and the risk of falls when compared to usual care, and there is evidence that exercise in community-dwelling older individuals also reduces the fear of falling.
- There are several well-planned quality initiatives to address fall prevention and sedentary behavior in community-dwelling individuals. They may be recommended by a primary care provider upon one's annual wellness visit or following discharge from physical therapy.

Section 1: Key Terms

- **Fall** - an unexpected event in which someone comes to rest on the ground, floor, or lower level
- **Hospital-acquired conditions** - acquired after hospitalization and not present at time of admission
- **Early mobilization** - refers to the application of physical activity as early as the second day after the onset of critical illness or injury in an attempt to avoid negative health outcomes
- **Intrinsic (fall) risk factors** - Increased susceptibility to falls due to risk factors that are internal to each individual (impaired cognition, vision, etc.,)
- **Extrinsic (fall) risk factors** - Increased susceptibility to falls due to risk factors that are external to each individual (environment, footwear, tripping hazards)
- **Fear of falling** - a lasting concern about falling that can lead an individual to avoid activities that he/she remains capable of performing

- **Modifiable (fall) risk factors** - Increased susceptibility to falls due to risk factors that may be amenable to certain types of treatment or intervention
- **Non-modifiable (fall) risk factors** - Increased susceptibility to falls due to risk factors that cannot be changed or altered by treatment (age, gender, etc.)
- **Polypharmacy** - refers to the use of multiple medications, which is especially common in the older population or those with complex medical diagnoses
- **Stopping Elderly Accidents, Deaths, and Injuries (STEADI) initiative** - a program initiated by the Centers for Disease Control and Prevention to provide a coordinated approach for the implementation of fall prevention services
- **Free Falls Initiative** - a national effort to address the growing public health concern related to falls, injurious falls, and fall-related deaths that includes over 70 coalitions

Section 1: Personal Reflection Question

How do falls affect the healthcare system on a micro and macro level?

Section 2: Standardized Balance Outcome Measures

Physical therapists and physical therapy assistants should possess knowledge regarding standardized balance outcome measures in order to quantify deficits to postural control. Additionally, physical therapists should have a firm understanding of the utility, psychometric properties, and clinical application of various static and dynamic balance outcome measures to enable them to adequately measure and capture change throughout the episode of care. While the review of every available standardized balance outcome measure is beyond the scope of this course, Section 2 will focus on pertinent measures to address static, dynamic, and perceived balance dysfunction.

Components of balance^{27,28,29,38,44,45,46,47}

Balance is the ability to maintain one's center of gravity over a base of support. The ability to maintain one's balance is the result of finely tuned motor output that integrates multimodal sensory input with environmental conditions.

- The balance system arises from vestibular, visual, and proprioceptive input in the body.

- Proprioceptive input, or proprioception, is information obtained through sensory receptors in the skin, muscle and joint receptors that relay information about ankle position sense.
 - When combined with input from the visual system, which provides visual cues regarding one's orientation relative to other objects, these two components of balance can be used in a feedforward mechanism loop to anticipate a loss of balance.
 - The vestibular system is responsible for relaying sensory information with respect to equilibrium, motion, and spatial orientation using information from the inner ear.
- Together, these three components provide valuable information that allow the body to maintain postural control.
 - Postural control, also referred to as postural stability, is an automated task controlled by spinal and cortical structures. Postural stability can be used to describe one's ability to maintain stable posture against gravity during static (non-moving) and dynamic (moving) activities.
 - Poor postural control, also known as postural instability, can result from increased postural sway (movement variability) during static and dynamic tasks. This increase in movement variability has been linked to increased fall risk in older adults.
 - An increase in movement variability can originate from many factors, like the intrinsic risk factors described Section 1, Table 1.
 - Movement variability can also originate from age-related changes to proprioception, vision, vestibular peripheral organs, and muscle mass.
 - Balance also requires adequate range of motion and muscular strength in order to produce effective and efficient motor output that allows one to remain upright against gravity or perturbations.
 - Balance reactions are intrinsic strategies that have been identified as primary modes of postural control during static stance. These three primary strategies are utilized by the body, under various circumstances, in order to maintain upright stance against gravity or perturbations.

- Ankle strategy
 - When the body utilizes the ankle strategy, its center of mass is maintained by muscle contractions that occur from the distal to the proximal portion of the lower body. It has been shown to be the dominant strategy during static stance.
 - This strategy is particularly important when providing stability for balance control. It is frequently affected after a musculoskeletal injury to the ankle in which studies have found decreased and insufficient neuromuscular control at the ankle joint.
 - Other factors that may affect one's ankle strategy include weak ankle dorsiflexors, stiff and passively spastic plantarflexion, and injury within the ankle joint.
- Hip strategy
 - The hip strategy is used under challenging conditions that require increased stabilization from the lower body.
 - Hip strategy is often recruited following an unsuccessful utilization of the ankle strategy.
- Stepping strategy
 - The stepping strategy can be used when ankle and hip strategy are insufficient to maintain balance within the base of support, thus, requiring a step to recover one's equilibrium.
 - However, utilization of this strategy is not always successful as healthy, older adults appear to experience difficulty in controlling stepping reactions. It is common to see individuals require multiple steps in one direction to regain balance.

Personal Reflection Question

What is the difference between postural control, balance, and the balance systems?
How does each one contribute to upright posture and movement?

The importance of measuring balance^{26,27,28,29}

As discussed previously, multiple body systems must extensively coordinate in order to maintain postural control. Therefore, it is imperative to collect information regarding the integrity of the balance system.

- There is strong evidence to support the use of static and dynamic sitting and standing balance assessments, walking balance assessments, self-reported measures, walking speed assessments, and transfer assessments to inform and monitor changes in a specific neurologic construct, such as balance.
- Experts also suggest selecting outcome measures that address each level of the International Classification of Functioning, Disability, and Health.

Introduction to balance impairments

- The multifactorial nature to maintain upright balance predisposes every individual to balance impairments. Changes to the balance systems, whether due to trauma, advancing age, injury, or disease, can create catastrophic consequences for individuals, society, and the health system.
- The variation of balance problems that can incur requires a systematic approach in order to accurately identify the dysfunction.
 - It is important that balance dysfunction is identified in order to halt the cascading effects on function, mobility, and patient perception. Luckily, many balance outcome measures do not require expensive equipment and are feasible to perform by busy clinicians.
 - Additionally, results from outcome measures can indicate the need for skilled therapeutic interventions and/or quantify one's risk for falls. This information may also be used to identify specific components, within the balance system, that may be amenable to treatment.

The subsequent section will identify pertinent categories of balance outcome measures, including:

1. Static balance outcome measures
2. Dynamic balance outcome measures
3. Seated balance outcome measures

4. Patient perception of balance

5. Posturography

Common balance outcome measures

1. Static balance outcome measures^{24,25,37,39}

Static balance outcome measures quantify changes in static “quiet” stance.

“Standing still” is a misleading description of static stance. During static stance, multiple muscles coordinate together to produce miniscule, sustained movements in order to maintain upright balance. In a healthy individual, these miniscule movements are virtually undetectable to the human eye and collectively known as postural sway or movement variability.

- a. The gold standard for measuring postural sway is through a device called posturography. Posturography uses a force plate to quantify metrics of postural sway that may be affected by injury, trauma, disease, or illness.

Static posturography has the ability to assess passive postural sway, which is a measure of one’s response to gravity and the effects of self-imposed corrective movements, also known as balance reactions discussed previously. Posturography will be explored in-depth later in this section.

- b. The ***Modified Clinical Test of Sensory Interaction in Balance (mCTSIB)***^{37,38,39} measures how long a patient can stand in a particular sensory condition as an indirect measure of postural sway.
 - This outcome measure is designed to manipulate the body’s unique utilization of sensory input from the visual, vestibular, and proprioceptive systems. Theoretically, use of all three sensory systems results in the ability to maintain one’s balance, thereby producing minimal amounts of postural sway or movement variability. As the testing continues, each condition manipulates the primary sensory system involved and can expose one’s impairments or over/underutilization of a particular sensory system.
 - The mCTSIB is administered using four increasingly challenging balance conditions:

1. Firm surface, eyes open

2. Firm surface, eyes closed
 3. Eyes open, foam surface
 4. Eyes closed, foam surface
- Each condition is scored on a scale of 0-3 based on one's ability to withstand each condition for 30 seconds, as well as the amount of postural sway present. A higher score indicates adequate stabilization for 30 seconds.
 - The mCTSIB has been validated on various patient populations such as brain injury, Multiple Sclerosis, Parkinson's Disease, geriatrics, vestibular disorders, and stroke.
 - This outcome is based upon the Clinical Test of Sensory Interaction in Balance (CTSIB) and the Sensory Organization Test (SOT), a specific outcome measure that is often included in particular systems of computerized dynamic posturography. Due to its enormous cost associated with use of the posturography platform, many clinics are unable to afford the expenditure and, thus, utilize simpler versions of the SOT, like the mCTSIB, that are more feasible to administer.
 - Normative data for the mCTSIB is highly dependent upon the patient population, however, there are some generalized agreeable findings in the literature. Females usually perform better than males during each testing condition but may have increased postural sway due to age-related changes.

2. Dynamic balance outcome measures

Dynamic balance outcome measures help to quantify an individual's ability to maintain balance while moving.

- a. **Timed up and Go (TUG)**^{15,16,17} is a dynamic measure of balance that consists of basic mobility tasks (standing, walking, turning, sitting) and is a feasible measure to identify a fall risk in a vulnerable population.
 - The TUG is a time-based measure that requires the patient to rise from a chair, walk 3 meters, turn around, and walk back to the chair before sitting down. The timer begins once the patient stands and

stops once the patient is safely seated. Participants are instructed to perform the test at a comfortable walking speed, with or without an assistive device.

- There are several subsets of the test that can test the patient's ability to dual task such as the TUG-Cognitive and TUG-Manual.
 - For functionally impaired individuals in residential care, performance on the TUG can be predictive of falls by using a clinical cutoff score of greater than 35 seconds with a likelihood ratio of 2.6. Participants who can complete the test in less than 15 seconds is indicative of a reduced risk for falls.
 - Many experts question the use of the TUG in solidarity to detect falls in community-dwelling older adults and recommend its use in conjunction with other assessment tools. Clinical cut off score to predict falls in this population is 13 seconds or greater.
 - The TUG has been validated in multiple patient populations including geriatrics, Parkinson's Disease, vestibular, stroke, spinal cord injuries, brain injury, cognitive impairment, and osteoarthritis.
 - The use of the TUG with dual tasking has been widely documented but difficult to appropriately quantify due to an array of mitigating factors that can affect motor and cognitive performance. Dual tasking is a method for assessing one's ability to perform two tasks simultaneously and has been suggested as a justified balance measure to assess fall risk. The added value of dual task balance tasks is useful to classify older adults who may be susceptible to falls due to cognitive impairments.
- b. **Berg Balance Scale (BBS)**^{18,19,20,29} is a widely-used 14-item instrument that assesses static and dynamic sitting and standing balance.
- The test can be administered in 15 to 20 minutes. Each individual item is scored from 0-4 pending the individual's ability to complete each activity. The sum of all items is calculated and scored out of 56 possible points.

- The BBS may also have clinical utility in predicting falls in older adults with a clinical cut off score <45 out of 56. A score of <40/56 is associated with almost 100% fall risk.
 - There is strong evidence to support the use of the BBS for patients with Multiple Sclerosis, Parkinson's Disease, Spinal Cord Injury, stroke, TBI, and vestibular impairments to assess changes in static and dynamic sitting, as well as standing balance.
 - Unfortunately, a recent systematic review calculated clinical cut off scores, ranging from 45-52/56, and found insufficient evidence to recommend the use of the BBS in solidarity to identify individuals who are at a high risk for falls. Experts agree that performance on the BBS should be carefully considered with respect to the patient's age, acuity of impairments, comorbidities, and history of falls.
 - It has excellent test-retest and intra-rater reliability, which makes the BBS a feasible test for clinical use to illustrate change over time.
 - Ceiling and floor effects vary, depending upon patient population and healthcare setting, and can assist in test interpretation. For example, those with high level balance deficits may experience a ceiling effect in which another standardized balance outcome measure should be used to measure change over time.
- c. **The Dynamic Gait Index (DGI)**^{21,29} is a clinical assessment tool to assess an individual's ability to maintain balance while performing gait-related tasks.
- Individual test items are scored on a scale of 0-4, depending on the patient's ability to safely perform each task. Patients may use an assistive device and will be required to walk 20 feet for each test item.
 - Clinical cut off scores below 19/24 in community-dwelling older adults indicate a heightened risk for falls. In patients with vestibular deficits, patients who score below 19/24 are 2.5 times more likely to have reported a fall within the past six months.
 - It has been validated in the following populations: vestibular disorders, stroke, Parkinson's Disease, Multiple Sclerosis, brain injury, and geriatrics.

- Interestingly, the DGI may have informative clinical utility when administered in patients with Normal Pressure Hydrocephalus, as a baseline score greater than 7 was found to be significant in identifying patients who may be appropriate for surgical interventions.
- Most experts recommend careful consideration of patient population when selecting the DGI as a performance-based outcome measure. Its psychometric properties vary based upon condition and disease severity. With respect to quantifying an individual's risk for falls, the DGI should be utilized in combination with other measures. A drawback to the utility of the DGI would be a poor ceiling effect, and caution should be applied when selecting this outcome measure to quantify treatment efficacy in higher functioning adults.
- Interestingly, the Functional Gait Assessment (FGA) was developed as a modification of the DGI. However, in some situations, the FGA may be prioritized over the DGI in lieu of its increased reliability across the recovery spectrum and the inclusion of other gait-related tasks, such as gait with a narrow base of support, gait with vision removed, and backwards ambulation. The FGA has excellent clinical feasibility with excellent internal consistency in individuals with acute and chronic neurologic conditions.

d. **Gait speed as measured by the 10 meter Walk Test (10mWT)**^{29,34,35,36}

- The measurement of gait speed has been frequently referred to as a sixth vital sign due to its significance on mortality, disability, cognition, and overall function. It is recognized as an imperative outcome measure in the assessment of older adults across multiple disciplines.
- There is strong supporting evidence to suggest that use of the 10mWT should be considered in community-dwelling adults, as it is a useful measure to determine their ability to ambulate at various speeds.
- This test requires the patient to ambulate 10 meters, with or without an assistive device, and is measured according to the time it takes for the individual to ambulate the full distance. Results are recorded in

meters per second (m/sec) and can be measured using the patient's comfortable and fast gait speed.

- Meaningful data has been collected for various patient populations including geriatrics, stroke, brain injury, progressive conditions, and spinal cord injury.
- Normative data on gait speed varies according to patient population, age, and health status. In older adults without a history of an acute event, it is recommended to use a clinical cut off score at 1.0m/sec to identify individuals who may be at risk for developing a self-reported mobility disability. Those who ambulate at a gait speed equal to or below 0.6m/sec are at higher risk for reporting a mobility disability.
- For community-dwelling older adults, minimally clinically important difference (MCID) is calculated as .05m/sec and .13m/sec for small and substantial meaningful changes, respectively. It is important to note that values for MCID vary across patient populations, thus, clinicians are cautioned against generalizing results of one patient population to another. By utilizing MCID, as opposed to normative data, clinicians are able to interpret results of the 10mWT as a method to accurately measure change over time.
- With respect to the ability of gait speed to predict mortality and rates of hospital readmission, a reduction in gait speed by 0.1m/sec was found to be associated with a 13% greater risk of readmission to the hospital within 30 days. Mean gait speed, as measured by the 10mWT, in those who are discharged but return for readmission within 30 days is 0.8m/sec, whereas those who are not readmitted ambulate 0.9m/s at discharge.
 - These statistics indicate that a lower gait speed, at hospital discharge, places patients at a higher risk for 30-day readmission.
 - This has been correlated with poor quality of life measures and increased costs for healthcare systems.

- Experts agree that utilizing a standardized testing protocol for the 10mWT will help to achieve generalizability and comparability between tests and within various patient populations.

e. 5 Times Sit-to-Stand test (5xSTS)⁵⁵

- The 5xSTS has been well validated in the literature as a quick assessment of functional lower body strength in older adults. The test involves measuring the fastest time that an individual can stand from a seated position five times in a row.
- In community-dwelling older adults, the clinical cut off score to identify those who may be at risk for falls is 12 seconds or greater.
- It has excellent test-retest reliability and a strong correlation to the TUG and gait speed.
- Older literature has identified the presence of floor and ceiling effects for the following age groups:
 - 60-69 years: 11.4 seconds
 - 70-79 years: 12.6 seconds
 - 80-89 years: 14.8 seconds
- It has been validated for several populations including: stroke, vestibular disorders, pulmonary disorders, Parkinson's Disease, geriatrics, Multiple Sclerosis, Cerebral Palsy, and arthritis.

f. Other standardized dynamic balance outcome measures that may be appropriate, depending on the patient population and setting, include:

- Four Square Step Test
- BESTest
- Fullerton Advanced Balance Scale
- Physical Performance Test
- Short Physical Performance Battery

3. Seated balance outcome measures

- a. **The Tinetti Performance Oriented Mobility Assessment (Tinetti/POMA)^{22,23}** is a performance-based outcome measure that assesses a wide variety of functional movements, including transfers, gait and balance.
- Each individual item scored from 0-3, where a higher score denotes complete independence.
 - Various versions of the POMA are available, including two subscales for separate balance (POMA-B) and gait (POMA-G) tasks.
 - Both versions have been validated for use in several patient populations, but most research has focused on the use of the POMA-B in an older generation.
 - Clinical cut off scores for the POMA-B in older adults range from 10-14 out of 16.
 - In patients with Parkinson's Disease, experts recommend a clinical cut off score of 13/16 to identify non-fallers and 7/16 to identify fallers on the POMA-B.
 - There is excellent test-retest reliability for POMA-B and POMA-G.
 - While the Tinetti/POMA has been a widely-accepted mobility outcome measure for many years, it is best utilized as a screening fall risk measure due to its limited correlation to falls, according to recent literature. Additional evaluative measures, such as the Berg Balance Scale, should be administered to quantify additional risk.
- b. **Functional Independence Measure (FIM)^{30,31}** is an 18-item measure of basic functional tasks, measured across multiple disciplines, and based upon the extent to which a patient requires assistance or compensation to perform functional tasks.
- Subcategories include eating, grooming, bathing, dressing, toileting, control of bowel and bladder, transfers, ambulation, stair climbing, and cognitive domains.

- Typically, the FIM is performed by physical therapists, occupational therapists, and speech language pathologists within an acute or inpatient setting.
 - Each discipline is responsible for generating scores that are applicable to each respective therapy. Scores are compiled for one total score.
 - Individual item scores range from 1 (total assistance) to 7 (complete independence), and a higher total score indicates a greater degree of independence.
 - Its widespread utilization in inpatient facilities has clinical and financial implications. The instrument has excellent psychometric properties with respect to assessing patient disability, and many inpatient rehabilitation facilities are required to document patient scores upon admission and discharge as components of their reimbursement models.
- c. **Motor Assessment Scale trunk subscale (MAS-T)**³¹ is a subscale of the Motor Assessment Scale, which is an eight-item standardized outcome measure related to motor function and muscle tone.
- Each item is individually scored from 0-6, where a higher score indicates higher performance.
 - The trunk subscale assesses the individual's performance during rolling, supine to sit, and balanced sitting.
 - Experts suggest a clinical cut off score of 7.5 (out of 18 possible points) to distinguish between those who can sit and those who cannot sit independently due to inadequate trunk control.
 - The MAS-T is correlated with the FIM-motor subscale as a prognostic indicator for motor recovery.

4. Patient reported outcomes of perception of balance

- a. **Activities-specific Balance Confidence Scale (ABC Scale)**^{14, 29} is a patient-reported outcome that assesses an individual's perception of confidence when performing gait-related tasks.

- It is a 16-item questionnaire in which the patient rates each item based upon his or her confidence on a scale of 0% to 100%. Results are averaged and range from 0% to 100%, which reflects overall perceived confidence.
 - The ABC Scale can distinguish between those who are at risk for falls (clinical cut off score of 58%) and those without a history of falls (clinical cut off score of 81%).
 - Scores between 50-80% indicates moderate level of functioning, whereas a total score greater than 80% is indicative of a high functioning individual who is confident in performing functional activities without loss of balance.
 - These scores can illustrate the effectiveness of physical therapy services when used to measure the patient's perceived ability and balance confidence over time.
 - It has been validated in individuals with acute, chronic, progressive, and stable neurologic conditions.
 - Clinicians are urged to use clinical judgment when administering this self-reported outcome measure due to its intentional ambiguity regarding each test question. Patients are instructed to rate their level of confidence when performing each task, however, they are not provided with any additional information regarding how to respond if they do not engage in a particular activity. Individuals who are recovering from acute condition, who may not have had the opportunity to perform these tasks since the injury, may score poorly whereas individuals with a lack of insight into deficits may overestimate their abilities.
- b. **Falls Efficacy Scale (FES)**^{32,33} consists of 10 items that are individually scored from one to 10. A lower score indicates greater confidence with functional tasks, like reaching and walking around the house.
- In community-dwelling older adults, scores between 16-19 indicate a low self concern regarding falls, whereas scores between 28-64 indicate a high self concern about falls.
 - A score greater than 70 suggests a heightened fear of falling.

- The FES has excellent internal consistency when performed in older adults with cognitive impairments.

5. Posturography^{24,25,57}

- Posturography has been utilized for research paradigms and has gained interest as a useful measure in some clinical settings. It holds value as a method for quantifying postural sway by using a force plate that can measure center of pressure movements.
- Computerized balance platforms are able to measure changes in center of pressure under variable conditions. In older adults, with or without impairments, these measurements can provide valuable information regarding the patient's ability to recover from postural perturbations and may be predictive of future falls.
- A caveat to the use of posturography is its inability to specify which component of the balance system is impaired.
 - Its intended use is to quantify the degree to which postural instability is present.
 - Experts agree that clinical utility of posturography may be better suited as a viable screening measure to identify older adults who are at risk for falls.
 - Also, the cost of a computerized posturography platform often outweighs its benefit, and many smaller clinics are unable to justify the expenditure.

The two types of posturography that are utilized are static platform and dynamic platform posturography.

- a. Static platform posturography involves testing a patient's ability to maintain static stance on a fixed (non-moving) platform.
 - i. Performance is measured by quantifying changes in the patient's center of pressure while the eyes are open and closed.
 - ii. Findings from static platform posturography can also support the hypothesis regarding predictable age-related changes to postural control. Many studies have reported on changes to the three

sensory systems that contribute to balance (visual, vestibular, and proprioception) that are seen with advancing age. Using static outcome measures, like posturography, can help to quantify and affirm these deficits.

- b. Dynamic platform posturography measures the displacement of a patient's center of pressure under dynamic, or moving, conditions which enables the clinician to assess visual, somatosensory, and vestibular system contributions to postural control.
 - i. Some experts rely upon these measures to quantify an individual's response to anticipatory or reactive balance perturbations, whereas others are more interested in the patient's ability to generate and produce adequate amounts of muscle activity to sustain upright stance.
 - ii. During a specific computerized dynamic platform posturography test, referenced earlier in the section as the Sensory Organization Test, a force plate and surrounding platform are utilized to generate six testing conditions. These conditions are designed to be performed in order as Condition 6 is progressively more difficult than Condition 1 (Refer to Table 2).

Table 2 - The Sensory Organization Test (a form of computerized dynamic platform posturography)

Condition	Visual input	Surface	Visual Surround
1	Eyes Open	Stable	Stable
2	Eyes Closed	Stable	Stable
3	Eyes Open	Stable	Sway-Referenced
4	Eyes Open	Sway-Referenced	Stable
5	Eyes Closed	Sway-Referenced	Stable

6	Eyes Open	Sway-Referenced	Sway-Referenced
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Section 2: Clinical application through a case study

During a community fall screening event, a woman reports one previous fall, use of sleeping pills, a heightened fear of falling, and use of a cane for outdoor ambulation. She also requires assistance to bathe and uses a shower chair to avoid standing.

1. Based upon her subjective history, which components of the balance system may be impaired?
2. Should the physical therapist prioritize seated, standing, or walking balance outcome measures?
3. Would you expect this patient to report a higher or lower score on the Activities-specific Balance Confidence Scale?
4. Name three balance outcome measures that would be appropriate to perform for this individual.

Section 2: Summary

- Balance is the result of maintaining one's center of gravity over a base of support due to highly coordinated motor output that integrates multiple forms of sensory information with environmental conditions.
- Collecting information regarding the integrity of the balance systems is valuable in establishing the foundation for treatment and presence of balance impairments. Unfortunately, every individual is susceptible to changes in balance due to trauma, advancing age, injury, or disease. When left untreated, these changes can cause catastrophic effects on the body and overall mobility.
- Comprehensive clinical outcome measures that quantify balance from various perspectives are recommended to identify specific balance impairments.
- Clinicians may choose to administer static assessments for standing balance, dynamic and walking balance outcome measures, functional/performance-based measures, and patient-reported outcomes. Other objective measures of the balance system, collected through posturography, can be useful in quantifying changes to balance to inform clinical practice.

Section 2: Key Terms

- **Balance** - ability to maintain one's center of gravity over a base of support
- **Balance system** - arises from vestibular, visual, and proprioceptive input that is used to maintain postural control.
- **Postural control** - ability to maintain steady upright standing
- **Postural sway** - a complex feedback system that produces sustained oscillatory movement around a fixed posture.
- **Postural instability** - excessive movement or increased movement variability during static and dynamic tasks.
- **Perturbations** - events or situations that affect one's standing balance
- **Proprioceptive** - sense of body position and movement that originates from sensory receptors in the skin, muscle and joint receptors
- **International Classification of Functioning, Disability, and Health** - a classification of health and health-related domains
- **Posturography** - refers to a quantitative method of measuring postural sway that may be affected by injury, trauma, disease, or illness.
- **Passive postural sway** - a measure of one's response to gravity and the effects of self-imposed corrective movements
- **Balance reactions** - self-imposed corrective movements that an individual may utilize against perturbations
- **Sensory Organization Test (SOT)** - a specific outcome measure that is often included in particular systems of computerized dynamic posturography
- **Clinical cutoff score** - scores that differentiate the levels of performance on standardized outcome measures
- **Likelihood ratio** - a method to measure and express diagnostic accuracy of an outcome measure

- **Dual tasking** - a method for assessing one's ability to perform two tasks simultaneously and has been suggested as a justified balance measure to assess fall risk
- **Test-retest reliability** - the degree to which test scores remain unchanged when measuring a stable individual characteristic on different occasions
- **Intra-rater reliability** - a type of reliability assessment in which the same assessment is completed by the same rater on two or more occasions
- **Ceiling effects** - occur when the individual's score(s) cluster toward the high end (or best possible score) of the measure/instrument
- **Floor effects** - occur when the individual's score(s) cluster toward the lowest end (or worst possible score) of the measure/instrument
- **Minimally clinically important difference (MCID)** - scores that reflect changes in a therapeutic intervention that are meaningful for the individual
- **Minimal detectable change (MCD)** - the minimal amount of change that is required to distinguish a true performance change from a change due to variability in performance or measurement error
- **Prognostic indicator** - A situation or condition, or a characteristic of a patient, that can be used to estimate the chance of recovery or recurrence
- **Internal consistency** - a measure based on the correlations between different items on the same test (or the same subscale on a larger test). It measures whether several items that propose to measure the same construct produce similar scores.
- **Static platform posturography** - tests an individual's ability to maintain static stance on a fixed platform, with or without visual input
- **Dynamic platform posturography** - measures the displacement of an individual's center of pressure under dynamic (moving) conditions

Section 2: Personal Reflection Question

Translating research into evidence-based practice can be a challenge for clinicians due to busy caseloads, documentation requirements, and pressure to maintain productivity. However, research can help to inform practice standards by establishing new clinical cut

off scores or normative data for specific patient populations. How would you rate your ability to select appropriate balance outcome measures based upon recommendations from the research? Are there other balance outcome measures that you frequently administer in your clinic? If so, have you recently reviewed any recent publications related to their clinical utility?

Section 3: Clinical interpretation of balance outcome measures

Physical therapists and assistants should understand the importance of utilizing balance outcome measures that are appropriate for each individual by acknowledging the role of functional status, setting, and disease/condition on postural control. In doing so, clinicians are able to select outcome measures based upon psychometric properties and trust that they measure their intended constructs. Furthermore, understanding how to accurately interpret and analyze the findings that result from administering balance outcome measures is critical in order to establish a foundation for treatment, monitor change over time, and improve health outcomes.

Importance of selecting appropriate balance outcome measures^{26,29,40,41}

By selecting the most appropriate balance outcome measures for each patient, the clinician will be able to determine the presence (or absence) of a balance dysfunction.

- Ideally, the physical therapist should select quantitative, norm-referenced outcome measures that assess postural control under various circumstances and are feasible to administer. Norm-referenced outcome measures are assessment tools that allow clinicians to compare the performance of one individual to others who share similar conditions or characteristics.
- The balance outcome measure should be reflective of the patient's functional capability and current postural control.
 - For example, an outcome measure that assesses trunk stability in sitting, like the POMA-B, would not be appropriate for a patient with impairments during standing or walking tasks, which may be better addressed through measures like the TUG, DGI, or FGA.

- Conversely, patients who are non-ambulatory or those who require a significant amount of assistance to stand would not be appropriate for outcome measures that address standing balance or walking speed.
- The balance outcome measure should be able to detect changes in postural control.
 - The ability of an outcome measure to indicate positive finding or condition is a concept known as the sensitivity. In this situation, the balance outcome measure should be sensitive enough to detect changes in the individual's postural control and/or confirm the presence of a balance dysfunction.
 - For example, the 6-Minute Walk Test is an excellent and well-validated outcome measure that identifies changes in one's walking endurance, however, it is not intended to measure the construct of balance. Performing the 6-Minute Walk Test with the intention of identifying changes in postural control would not be an appropriate choice of outcomes to achieve that goal.
- The outcome measure should have reasonable psychometric properties, especially when utilizing measures with normative data for specific patient populations.
 - Psychometric properties refer to the validity and reliability of an outcome measure. Clinicians should ask themselves, "is this outcome measure accurately measuring the individual's balance?" and "is this outcome measure consistently measuring the patient's balance when performed multiple times?" when using specific outcome measures for balance assessments.
 - The outcome measure should be practical to administer with consideration of budget, ease of use, value, and completion time. For example, a clinician may choose to prioritize the TUG over the BBS when selecting a dynamic outcome measure during the initial evaluation due to the differences in completion time.

Importance of accurately interpreting balance outcome measures^{26,29,40,41}

For the purpose of quantifying balance dysfunction, clinicians should consider a plethora of measures that expose different facets of the balance system. Depending upon the patient's abilities, this may include a static assessment of standing balance, dynamic and

walking balance outcome measures, functional/performance-based measures, and patient-reported outcomes.

- Interpreting the results of each balance outcome measure should be performed with several factors in mind:
 1. The psychometric properties of the outcome measure, as well as any normative data, minimal detectable change and minimally clinically important difference measures, and ceiling and floor effects should always be considered.
 2. Supporting evidence regarding the intended use of the outcome measure in specialized populations should always be acknowledged as many results are not generalizable. For example, clinicians should avoid utilizing normative gait speed values in community-dwelling healthy adults for patients recovering from acute cerebrovascular events.
 3. Administering balance outcome measures to assess change over time requires careful documentation of administration protocols in order to accurately replicate testing conditions during future sessions.
 4. Understanding the limitations of each test will enable the clinician to utilize each outcome measure appropriately.
- The ability to accurately interpret information acquired through balance outcome measures will provide a framework for effective treatment and evidence-based strategies to address the primary cause(s) of balance dysfunction. This also highlights the need for a multidisciplinary approach and coordination with other valuable members of the healthcare to comprehensively address underlying medical conditions and behaviors that may exacerbate balance impairments.
- Many experts emphasize the importance of administering and interpreting several types of balance outcome measures in order to make valid conclusions regarding a patient's level of function. Clinicians should avoid using one outcome measure to diagnose a balance impairment and select multiple measures from a variety of constructs including static/dynamic, walking balance, and functional outcome measures.
 - Lusardi et al. (2017) recommends administering three specific outcome measures, the BBS, TUG, and 5 times sit-to-stand, to determine an

individual's risk for falls based upon strong psychometric values. Researchers recommend using the following clinical cutoff scores:

- BBS <50/52
 - TUG >11 seconds
 - 5 times sit-to-stand test >12 seconds
- Interestingly, research has shown that performance-based measures demonstrate a stronger predictability for future falls than standardized medical history screening questions or self-reported measures alone.
 - In situations when a fall screen is warranted, but time and equipment are scarce, experts recommend the following tools:
 - Self-selected walking speed
 - Single limb stance
 - In addition to standardized medical history questions
 - Additionally, performance-based measures allow for the opportunity to observe other underlying factors that may contribute to balance impairments such as lower extremity muscle performance, flexibility and range of motion, and visual deficits that can be addressed through skilled treatment interventions.

Section 3: Clinical application through a case study

During a community fall screening event, a woman reports one previous fall, use of sleeping pills, a heightened fear of falling, and use of a cane for outdoor ambulation. She also requires assistance to bathe and uses a shower chair to avoid standing. Upon seeing her primary care physician, she was recommended for physical therapy.

Upon completion of the evaluation, the patient's objective findings are as follows:

Outcome measure	Result
<i>Berg Balance Scale (BBS)</i>	50 out of 52
<i>Modified Clinical Test of Sensory Integration in Balance (mCTSIB)</i>	12 out of 12

<i>Gait speed (10 meter walk test)</i>	0.8 m/sec with a single point cane
<i>Dynamic Gait Index (DGI)</i>	14 out of 24
<i>Activities-specific Balance Confidence Scale (ABC Scale)</i>	70%

1. Based upon the patient's objective findings, does she have a heightened risk for falls? Which test results support your conclusion?
2. How would you interpret this patient's ability to score 12/12 on the mCTSIB but 14 out of 24 on the DGI?
3. How should a score of 70% on the ABC Scale be interpreted with respect to the patient's functional abilities?
4. How would you expect this patient to perform while ambulating in busy, crowded environments based upon the findings of the objective exam?
5. What treatment interventions should be prioritized for this patient?

Section 3: Summary

- Selecting balance outcome measures for each patient should be based upon individual factors, current functional status, setting, disease/condition, and feasibility of administration.
- The clinician should consider psychometric properties when administering outcome measures to specific patient populations as to avoid misinterpretation and creating invalid conclusions regarding the patient's current functional status.
- Experts recommend administering and interpreting several types of balance outcome measures together before arriving at conclusions regarding a patient's level of function.
- The ability to interpret information obtained through balance outcome measures is important in order to create a framework for effective treatment interventions and evidence-based strategies that will address the primary cause(s) of balance dysfunction. Consequently, an accurate interpretation of the findings can enable

the clinician to confidently document change over time, which may eventually lead to improvements in health outcomes.

Section 3: Key Terms

- **Norm-referenced outcome measures** - outcome assessments that compare an individual's performance to others who share similar conditions or characteristics.
- **Sensitivity** - refers to a outcome measure's ability to indicate positive finding, condition, or disease
- **Psychometric properties** - refers to the validity and reliability of the measurement tool
- **Performance-based measures** - used to evaluate specific components of the individual's performance on specific tasks, including how the task was approached. This can highlight specific impairments which can be addressed during skilled intervention strategies.

Section 3: Personal Reflection Question

Oftentimes, interpretation of outcome measures requires a foundational understanding of psychometric properties. How would you rate your ability to understand normative values, sensitivity/specificity, likelihood ratios, and clinical cut off scores? How would you use these concepts to determine the appropriateness of an outcome measure for use within your clinic's primary patient population?

Section 4: Case Studies Revisited

This section will explore concepts addressed throughout the course and will facilitate a discussion regarding the presented case study and its interpretation. The case study review also includes clinical pearls for selecting appropriate treatment interventions for balance dysfunction based upon the findings and interpretation of the specific balance outcome measures highlighted below.

Section 1: Clinical application through a case study

During a community fall screening event, a woman reports one previous fall, use of sleeping pills, a heightened fear of falling, and use of a cane for outdoor ambulation. She also requires assistance to bathe and uses a shower chair to avoid standing.

1. State the intrinsic risk factors that may be contributing to this woman's high susceptibility for falls.
2. Which non-modifiable risk factors are present in this individual?
3. State how a fear of falling may affect this woman's ability to participate or engage in social events.
4. Would this patient be appropriate for a formal physical therapy evaluation or a federal or state initiative program?

Section 1: REVIEW - Clinical application through a case study

- 1. State the intrinsic risk factors that may be contributing to this woman's high susceptibility for falls.**

Intrinsic risk factors refer to risk factors within an individual that may increase one's proclivity to falls and may include advancing age, history of falls, impaired vision or somatosensation, and changes to cognitive function. Intrinsic risk factors that may contribute to this case include: a history of a previous fall, use of sleeping medications that could increase drowsiness, ambulation with an assistive device, decreased independence with activities of daily living, and a heightened fear of falling.

- 2. Which non-modifiable risk factors are present in this individual?**

Non-modifiable risk factors refer to risk factors that may not be resolved or affected by treatment/interventions. Non-modifiable risk factors in this patient include gender (females are more inclined to fall than males) and a previous history of falls.

- 3. State how a fear of falling may affect this woman's ability to participate or engage in social events.**

A fear of falling has been proven to have detrimental effects. Upon sustaining a fall, many individuals can later develop a fear of falling, which has been well-documented as a factor to increase one's susceptibility for future falls. Consequently, a fear of falling may lead to avoidance of social behaviors and mobility that will further perpetuate the fall-risk cycle.

In this case example, this woman's heightened fear of falling, combined with a previous history of falls and other risk factors, may affect her desire to attend

social outings, drive to new places, or meet friends in locations where she may feel unsteady. This lack of social engagement may eventually affect community ambulation which can have cascading effects on one's self-confidence in overall mobility. If this pattern of behavior continues, then the individual may begin to limit household mobility and engage in sedentary behaviors due to fear of falls and movement. Immobility and a sedentary lifestyle have been well-established in the literature as behaviors that significantly raise one's risk for falls.

4. Would this patient be appropriate for a formal physical therapy evaluation or a national falls prevention program initiative?

Because this patient exhibits multiple risk factors for falls and reports difficulty with activities of daily living, she would be an appropriate candidate for a formal physical therapy evaluation as opposed to participating in an unsupervised falls prevention initiative.

While falls prevention program initiatives are rooted in quality research based upon optimal interventions and techniques to help community-dwelling individuals lower their risk for falls, these programs are not intended to replace individualized therapeutic interventions that can address specific balance impairments. Once the patient has undergone a successful treatment program and has lowered her susceptibility for falls, she may be appropriate to maintain her level of function through a falls prevention program initiative.

Section 2: Clinical application through a case study

During a community fall screening event, a woman reports one previous fall, use of sleeping pills, a heightened fear of falling, and use of a cane for outdoor ambulation. She also requires assistance to bathe and uses a shower chair to avoid standing.

1. Based upon her subjective history, which components of the balance system may be impaired?
2. Should the physical therapist prioritize seated, standing, or walking balance outcome measures?
3. Would you expect this patient to report a high or low score on the Activities-specific Balance Confidence Scale?
4. Name three balance outcome measures that would be appropriate to perform for this individual.

Section 2: REVIEW - Clinical application through a case study

- 1. Based upon her subjective history, which components of the balance system may be impaired?**

Recall from the course material that balance is a complex integration of proprioceptive input with sensory information from the visual and vestibular systems. Based upon the limited information in the clinical scenario, one may reasonably assume that this woman's proprioception may be impaired due her inability to ambulate outdoors without use of an assistive device. In this case, proprioception relays information about ankle position sense that is required for maintaining postural control during gait, especially on uneven surfaces. Ambulating in the community requires stability on various surfaces including grass, gravel, pavement, cobblestone, doorway thresholds, or cement. Impaired proprioceptive input while ambulating on these types of surfaces would significantly contribute to this patient's sense of instability and decreased postural control.

- 2. Should the physical therapist prioritize seated, standing, or walking balance outcome measures?**

Because of her current functional status, the physical therapist should prioritize standing and walking balance measures for this patient. Functional and performance-based outcomes to address standing and walking balance in a variety of ways can allow the clinician to identify deficits in postural control, muscle imbalances, and confidence with movement.

Conversely, seated balance outcome measures should be prioritized in the presence of impaired trunk control which is typically observed in individuals with low functional status, patients who are non-ambulatory, or those following acute events, such as a cerebrovascular event or traumatic brain injury.

- 3. Would you expect this patient to report a high or low score on the Activities-specific Balance Confidence Scale?**

Due to a self-reported heightened fear of falls, this patient would most likely report a low score on the Activities-specific Balance Confidence Scale. Recall from the course material that a lower score indicates low self-confidence when performing activities of daily living.

4. Name three balance outcome measures that would be appropriate to perform for this individual.

Based upon the assumption that this patient would be appropriate for static and dynamic standing and walking balance measures, there are several outcomes that may be feasible to administer. Any performance-based outcome measure that assesses static and dynamic balance should be prioritized. Because her functional capacity includes active mobility and community ambulation, some appropriate tests and measures might include: modified Clinical Test for Sensory Integration in Balance, Berg Balance Scale, Timed Up and Go, Dynamic Gait Index, Functional Gait Assessment, walking speed, and/or 5 times sit-to-stand test.

Section 3: Clinical application through a case study

During a community fall screening event, a woman reports one previous fall, use of sleeping pills, a heightened fear of falling, and use of a cane for outdoor ambulation. She also requires assistance to bathe and uses a shower chair to avoid standing. Upon seeing her primary care physician, she was recommended for physical therapy.

Upon completion of the evaluation, the patient’s objective findings are as follows:

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<i>Dynamic Gait Index (DGI)</i>	14 out of 24
<i>Activities-specific Balance Confidence Scale (ABC Scale)</i>	70%

1. Based upon the patient’s objective findings, does she have a heightened risk for falls? Which test results support your conclusion?
2. How would you interpret this patient’s ability to score 12/12 on the mCTSIB but 14 out of 24 on the DGI?

3. How should a score of 70% on the ABC Scale be interpreted with respect to the patient's functional abilities?
4. How would you expect this patient to perform while ambulating in busy, crowded environments based upon the findings of the objective exam?
5. What treatment interventions should be prioritized for this patient?

Section 3: REVIEW Clinical application through a case study

- 1. Based upon the patient's objective findings, does she have a heightened risk for falls? Which test results support your conclusion?**

Results from these findings indicate that the patient is highly susceptible to falls, especially when engaging in walking-related activities. Her gait speed, with the use of an assistive device, places her below the clinical cut-off score of 1.0 m/sec, which may be indicative of a self-reported mobility disability. Secondly, her score of 14 on the DGI is significantly suggestive of a functional balance impairment that is present when performing gait-related tasks, such as walking with head turns or stepping over objects. While her score of 70% on the ABC Scale is mildly indicative of decreased self-confidence with respect to balance during activities of daily living, the results of these three outcome measures strongly support a heightened risk for falls during mobility.

- 2. How would you interpret this patient's ability to score 12/12 on the mCTSIB but 14 out of 24 on the DGI?**

The mCTSIB is considered to be a measure of static balance, whereas the DGI is a performance-based measure that addresses dynamic balance during gait-related tasks. Recall from the course material that static balance is the ability to maintain upright stance and postural stability within one's base of support. Dynamic balance is the measure of one's ability to maintain postural control while moving in various directions under varying circumstances, including gait. The patient's ability to score highly on the mCTSIB, but poorly on the DGI, is suggestive of adequate static balance but impaired dynamic balance.

Intrinsic risk factors that may contribute to impairments in dynamic balance include: cognitive impairments, impaired visual/vestibular sensory input, decreased proprioception, heightened fear of falling, limited ankle mobility, lower extremity weakness, impaired sensory integration, or slowed postural reactions.

3. How should a score of 70% on the ABC Scale be interpreted with respect to the patient's functional abilities?

The ABC scale is a patient-reported outcome that assesses an individual's perception of confidence with respect to functional activities. Results range from 0% to 100%, and scores between 50-80% indicates moderate level of function.

Interpreting this patient's score within a functional/performance context has several implications. Firstly, when taking this score into consideration along with the patient's DGI and history of falls, the therapist may be inclined to assume that the patient has impaired insight into her functional status and is over-reporting her functional ability. On the other hand, the ABC scale may be too vague to accurately capture the patient's perceived deficits during functional tasks. Lastly, a score greater than 80% is indicative of a high functioning individual who is confident in performing functional activities without loss of balance, which suggests that this patient feels less confident with these specific tasks.

4. How would you expect this patient to perform while ambulating in busy, crowded environments based upon the findings of the objective exam?

The clinician may assume that maintaining postural control while ambulating in busy and crowded environments is characteristic of dual tasking. Clinical outcome measures to assess dual tasking can quantify an individual's ability to perform two tasks simultaneously and have been suggested as a feasible option to assess fall risk.

Because the patient performed poorly on the DGI, which is a dynamic balance outcome measure that assesses performance during gait-related tasks, the clinician should expect the patient to perform poorly while ambulating in crowded and busy environments within the community. Ambulating within crowded areas frequently involves multidirectional stepping, alternating gait speeds, and constantly head movements. Postural instability during these tasks, as supported by the patient's score on the DGI, would heighten the patient's susceptibility for falls.

5. What treatment interventions should be prioritized for this patient?

Findings from multiple balance outcome measures serve to provide a framework for effective treatment and evidence-based strategies in order to address the primary cause(s) of balance dysfunction. According to the results of the patient's

exam, treatment interventions that address her dynamic balance reactions, impaired proprioceptive input, and walking speed should be prioritized. Specifically, clinicians should target exercises that incorporate dual tasking, ambulating under various conditions and surfaces, gait training with the proper assistive device, and neuromuscular re-education to retrain postural control during anticipatory and reactive conditions.

Personal Reflection Question

While not discussed during this course material, screening for fall risk should be included in most physical therapy evaluations, especially for community-dwelling older adults. What are some pertinent screening questions for this patient population?

Conclusion

Every year, injurious falls are responsible for millions of dollars of healthcare costs. Such statistics are the foundation for national fall prevention initiatives, like STEADI and the Free Falls Initiative, in order to identify and address those who may be at risk for falls. Furthermore, quantifying balance impairments through the use of standardized balance outcome measures can also help identify the presence of balance dysfunction and one's susceptibility for falls. Physical therapists can play a crucial role in this process by administering specific outcome measures to assess for changes in postural control.

While maintaining balance appears to be a simple task, it can be immensely difficult for those suffering from balance impairments due to injury, inflammation, or disease. Balance impairments can originate from intrinsic factors, which are further identified as modifiable or non-modifiable factors according to their ability to be addressed through interventions or treatment. Extrinsic fall factors refer to environmental concerns, like tripping hazards, that may increase one's proclivity to falls.

Balance outcome measures are designed to address multiple components of the balance system, which includes proprioceptive input and sensory information from the visual and vestibular systems. These outcome measures can identify impairments in static or dynamic balance under varying conditions and can then be interpreted to create a comprehensive assessment regarding the individual's functional capacity. Accurate interpretation and analysis of these balance measures are critical in order to assure that the clinician is assessing a true reflection of the patient's balance system. These findings can also inform clinical decision-making, skilled interventions, and evidence-based

strategies to improve postural control, decrease fall risk, increase self confidence with functional daily tasks, and improve overall health outcomes.

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