The Assessment and Prevention of Falls

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Children fall often during their first few years of life, but as we age the incidence of falls declines with improvements in our gait pattern, our base of support, and our center of gravity. During the later years of life, however, we enter the same state of unsteadiness that was present during the early years. In the United States, there is one death and 183 emergency department visits for fall-related injuries among older adults every hour.[1] Falls affect people of all races and genders and can often be prevented with the correct interventions. By understanding falls' risk factors, we can implement strategies to reduce their impact and incidence.

Falls have long been examined as a leading cause of hospital admissions in the older population. For adults 65 years old or older, 60% of fatal falls happen at home, 30% occur in public places, and 10% occur in health care institutions.[2] Tinetti has defined a fall as "a sudden, unintentional change in position causing an individual to land at a lower level, . . . other than as a consequence of sudden onset of paralysis, epileptic seizure, or overwhelming force."[3] One of every three adults over the age of 65 meets these criteria each year, and 20-30% of this group suffer moderate to severe injuries including bruises, fractures and head injuries.[4] In 1996 there were 340,000 admissions for patients over 65 year of age with hip fractures, a number that is projected to grow to over 500,000 admissions in 2040.[5] Other common fractures resulting from falls are those of the spine, forearm, leg, ankle, pelvis, upper arm, and hand.[6] Many people who fall, even those without fractures, develop a **fear of falling (FOF),** which increases the likelihood of recurrent falls.[7] FOF is defined as "low perceived self-efficacy at avoiding falls during essential, non-hazardous activities of daily living."[3]

It is important to identify both extrinsic and intrinsic risk factors to address preventive strategies. Extrinsic factors that we can influence are footwear, pathways, and assistive devices. Those at risk for falls should wear shoes with sufficient support to avoid ankle instability, as well as a good quality grip for the ground surface. Clear pathways and appropriately adjusted assistive devices are essential for those at **risk of falling (ROF).** Extrinsic factors that cannot be avoided and require caution include glare, slippery surfaces, or optokinetic effects such as escalators.

Balance tests help to assess the impact of multiple factors.

An intrinsic factor that greatly increases the risk of falling is muscle weakness, especially in the ankle flexors and knee extensors, which produces gait and balance deficits. Abnormal blood pressure, heart rate, and heart rhythms can greatly affect balance and lead to a higher ROF. With some conditions, the ability of reflexes to act appropriately is impaired. The use of multiple medications also increases fall risk, especially more than four medications that include psychotropics, sedatives, antihypertensives, antiarrhymthics or diuretics. Other intrinsic risk factors are arthritis, advanced age (>75), fear of falling, and depression. During a history and physical examination, certain findings are associated with a higher fall risk. Cataracts, macular degeneration, or glaucoma may cause poor vision. If patients complain of arthritis, especially of the foot, a podiatry evaluation may be helpful. Patients with diabetes may have reduced sensory function due to neuropathies, and nerve conduction studies may be indicated. For impaired proprioception, a vitamin B12 level should be checked. A history of a stroke or Parkinson's disease is associated with hip fractures. Bladder dysfunction, especially nocturnal frequency and incontinence, can lead to falls. Anxiety and depression should be addressed with judicious medication management. Orthostatic changes in blood pressure and pulse should lead to a reassessment of medications and an evaluation for dehydration. A brief mental status examination may reveal delirium or dementia. Cardiac findings may require follow-up with an EKG and a Holter monitor. Generalized muscle weakness may be due to thyroid dysfunction. These are a few examples of how a physician's evaluation may help reduce a patient's risk of falls.[8]

Balance tests help to assess the impact of multiple factors. Vision, posture, movement time, strength, **range of motion (ROM)** and the environment are all important when performing a balance test. An ideal balance test should discriminate between who is at risk of falling and who is not. Other criteria for an optimal test include high validity, inter-rater reliability, adaptability, and sensitivity to change.

The Sit To Stand test is a reliable measurement of lower extremity strength that can be utilized as both an outcome measure and a therapeutic exercise. In this timed repetitive test, the patient crosses his or her hands over the chest and goes from sitting in a chair with no arm rests to standing. The patient is timed for 5 repetitions, with average times of 11.4, 12.6, and 14.8 seconds for patients in their sixties, seventies, and eighties, respectively.[9] The test can be modified for frail patients by using a chair with arm rests.

Another reliable test is the Tinetti Assessment, which rates a patient's gait and balance. A score less than 19, out of a maximum of 28, indicates a fall risk. The reliability of the test was demonstrated when agreement was found between two or more professionals on over 85% of test items, and those that did not agree varied by less than 10%.[3, 10]

The Functional Reach test is performed using a yardstick fixed to a tripod. The patient stands next to it with the feet flat on the floor and reaches straight out. Next, the patient leans forward and reaches as far as possible without taking a step or lifting the heels off the floor. The therapist measures the distance of reach with both maneuvers. If the difference is under 6 inches, the patient is at high risk of falling; a difference

of 6-10 inches places a patient in the moderate risk category.[8] Another easily administered and reliable test is the **Timed Up and Go (TUG)** test, in which the patient stands up from a chair with armrests and walks to a target 3 meters away. Assistive devices may be used during this test; and they should be noted in the test results. If an individual takes 14 or more seconds to complete the test, there is a risk of falls. If the subject takes greater than 30 seconds, it indicates that the subject has significant impairments in ADLs.[11]

The **Four-Square Step Test (FSST)** is unique in that it involves stepping over low objects (2.5 cm) and movement in four directions. A pattern of four squares is laid out on the floor, and the patient walks clockwise from one square to the next three and then counterclockwise back to square one, all while facing the same direction. A score greater than 15 seconds is associated with a risk of falls. Although risk assessments are usually performed at outpatient clinics, the Stratify Assessment is an accurate inpatient instrument. The five areas of the test are scored with a 1 if present and 0 if not. These areas include a previous fall resulting in a hospital stay; agitation, visual impairments, high toilet frequency, and impaired transfer/bed mobility status. A score of two or more indicates a risk of falls. The strongest predictors of falling are a previous fall and impaired transfer/bed mobility.

After assessing fall risk, we must focus on preventive strategies. The easiest to prescribe, but often the most difficult to follow, are lifestyle changes such as increasing walking, minimizing caffeine intake (caffeine leads to urinary frequency, causing people to get up at night), treating visual impairments, and maintaining body weight. If a patient weighs less than at the age of 25, the ROF increases due to possible reductions in bone density as well as muscle mass.[8] A patient's diet, especially vitamin intake, can seriously affect the ROF. A double blind study of 122 elderly women in a long term care facility showed that vitamin D supplements added to calcium lowered the ROF and improved musculoskeletal function.[12]

Another intervention is a program to strengthen the lower legs through treadmill walking and resistance exercises of the knees and ankles. It is also important to focus on flexibility. For example, stretching the gastrocnemius and soleus muscles improves ankle plantarflexion, and stretching the tibialis muscles improves ankle inversion and dorsiflexion. Flexibility of the quadriceps and hamstrings for the knee and the hamstrings and iliopsoas for the hip are also important. Other areas that may be improved are coordination and postural stability. Exercises such as bridging, sit to stand, braiding, and forward stepping can aid with coordination. Weight shifting, trunk stabilization, sitting on a balance ball, and exercises that promote trunk rotation can also improve postural stability. These exercises can be performed at home or in a local fitness center, but physical therapy intervention is ideal. A randomized trial of patients after a hip fracture compared a **home exercise program (HEP)** to one supervised by a rehabilitation physical therapist. Compared to the HEP group, the supervised group had better strength, balance, gait speed, physical function, and quality of life.[13]

Another program for patients after a hip fracture is aquatic therapy. The buoyancy of water is ideal for patients with weight-bearing restrictions, severe pain, and postural instability. For instance, in chest-deep water the patient only supports 25% of the body weight.

Balance retraining can decrease the ROF. An optimal approach is to challenge the patient's balance and postural stability by engaging the visual, vestibular, and somatosensory systems. Balance trainer systems provide visual feedback for proper posture and their game-like activities increase patient interaction. These exercises help proprioception, stabilization, range of motion, and weight shifting. Another approach is through Tai Chi, an Eastern exercise with emphasis on balance, weight shifting, coordination, and postural training. Tai Chi has been found to decrease blood pressure, FOF, and the risk of falling.[14]

Education about safe environments is an effective strategy for the home or assisted living community. Clear travel paths and the removal of trip hazards such as appliance cords and throw rugs can minimize falls. Handrails and grab bars ensure a safe path. Educating patients about home adaptations can also be beneficial. In a study of facilities with patients who had fallen, physical therapists and other medical staff provided education on wheelchair and other assistive devices, medical management, gait analysis and an exercise program. Facilities that implemented the program reported a significant decrease in recurrent falls.[12]

Given the aging population, the incidence of falls, and the resulting complications, we must use our professional skill to implement preventive measures in our communities and clinical settings. We must use reliable risk assessment measures, repeat them as a patient's status changes, and then choose the best intervention strategies for each person.

References

1. Stevens J. Falls among older adults-risk factors and prevention strategies. NCOA Falls Free: Promoting National Falls Action Plan. Research Review Papers. 2004. <http://www.healthyagingprograms.org/content.asp?sentionis=69&ElementID=22>.
2. Sorock GS. Falls among the elderly. *Amer J Prevent Med* 1988;4:282-8.
3. Tinetti ME, Speechley M, Ginter SF. Risk Factors for falls among elderly persons living in the community. *NEJM* 1988; 319:1701-7.
4. Tinetti ME. Performance-oriented assessment of mobility problems in elderly patients. *JAGS* 1986; 34:119-26.
5. Centers for Disease Control and Prevention, Falls Among Older Adults: An Overview. Available at heept://www.cdc.gov/ncipc/factsheets/adultfalls.htm. Accessed 09/10/09.
6. Scott JC. Osteoporosis and hip fractures. *Rheum Dis Clin N Amer* 1990; 16::717-40.
7. Vellas B, Wayne S, et al. One-leg balance is an important predictor of injurious falls in older person. *J Am Geriatr Soc* 1997; 45:735-8.
8. Tideiksaar, Rein. *Falling in Old Age Prevention and Management Second Edition*. Springer Publishing Company; 1997; 5:207-11.
9. Susan L Whitney SL, PT, PhD, NCS, FAPTA. Balance and falls: Functional Assessment. APTA 2009.
10. Lewis C. Balance, gait test proves simple yet useful. PT.Bulletin 1993; 2/10:9 & 40.
11. Shumway-Cook A, Woollacott M. *Motor Control Theory and Applications.* Williams and Wilkins Baltimore, 1995: 323-4.
12. Bischoff HA, Stahelin HB, et al. Effects of vitamin D and calcium supplementation on falls. *J Bone Miner Res* 2003;18:343-51.
13. Binder E. Randomized trial-Outpatient physical therapy after hip fracture. *JAMA* 2004;292:837-46.
14. Wolf SL, Barnhar HX, et al. Tai chi and balance training. J Amer Geriatrics Soc 1996;44:489-97.

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Disclosure of Financial Interests

Patricia I. Wolfe, PT, MS,, and Christine Lourenco, SPT, and their spouses/significant others have no financial interests to disclose.

Jon Mukand. Speakers' Bureau: GlaxoSmithKline.

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Hip Fracture Surgical Treatment and Rehabilitation

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Approximately 325,000 people will have a hip fracture each year in the United States.[1] In elderly patients, they result in a one-year mortality rate of 18-33% and in-hospital mortality of 2.7%.[1] Hip fractures are more common in patients with pre-existing cardiac disease, chronic renal failure, diabetes mellitus, stroke, malignancy, and chronic obstructive pulmonary disease,[2] which also are major factors in the recovery process. Many patients experience a significant functional decline and inability to perform **activities of daily living (ADLs).**[1] Therefore, rehabilitation is a vital component of the patient's recovery in order to regain the previous functional level, whether as an independent community ambulatory or a full-assist nursing home resident. Only 14% of hip fracture patients return home after their hospital course;[1] the rest require some level of inpatient rehabilitation.

The population of individuals older than age 65 is expected to grow from 35 million to 77 million between 2000 and 2040.[3] Although hip fracture rates are declining in this age group—due to bisphosphonates, calcium and Vitamin D intake, weight-bearing exercises, and better prevention of falls[4]—the annual number of hip fractures will undoubtedly rise based upon changing demographics.

Clinical Presentation/Work-Up

Hip fracture patients are typically older than age 65, with a mean age of 85.[1] They usually present after a fall with complaints of pain on the affected side and an inability to ambulate. The affected limb is often shortened and externally rotated due to the muscular forces on the fracture fragments. Radiographs confirm the diagnosis, with standard views including an AP Pelvis and AP and lateral of the affected hip. Rarely is a CT or MRI needed to make the diagnosis. MRI can identify occult fractures in the patient with persistent pain and inability to ambulate with normal radiographs.[5] Once the diagnosis has been established, a discussion with the patient, family, and orthopedic surgeon should take place to determine the course of action. Currently, the vast majority of hip fractures are treated operatively with surgical techniques depending upon the fracture pattern. Rarely, in an elderly patient with multiple serious medical co-morbidities, non-operative treatment may provide the best outcome.

Non-operative Management and Rehabilitation

Non-operative treatment involves either early mobilization or a period of bed rest and/or traction followed by progressive weight-bearing. This is usually reserved for two subsets of patients. First, for patients with severe co-morbidities, the risks of the procedure and anesthesia outweigh the benefits. Second, for patients who are non-ambulatory or bedridden at baseline, fracture fixation will not improve their ambulatory status. Nevertheless, some centers prefer to operate on this population for improved pain control. Because about 90% of hip fractures are

Figure 1.

Figure 2.