

Balance and Falls in Older Adults

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3 contact hours - \$24

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If you are an occupational therapist or OT Assistant, you will need to know the following:

Target Audience: Occupational therapists, OTAs

Instructional Level: Intermediate

Content Focus:

Category One: Domain of OT: Activity Demands, Performance Skills

Category Two: Occupational Therapy Process: Intervention

Course Description

This course builds on basic knowledge of epidemiology and anatomy, adding a clinical perspective to assessment of falls and fall prevention in older adults. It outlines successful strategies for reduction of falls in the community-dwelling older adults and describes interventions that have been shown to improve balance and reduce the risk of falls.

Course Objectives

When you finish this course you will be able to:

- Provide definitions for balance, postural control, and falls.
- Describe the incidence of falls in the United States and their medical consequences.
- Relate the effects of polypharmacy on the incidence of falls in hospitals and nursing homes.
- Summarize the factors that increase fall risk in older adults.
- Outline interventions that have been shown to improve balance and reduce the risk of falls in older adults.
- Discuss the main components of a balance assessment.
- Discuss the sensory systems that contribute to balance and how sensory dysfunction affects balance.
- Summarize age-related changes that affect balance.

Balance and Posture Control

As healthcare professionals we see many clients with balance problems, whether from post-surgical weakness, illness, neurological disorders, or injury. Assessing and treating a balance disorder and decreasing the risk of future falls requires knowledge of medications, sensory and musculoskeletal systems, and age-related changes and cognitive changes. All of these factors have been shown to affect balance and falls in one way or another.

Balance is the ability to maintain your center of mass over your base of support. It's a seemingly simple skill and one we take for granted in our daily lives. But balance is a complex topic— involving multiple systems that interact flawlessly and automatically to coordinate input from the environment and the central nervous system. Postural control is related to balance—it is the ability to maintain the segments of our body in relation to one another and to maintain stability and orientation in space (Shumway-Cook and Woollacott, 2007).

When we lose our balance, we fall. This seems like a simple way to look at things but defining the term “fall” is more problematic than defining balance. As many of you know from working in healthcare settings, different definitions are used. Accidental falls, falls caused by equipment, or falls to a chair or bed may not be counted in facility statistics.

Fall prevention researchers run into the same problem as clinicians in their effort to define falls. In a recent review of 90 publications dealing with fall prevention interventions, 44 had no definition of the term fall and of the remainder, no definition stood out as a gold standard (Hauer et al, 2006). In the studies that included a definition, falls were defined using a combination of mechanical, behavioral, medical descriptions. There was agreement that a fall occurs when a person comes to rest at a lower level but the description of that level varied. In most of the studies, falls attributed to acute medical events or external force (such as a collision) were excluded or characterized as an accident (Hauer et al, 2006).

In their excellent book *Motor Control: Translating Research into Clinical Practice*, Anne Shumway-Cook and Marjorie Woollacott describe a fall as “an unplanned and unexpected contact with a supporting surface” (Shumway-Cook and Woollacott, 2007). But they differentiate between the research and clinical setting. In a clinical setting a fall is usually defined as a fall to the floor or “coming to rest at a lower level”. In the research setting, in order to protect the subject from injury, a fall is often defined as “a movement of the center of gravity outside the base of support”.

An agreement on what defines a fall is needed in both clinical and research settings. The Prevention of Falls Network Europe and Outcomes Consensus Group, among others, have suggested a comprehensive definition of falls: “an unexpected event in which the participant comes to rest on the ground, floor, or lower level”. They stress that any definition should:

- Be simple
- Be understood reliably by lay people, who document their own falls
- Include time, location, and activity when documented by staff (Hauer et al, 2006).

In an attempt to address this issue, the National Database of Nursing Quality Indicators defined a fall as “an unplanned descent to the floor (or extension of the floor, e.g., trash can or other equipment) with or without injury to the patient.” They further state when staff members “attempt to minimize the impact of the fall by easing the patient's descent to the floor or in some manner

attempting to break the patient's falls" the event is classified as an "assisted fall" (Hook and Winchel, 2006).

In 2005 the Joint Commission added the goal of "reducing the risk of patient harm resulting from falls" to its 2005 JCAHO National Patient Safety Goals and renewed the goal in 2007 and 2008. The goal includes a mandate to implement a fall reduction program including an evaluation of the effectiveness of the program (Joint Commission, 2008).

Epidemiology

Incidence and Cost of Falls in the United States

A fall can significantly limit the ability of an older adult to remain self-sufficient. More than one-third of people aged 65 and older fall each year, and those who fall once are two to three times more likely to fall again. Fall injuries are responsible for significant disability, reduced physical function, and loss of independence. In 2000, direct medical costs for fall injuries totaled \$19 billion. In recent years, systematic reviews of fall intervention studies have established that prevention interventions can reduce falls (Stevens and Sogolow, 2008).

The rates of fall-related deaths among older adults rose significantly over the past decade. Among older adults, falls are the most common cause of nonfatal injuries and hospital admissions for trauma. In 2005:

- 15,800 people 65 and older died from injuries related to unintentional falls.
- About 1.8 million people 65 and older were treated in emergency departments for nonfatal injuries from falls.
- More than 433,000 of these patients were hospitalized (CDC, 2008).

Of the nonfatal injury costs, 63% (\$12 billion) were for hospitalizations, 21% (\$4 billion) were for emergency department visits, and 16% (\$3 billion) were for treatment in outpatient settings (CDC, 2007).

Medical expenditures for women—who made up 58% of the older adult population in 2000—were two to three times higher than for men for all medical treatment settings. Fractures accounted for just 35% of nonfatal injuries but 61% of costs. Fall-related injuries among older adults, especially among older women are associated with substantial economic costs. The magnitude of this economic burden underscores the critical need to implement cost-effective fall interventions (CDC, 2007).

According to CDC, men are more likely to die from a fall. After adjusting for age, the fall fatality rate in 2004 was 49% higher for men than for women. Women are 67% more likely than men to have a nonfatal fall injury. Rates of fall-related fractures among older adults are more than twice as high for women as for men. In 2003, about 72% of older adults admitted to the hospital for hip fractures were women (CDC, 2008).

The risk of being seriously injured in a fall increases with age. In 2001, the rates of fall injuries for adults 85 and older were four to five times that of adults 65 to 74. Nearly 85% of deaths from falls in 2004 were among people 75 and older. People 75 and older who fall are four to five times more likely to be admitted to a long-term care facility for a year or longer (CDC, 2008).

There is little difference in fatal fall rates between whites and blacks from ages 65 to 74. After age 75, white men have the highest fatality rates, followed by white women, black men, and black women. White women have significantly higher rates of fall-related hip fractures than black women. Among older adults, non-Hispanics have higher fatal fall rates than Hispanics (CDC, 2008).

Medical Consequences

Twenty percent to 30% of people who fall suffer moderate to severe injuries such as bruises, hip fractures, or head traumas. These injuries can make it hard to get around and limit independent living and can increase the risk of early death. Falls are the most common cause of traumatic brain injuries (TBI); in 2000, TBI accounted for 46% of fatal falls among older adults (CDC, 2008).

Most fractures among older adults are caused by falls; the most common fractures are of the spine, hip, forearm, leg, ankle, pelvis, upper arm, and hand. Those who fall, even those who are not injured, develop a fear of falling. This fear may cause them to limit their activities, leading to reduced mobility and physical fitness, and increasing their actual risk of falling (CDC, 2008).

A review of 33 studies that looked at fear of falling (FOF) in community-dwelling older adults found that FOF is widespread with both those who have a history of falls and those who had not yet experienced a fall (Scheffer et al, 2008). The main risk factor for developing a fear of falling was a previous fall. Several studies showed fear of falling increasing with age and more prevalent in women than men. Other risk factors for developing a fear of falling included:

- Dizziness
- Self-rated health status
- Depression
- Gait and balance disorders (Scheffer et al, 2008)

More than 95% of hip fractures among adults ages 65 and older are caused by falls. These injuries can cause severe health problems and lead to reduced quality of life and premature death. In 2003, there were more than 309,500 hospital admissions for hip fractures. From 1993 to 2003, the number of hip fracture hospitalizations increased 19%, from 261,000 to 309,500 (CDC, 2008).

After adjusting for the increasing age of the U.S. population, the hip fracture rate decreased 14%, from 901 per 100,000 population in 1993 to 776 per 100,000 population in 2003. In 1990, researchers estimated that the number of hip fractures would exceed 500,000 by the year 2040 (CDC, 2008).

As many as 20% of hip fracture patients die within a year of their injury. Most patients with hip fractures are hospitalized for about one week. Up to 25% of adults who lived independently before their hip fracture have to stay in a nursing home for at least a year after their injury. In 1991, Medicare costs for hip fractures were estimated to be \$2.9 billion (CDC, 2008).

Women sustain about 80% of all hip fractures; in 2003, 72% of hip fracture hospitalizations were among women. Among both sexes, hip fracture rates increase exponentially with age.

People 85 and older are 10 to 15 times more likely to sustain hip fractures than are people ages 60 to 65. People with osteoporosis are more likely to sustain a hip fracture than those without this condition (CDC, 2008).

Falls in Hospitals and Nursing Homes

In 2003, 1.5 million people 65 and older lived in nursing homes. If current rates continue, by 2030 this number will rise to about 3 million. Each year, a typical nursing home with 100 beds reports 100 to 200 falls, many of which go unreported. As many as 3 out of 4 people in nursing homes fall each year, which is twice the rate of falls for older adults living in the community. Patients often fall more than once; the average is 2.6 falls per person per year. About 35% of fall injuries occur among residents who cannot walk. Although only 5% of adults 65 and older live in nursing homes they account for about 20% of deaths from falls in this age group (CDC, 2008).

Physical Restraints

Physical restraints have been used in nursing homes and hospitals both as a safety device and as a falls prevention tool. Because restrained patients cannot arise from a chair or transfer out of bed, they theoretically will not fall or, in the case of bedrails, will not roll out of bed. However, the use of physical restraints may lead to substantial adverse outcomes. In fact, serious injuries and even death have been reported with use of these devices (AHRQ, 2001).

Several studies have revealed no statistically significant difference in falls compared with historical controls when bedrails are removed. In fact, restrained patients appear to have a modest increase in fall risk or fall injuries based on several studies (AHRQ, 2001). In one study of 251 patients in 4 urban nursing homes bed alarms, transfer poles, floor mats, and low beds were used in the place of bed side rails. The reduction in side rail use did not result in increased falls (Magaziner et al, 2007).

The use of physical restraints is not always a clear picture. In a study conducted over 4 years in Sweden a restraint was defined as anything that inhibits a person's movement, no matter what the purpose of the item. The study noted a significant correlation between fall risk and the use of wheelchairs, bed rails, and safety belts. A correlation was also noted between the use of belts and neuroleptics, sedatives, benzodiazepines, and antidepressants (Fonad et al, 2008).

Medication and Falls

It has been well-established that polypharmacy is a risk factor for falls. In 1994 Tinetti studied multiple-modifiable risk factors and the effects of multifactorial interventions on the risk of falling among community-dwelling elder adults (Tinetti, 1994). The study used physicians, nurse practitioners, and physical therapists to examine these risk factors:

- postural hypotension;
- use of sedatives;
- use of at least four prescription medications; and
- impairment in arm or leg strength or range of motion, balance, ability to move safely from bed to chair or to the bathtub or toilet (transfer skills), or gait (Tinetti, 1994).

In the intervention group a reduction in the proportion of subjects who fell and in the incidence of falls was noted. The subjects in the intervention group also reported fewer injuries and fewer episodes of medical care associated with falls. The greatest difference between the control and intervention groups was noted in those with balance and transfer impairments and those taking 4 or more prescription medications. Several physicians participating in the study reported an increased awareness of the effects of postural hypotension and the relationship of medications to fall risk (Tinetti, 1994).

What is less known is that fall risk increases significantly in the days after a medication is changed. In October 2004, researchers at Johns Hopkins University studied the effect of medication changes on the risk of falls among residents of three nursing homes who fell during 2002–2003. The study looked at medication changes that occurred 1 to 9 days before the fall including the odds ratio of falling after a start, stop, or dose change in medication in the case time period versus the control time period (CDC, 2007).

The results indicated that the short-term risk of single and recurring falls may triple within two days after a medication change. Study outcomes may be used to develop similar fall risk studies in other clinical settings; identify high-risk times for falls depending on medication changes; and to develop intensive, short-term interventions for vulnerable residents after medication changes (CDC, 2007).

The risk of falls from polypharmacy is especially associated with certain classes of medications. These include:

- Hypnotics
- Sedatives
- Analgesics
- Psychotropics
- Antihypertensives
- Laxatives
- Diuretics
- Changes in medications (CDC, 2007)

Fall Risk in the Older Adults

The American Geriatrics Society Panel on Falls Prevention note that multiple risk factors are associated with falls in the older adults. Risk factors can be classified as intrinsic (weakness, cognitive impairment, visual dysfunction) or extrinsic (polypharmacy). In a review of 16 studies the most common risk factors for falls were identified:

- Muscle weakness
- History of falls
- Gait deficit
- Balance deficit
- Use of assistive device
- Visual deficit
- Arthritis
- Impaired ADL
- Depression
- Cognitive impairment
- Age >80 years (American Geriatrics Society, 2001)

Agencies such as the US Department of Veterans Affairs list the following factors, which if present, set into action a series of fall prevention assessments and interventions:

- Agitation/delirium
- Medication timing and dosing
- Orthostatic hypotension, autonomic failure
- Frequent toileting
- Impaired mobility
- Impaired vision, inappropriate use of assistive devices or footwear
- History of falls
- Psychotropics, digoxin, type 1A antiarrhythmic, diuretic (thiazides > loop diuretics)
- Antihistamines/benzodiazepines: withdrawal has shown decrease in falls risk
- Antidepressants: tricyclics higher risk than SSRI, but SSRI's have risk as well, high level of phenytoin; low dose amitriptyline affects gait
- Drugs treating nocturia (USDVA, 2007)

In the VA system, nursing fall risk assessment, diagnoses, and interventions are based on use of the Morse Fall Scale (MFS). The MFS is used widely in acute care settings, both in hospital and long term care inpatient settings. The MFS (See Tables 1 and 2) requires systematic, reliable assessment of a patient's fall risk factors upon admission, fall, change in status, and discharge or transfer to a new setting (USDVA, 2007).

1. History of falling; immediate or within 3 months	No = 0 Yes = 25
2. Secondary diagnosis	No = 0 Yes = 15
3. Ambulatory aid	None, bed rest, wheel chair, nurse = 0 Crutches, cane, walker = 15 Furniture = 30
4. IV/heparin lock	No = 0 Yes = 20
5. Gait/transferring	Normal, bed rest, immobile = 0 Weak = 10 Impaired = 20
6. Mental status	Oriented to own ability = 0 Forgets limitations = 15

Risk Factor	MFS Score	Action
No risk	0–24	None
Low risk	25–50	Initiate standard fall prevention interventions
High risk	= 51	Initiate high risk fall prevention interventions

Interdisciplinary Interventions

A number of studies have shown the benefits of interdisciplinary interventions to reduce the risk of falls in the community-dwelling older adults, a practice that is becoming commonplace. A breakthrough 1994 study by Yale researcher Mary Tinetti, MD, used a combination of intervention strategies based on an assessment of each participant's fall risk factors. Results of the 3-month study indicated that participants were about 30% less likely to fall compared with people who did not receive the intervention (Stevens and Sogolow, 2008).

Key elements of the study involved linking the assessments to the intervention components. Assessment responsibilities were divided between a nurse practitioner and a physical therapist (see Table 3).

Table 3. Yale FICSIT (Frailty and Injuries: Cooperative Studies of Intervention Techniques) (Stevens and Sogolow, 2008)	
Risk Factor	Intervention
Assessed by a nurse practitioner:	
Postural hypotension	<ul style="list-style-type: none"> • Behavioral modifications such as elevating the head of the bed and using ankle pumps • Changes in medications
Use of sedative-hypnotic medication	<ul style="list-style-type: none"> • Education • Discontinued medications • Non-pharmacological alternatives
Use of 4+ prescription medication	<ul style="list-style-type: none"> • Reviewed medications with primary physician • Final decision on changes made by physician
Inability to transfer safely to bathtub or toilet	<ul style="list-style-type: none"> • Training in transfer skills • Home modifications (installing grab bars, raising toilet seat)
Environmental hazards	<ul style="list-style-type: none"> • Home modifications (removing rugs, installing rails)
Assessed by a physical therapist:	
Gait impairments	<ul style="list-style-type: none"> • Gait training • Use of assistive devices • Balance training • Strength exercise
Impairments in transfer skills or balance	<ul style="list-style-type: none"> • Training in transfer skills • Home modifications • Progressive balance exercises
Impairment in leg or arm strength, range of motion	<ul style="list-style-type: none"> • Progressive strength exercises • Exercises performed 10–20 minutes per day

Interventions to Improve Balance and Reduce Falls: Fall Prevention Programs

A compendium of exercise-based interventions completed for CDC by Stevens and Sogolow (2008) reviewed 6 programs that targeted community-based interventions for the prevention of falls. The report gathered information about science-based fall prevention intervention studies that met the following criteria:

- Included community-dwelling adults aged 65 and older
- Used a randomized controlled study design
- Measured falls as a primary outcome (did not include intervention studies using other outcomes, such as balance improvement or reduced fear of falling)
- Demonstrated statistically significant positive results in reducing older adult falls (Stevens and Sogolow, 2008)

Exercise-Based Interventions

Stay Active, Stay Fit

This Australian study used weekly structured group sessions of moderate-intensity exercise, held in community settings, with additional exercises performed at home. Participants were 40% less likely to fall and one-third less likely to suffer a fall-related injury compared with those who did not receive the intervention. Participants were individuals at risk for falling because of lower limb weakness, poor balance, or slow reaction time. All were aged 67 or older and lived in the community. About two-thirds of participants were female (Stevens and Sogolow, 2008).

In this study the classes were designed by a physical therapist to address physical fall risk factors: balance and coordination, strength, reaction time, and aerobic capacity. Each class began with 5 to 10 minutes of warm-up that included stretching of the major lower limb muscle groups and 10 minutes of cool-down that included gentle stretching, relaxation, and controlled-breathing practice. Each class included music chosen by the participants. The classes included the following types of exercises:

- Balance and coordination exercises, including modified Tai Chi exercises, practice in stepping and in changing direction, dance steps, and catching and throwing a ball.
- Strengthening exercises, including exercises that used the participant's weight (e.g., sit-to-stand, wall press-ups) and resistance-band exercises that worked both upper and lower limbs.
- Aerobic exercises, including fast-walking practice with changes in pace and direction (Stevens and Sogolow, 2008).

As the classes progressed, the complexity and speed of the exercises and the resistance of the bands were steadily increased. Participants also took part in a home exercise program using content from the exercise class and recorded their participation in a home exercise diary (Stevens and Sogolow, 2008).

The Otago Exercise Program

This intervention, tested in four randomized controlled trials and one controlled multi-center trial, was an individually tailored program of muscle-strengthening and balance-retraining exercises of increasing difficulty, combined with a walking program. This extensively tested fall prevention program is now used worldwide. Overall, the fall rate was reduced by 35% among program participants compared with those who did not take part. The program was equally effective for men and women. Participants aged 80 years and older who had fallen in the previous year showed the greatest benefit (Stevens and Sogolow, 2008).

The program was conducted in participants' homes and was intended for people who did not want to attend, or could not reach, a group exercise program or recreation facility. A physical therapist or nurse visited each participant four times at home over the first 2 months (at weeks 1, 2, 4, and 8) and visited again for a booster session at 6 months. To maintain motivation, participants were telephoned once a month during the months when no visits were scheduled. The first home visit lasted an hour; all subsequent visits took about half an hour. During the visits, the PT or nurse prescribed a set of in-home exercises (selected at appropriate and increasing levels of difficulty) and a walking plan (Stevens and Sogolow, 2008).

The exercises included:

- Strengthening exercises for lower leg muscle groups using ankle cuff weights.
- Balance and stability exercises such as standing with one foot in front of the other and walking on the toes.
- Active range of motion exercises such as neck rotation and hip and knee extensions (Stevens and Sogolow, 2008).

Participant safety was ensured by tailoring the exercise program and by giving participants instructions and an illustration for each exercise. The exercises took about 30 minutes. Participants were encouraged to complete the exercises three times a week and to walk outside the home at least two times a week. Exercises then were continued on an ongoing basis. In three trials, the exercise program was prescribed for 1 year and in one trial was extended to 2 years. The program was delivered by either a PT experienced in prescribing exercises for older adults, or a nurse who was given special training and received ongoing supervision from a PT (Stevens and Sogolow, 2008).

Tai Chi: Moving for Better Balance

This Portland, Oregon study compared the effectiveness of a 6-month program of Tai Chi classes with a program of stretching exercises. Participants in the Tai Chi classes had fewer falls and fewer fall injuries, and their risk of falling was decreased 55 percent. Participants were inactive seniors aged 70 years or older. Three-quarters were female. All participants lived in the community (Stevens and Sogolow, 2008).

The program included 24 Tai Chi forms that emphasized weight shifting, postural alignment, and coordinated movements. Synchronized breathing aligned with Tai Chi movements was integrated into the movement routine. Each session included instructions in new movements as well as review of movements from previous sessions.

Each practice session incorporated musical accompaniment. Each hour-long session included:

- A 5- to 10-minute warm-up period.
- Practice of Tai Chi movements.
- A 5- to 10-minute cool-down period (Stevens and Sogolow, 2008).

Practicing at home was encouraged and monitored using a home-practice log. One-hour classes were held three times a week for 26 weeks, followed by a 6-month period in which there were no organized classes (Stevens and Sogolow, 2008).

Australian Group Exercise Program

This study evaluated a 12-month group exercise program for frail older adults. The program was tailored to each participant's abilities. Overall, the fall rate was 22 percent lower among people who took part in the program, and 31 percent lower among participants who had fallen in the previous year, compared with those who were not in the program. Ages ranged from 62 to 95, although nearly all were 70 years or older. Most study participants were female. Participants lived in retirement villages and most were independent (Stevens and Sogolow, 2008).

The program consisted of four 3-month terms. The first term included understanding movement, how the body works, training principles, and basic exercise principles. This was followed by progressive strength training and increasingly challenging balance exercises, using equipment to maintain interest. In each term, the exercise sessions built on the skills acquired in the previous term (Stevens and Sogolow, 2008).

Each hour-long class had three segments:

- A 5- to 15-minute warm-up period that included chair-based activities, stretching large muscle groups, and later in the program, slow to moderate walking.
- A 35- to 40- minute conditioning period that included aerobic exercises, strengthening exercises, and activities to improve balance, hand-eye and foot-eye coordination, and flexibility. As the program progressed, the number of repetitions of each exercise increased, beginning with 4 repetitions at week 2 and reaching 30 by week 10. Thirty repetitions were maintained for rest of the program.
- A 10-minute cool-down period that included muscle relaxation, controlled breathing, and guided imagery (Stevens and Sogolow, 2008).

One-hour classes were held twice a week for 12 months. The program consisted of four successive 3-month terms (Stevens and Sogolow, 2008).

Veterans Affairs Group Exercise Program

This study evaluated a structured group exercise program for fall-prone older men. During the 3-month program, participants were two-thirds less likely to fall compared with those who did not take part in the program. All participants were aged 70 or older and lived in the community. All were males who had at least one of these fall risk factors: leg weakness; impaired gait, mobility, or balance; and had fallen two or more times in the previous 6 months. The study calculated the fall rate as the number of falls per hour of physical activity (Stevens and Sogolow, 2008).

The program was conducted at a Veterans Affairs ambulatory care center. Strength training included hip flexion, extension, abduction, and adduction; knee flexion and extension; squats, dorsiflexion, and plantar flexion. Over the first 4 weeks, participants increased each exercise from one to three sets of 12 repetitions. Resistance levels also were increased progressively. The rate of progression was modified for subjects with physical limitations (Stevens and Sogolow, 2008).

Endurance training used bicycles, treadmills, and indoor walking sessions. Endurance training alternated between cycling (once a week), using a treadmill (twice a week), and indoor walking that included a walking loop as well as two flights of stairs (twice a week). Heart rates were monitored to ensure that participants did not exceed 70 percent of their heart rate reserve (Stevens and Sogolow, 2008).

Balance training used a rocking balance board, balance beam, obstacle course, and group activities such as balloon volleyball and horseshoes. Balance training sessions were held twice a week and increased in difficulty over the 12-week program (Stevens and Sogolow, 2008).

Simplified Tai Chi

This study compared a 15-week program of Tai Chi classes that used 10 simplified movements, with a balance training program. After 4 months, the risk of falling more than once among participants in the Tai Chi classes was almost half that of people in the comparison group. Participants reported that after the study they were better able to stop themselves from falling by using their environment and appropriate body maneuvers. After the study ended, almost half the participants chose to continue meeting informally to practice Tai Chi. All were 70 years or older and lived in the community. Most study participants were female (Stevens and Sogolow, 2008).

Participants were taught a simplified version of Tai Chi. The 108 existing Tai Chi forms were synthesized into a series of 10 composite forms that could be completed during the 15-week period. The composite forms emphasized all elements of movement that generally become limited with age (Stevens and Sogolow, 2008).

Exercises systematically progressed in difficulty. The progression of movements led to gradually reducing the base of standing support until, in the most advanced form, a person was standing on one leg. This progression also included increasing the ability to rotate the body and trunk as well as performing reciprocal arm movements. These exercises were led during the group sessions; however, individuals were encouraged to practice these forms on their own, outside of the group setting (Stevens and Sogolow, 2008).

The 15-week program included:

- Twice weekly 25-minute group sessions.
- Weekly 45-minute individual contact time with the instructor.
- Twice daily 15-minute individual practice sessions at home without an instructor (Stevens and Sogolow, 2008).

Home Modification Interventions

Home Visits by an Occupational Therapist

This Australian study used an occupational therapist (OT) who visited participants 65 years and older in their homes, identified environmental hazards and unsafe behaviors, and recommended home modifications and behavior changes. Fall rates were reduced by one-third but only among men and women who had experienced one or more falls in the year before the study (Stevens and Sogolow, 2008).

The OT visited each participant's home and conducted an assessment using the standardized Westmead Home Safety Assessment form. The OT identified environmental hazards such as slippery floors, poor lighting, and rugs with curled edges, and discussed with the participant how to correct these hazards. The therapist also assessed each participant's abilities and behaviors, and how each functioned in his or her home environment. Specific unsafe behaviors were identified such as wearing loose shoes, leaving clutter in high-traffic areas, and using furniture to reach high places. The OT discussed with the participants ways to avoid these unsafe behaviors (Stevens and Sogolow, 2008).

Two weeks after the initial home visit the OT telephoned each participant to ask whether they had made the modifications and to encourage them to adopt the recommended behavioral changes (Stevens and Sogolow, 2008).

Falls-HIT (Home Intervention Team) Program

This German intervention provided home visits to identify environmental hazards that can increase the risk of falling, provided advice about possible changes, offered assistance with home modifications, and provided training in using safety devices and mobility aids. The fall rate for participants was reduced 31%. The intervention was most effective among those who had experienced two or more falls in the previous year; the fall rate for these participants was reduced 37% (Stevens and Sogolow, 2008).

Participants were frail community-dwelling older adults who had been hospitalized for conditions unrelated to a fall, and then discharged to home. Participants showed functional decline, especially in mobility. All were 65 years or older and lived in the community and three-quarters were female (Stevens and Sogolow, 2008).

The intervention team consisted of a physical therapist, occupational therapist, three nurses, a social worker, and a secretary. The first home visit was conducted while the participant was still hospitalized. Two team members, an occupational therapist with either a nurse or a physical therapist, depending on patient's anticipated needs, conducted a home assessment. They identified home hazards using a standardized home safety checklist and determined what safety equipment a participant needed (Stevens and Sogolow, 2008).

During two to three subsequent home visits, an occupational therapist or nurse met with the participant to:

- Discuss home hazards
- Recommend home modifications
- Facilitate necessary modifications
- Teach participants how to use safety devices and mobility aids when necessary (Stevens and Sogolow, 2008)

Multifaceted Interventions

Stepping On

This Australian study used a series of small group sessions to teach fall prevention strategies to community-dwelling older adults. The fall rate among participants was reduced about 30 percent compared with those who did not receive the intervention. The intervention was especially effective for men. The fall rate among male participants was reduced almost two-thirds. Participants were individuals who had fallen in the previous year or who were concerned about falling. All were 70 years or older and lived in the community. Most study participants were female (Stevens and Sogolow, 2008).

The program addressed multiple fall risk factors: improving lower limb balance and strength, improving environmental and behavioral safety in both the home and community, and encouraging visual and medical screenings to check for low vision and possible medication problems. Each session covered a different aspect to reducing fall risk:

- Session 1: Risk appraisal; introducing balance and strength exercises
- Session 2: Review and practice exercises; how to move safely in the home
- Session 3: Hazards in and around the home and how to remove or reduce them
- Session 4: How to move safely in the community; safe footwear and clothing
- Session 5: Poor vision and fall risk; the benefits of vitamin D, calcium, and hip protectors
- Session 6: Medication management; review of exercises; more strategies for moving safely in the community
- Session 7: Review of topics covered in program (Stevens and Sogolow, 2008)

The program included seven weekly 2-hour program sessions, a 1 to 1 ½ -hour home visit by an occupational therapist, and—6 weeks after the final session—a 1-hour booster session 3 months after the final session. The follow-up home visit included review of fall prevention strategies, assistance with home adaptations, and modifications, if needed. A three-month booster session included review of achievements and how to maintain motivation (Stevens and Sogolow, 2008).

A team of content experts, trained by the OT and guided by the Stepping On manual, participated in the study. These included:

- A physical therapist introduced the exercises and led a segment on moving about safely.
- An OT led segments on home safety, community safety, behavioral methods for better sleep, and hip protectors.
- An older adult volunteer from the Roads and Traffic Authority spoke on pedestrian safety.
- A retired volunteer nurse from the Medicine Information Project discussed how to manage medications.
- A mobility officer from the Guide Dogs spoke on coping with low vision (Stevens and Sogolow, 2008).

PROFET (Prevention of Falls in the Elderly Trial)

This British intervention provided medical assessments for fall risk factors with referrals to relevant services and an occupational therapy home hazard assessment with recommendations for home modifications. After 12 months, those in the intervention group were 60% less likely to fall once and 67% less likely to fall repeatedly (at least three times), compared with those who did not receive the intervention. Participants were seniors who had been treated for a fall in a hospital emergency department. All were aged 65 years and older and lived in the community. Two-thirds of participants were female (Stevens and Sogolow, 2008).

An outpatient medical assessment was conducted soon after the fall that was treated in the emergency room. It included assessments of visual acuity, postural hypotension, balance, cognition, depression, and medication problems. The results were used to identify and address problems that could contribute to fall risk. Participants received referrals to relevant services, based on identified risk factors (Stevens and Sogolow, 2008).

The home assessment was conducted during a single visit. The occupational therapist (OT) identified environmental hazards in the home such as uneven outdoor surfaces, loose rugs, and unsuitable footwear. Based on findings, the OT provided advice and education regarding safety within the home, made safety modifications to the home with the participant's consent, and provided minor safety equipment. The OT made social service referrals for participants who required hand rails, other technical aids, adaptive devices such as grab bars and raised toilet seats, and additional support services. The average length of the medical assessment was 45 minutes. The average length of the home assessment was 60 minutes (Stevens and Sogolow, 2008).

The NoFalls Intervention

This Australian study looked at the effectiveness of group-based exercise in preventing falls when used alone or in combination with vision improvement and home hazard reduction. The intervention components focused on increasing strength and balance, improving poor vision, and reducing home hazards (Stevens and Sogolow, 2008).

The group-based exercise was the most potent single intervention; when used alone, it reduced the fall rate by 20%. Falls were reduced further when vision improvement or home hazard reduction was combined with exercise. The most effective combination was the group-based exercise with both vision improvement and home hazard reduction. Participants who received all three components were one-third less likely to fall. All participants were aged 70 and older and lived in the community. Sixty percent were female (Stevens and Sogolow, 2008).

The exercise program was delivered in community settings such as exercise rooms in fitness centers and community health centers. The vision intervention was delivered via usual services available in the community. Participants went to their optometrist or ophthalmologist if they had one. If any further action was required, it was facilitated using normal services such as hospitals for cataract surgery, optometrists for new glasses, and general practitioners or ophthalmologists for medication if required. The home hazard intervention was conducted in participants' homes (Stevens and Sogolow, 2008).

The exercise intervention consisted of weekly 1-hour classes plus daily home exercises. Classes were designed by a physical therapist to improve flexibility, leg strength, and balance. About one-third of the exercises were devoted to balance improvement. Exercises were adjusted for participants with limitations. Music was played during the sessions. Leaders provided a social time with coffee and tea after each session to talk informally about exercise improvements and opportunities (Stevens and Sogolow, 2008).

The vision intervention included referral to an appropriate eye care provider if a participant's vision fell below predetermined criteria during the baseline assessments for visual acuity, contrast sensitivity, depth perception, and field of view. Criteria for referral included more than four lines difference between the line of smallest letters read correctly on the high and low contrast sections of the vision chart or any loss of field of view (Stevens and Sogolow, 2008).

A referral was recommended if:

- (1) A potential visual deficit was identified and the participant was not already receiving treatment, or
- (2) If a deficit had been identified previously but the participant had not received treatment during the previous 12 months. The intervention consisted of the participant receiving the recommended treatment by an appropriate specialist (Stevens and Sogolow, 2008).

The home hazard assessment consisted of a walk-through using a checklist for those rooms used in a normal week. The checklist included a comprehensive section defining the different areas of the house and specific hazards. The checklist was divided into rooms or areas of the house—access points (main entry door, back door, etc.), hallways, stairwells, dining room, living room, den, bedrooms, and wet areas (kitchen, bathroom, laundry rooms). Within each of these areas, the

focus was on steps and stairs, floor surfaces, lighting, and some key furniture items or fixtures such as a favorite chair or bathroom fixtures (Stevens and Sogolow, 2008).

After the assessment, the results were discussed with the participant and potential interventions described in the checklist were suggested. If the participant agreed to the intervention, it was determined who would carry it out. Hazards could be removed or modified by the participant, their family, the City of Whitehorse home maintenance program, or some other person. Study staff visited the participants' homes and provided quotes for the materials needed for the suggested modifications; labor was provided free of charge (Stevens and Sogolow, 2008).

The duration of the study was as follows:

- **Exercise:** Weekly 1-hour group classes for 15 weeks and 25 minutes of daily home exercises.
- **Vision improvement:** Duration depended on the specific intervention (such as cataract surgery or new glasses).
- **Home hazard reduction:** Duration depended on the length of time the home modifications were left in place by the participant (Stevens and Sogolow, 2008).

The SAFE Health Behavior and Exercise Intervention

The Study of Accidental Falls in the Elderly (SAFE) health behavior intervention, conducted in Washington and Oregon, was a program of four group classes on how to prevent falls. The classes addressed environmental, behavioral, and physical risk factors and included exercise with instructions and supervised practice. The home safety portion included a home inspection by a BA-level home assessor with guidance and assistance in reducing fall hazards (Stevens and Sogolow, 2008).

Overall, participants were 15% less likely to fall compared with those who did not receive the intervention. Male participants showed the greatest benefit. All were participants were 65 years or older and lived in the community. About 60% of participants were female (Stevens and Sogolow, 2008).

The SAFE health behavior intervention consisted of four 1 ½- hour group classes that used a comprehensive approach to reducing fall risks. Classes addressed environmental, behavioral, and physical risk factors. Classes included:

- A slide presentation on common household risks.
- Discussions of behavioral risks such as walking on ice or using a chair to reach high places.
- A self-appraisal of home hazards using a specially designed form.
- Small group sessions during which participants worked together to develop action plans (Stevens and Sogolow, 2008).

Each class session also had an exercise component that included a brief demonstration of fall prevention exercises and about 20 minutes of supervised practice. Participants received a manual describing the exercises and were encouraged to begin walking at least three times a week. The exercises were chosen to:

- Actively involve all parts of the body
- Maintain full range of motion of all joints
- Strengthen muscles
- Improve posture
- Improve balance (Stevens and Sogolow, 2008)

During the home safety inspection, the assessor inspected the participant's home and identified fall hazards using a standard protocol. The assessor encouraged the participant to remove or repair the hazards identified during this initial visit. The participant was also given fact sheets on how to obtain technical and financial assistance for making repairs and modifications to his or her home (Stevens and Sogolow, 2008).

After the four classes were completed, the assessor returned to the participant's home to check on the progress of repairs and to offer financial and technical assistance if needed, as well as discounts on safety equipment. The full duration of the study included two home visits, each lasting about 15 minutes and four weekly 1 ½-hour classes (including 20 minutes of supervised exercise) over a 1-month period (Stevens and Sogolow, 2008).

Yale FICSIT (Frailty and Injuries: Cooperative Studies of Intervention Techniques)

This study used a tailored combination of intervention strategies based on an assessment of each participant's fall risk factors. Participants were about 30% less likely to fall compared with people who did not receive the intervention. Participants were members of a health maintenance organization. All were 70 years or older and lived in the community. Most participants were female (Stevens and Sogolow, 2008).

The intervention was delivered to participants in their homes. This program provided an individualized intervention for each participant. The content varied based on the fall risk factors identified. Possible intervention components included medication adjustment, recommendations for behavioral change, education and training, home-based physical therapy, and a home-based progressive balance and strengthening exercise program. The selection of interventions was guided by decision rules and priorities. No participant received more than three balance and strength training programs (Stevens and Sogolow, 2008).

The assessments need to be clearly linked to the intervention components. The minimum risk factor interventions include (1) postural blood pressure and behavioral recommendations; (2) medication review and reduction (especially psychoactive medications); (3) balance, strength, and gait assessments and interventions; and (4) environmental assessment and modification. It is essential that the progressive balance and strength exercise program includes both supervised and at-home (unsupervised) components (Stevens and Sogolow, 2008).

A Multifactorial Program

This Seattle study tested a moderate-intensity intervention that used tailored strategies based on assessments of each participant's risk factors. After 1 year, participants were 10% less likely to fall and 5% less likely to have an injurious fall, compared with people who received usual medical care. All participants were 65 years and older and lived in the community and about 60% of participants were female (Stevens and Sogolow, 2008).

Participants received the assessments and interventions from a nurse at local health maintenance organization (HMO) centers. Participants conducted a home assessment or had it done by a family member or volunteer. The assessments consisted of simple screening tests for six risk factors. The intervention content varied based on the individual's risk factors (see [Table 4](#)).

Risk Factor	Intervention
Inadequate exercise	Participated in a 2-hour exercise orientation class testing fitness, given exercise instruction, and encouraged to begin a program of brisk walking
Excessive alcohol use	Referred to an alcohol treatment program if alcoholism suspected Given instructional booklet with strategies for limiting use
Home hazards	Assessed home safety using a home safety checklist
Use of psychoactive drugs	Reviewed medications using a pharmacist and sent written recommendations to primary care provider
Impaired hearing	Hearing aid evaluation Program provided behavioral intervention classes for participants with uncorrectable deficits
Impaired vision	Corrected when possible Participants with uncorrectable vision impairments received information about available community resources

Assessing Balance

Multifactorial Assessment of Balance

Assessing balance necessitates evaluation of multiple systems, both physical and cognitive. Your client may have a fear of falling, muscle weakness, abnormal muscle tone, visual impairment, dementia, or a medical condition such as urinary incontinence. Conditions for which an increased risk of falling has been documented include:

- Stroke
- Parkinson's disease
- Peripheral neuropathy
- Dementia (Thurman et al, 2008)

Neurologic dysfunctions that carry an increased risk of falling regardless of diagnosis include:

- Disorders of balance
- Disorders of gait
- Lower extremity weakness or sensory loss
- Loss of vision (Thurman et al, 2008)

The goal of a balance assessment is to find the cause of the balance impairment and design a program to improve balance, decrease the risk of future falls, and to determine the need for equipment, home modification, and assistive devices. In a busy clinic, hospital, or nursing home reliable, repeatable, and simple evaluations are necessary. A balance assessment can be divided into 4 parts:

- 1) Subjective assessment
- 2) Functional mobility and gait
- 3) Musculoskeletal assessment (strength, range of motion, posture)
- 4) Movement strategies and sensory systems used for balance

Subjective Assessment

Subjective data is information supplied by the patient including medical history, medications, and other non-objective factors that may contribute to loss of function. Both subjective and objective information guide the treatment plan and help with the assessment of outcomes. During the subjective evaluation, ask your client for a brief history of recent falls. A history of falls was found to be predictive of future falls in a high percentage of patients in several studies (Thurman et al, 2008). Pay particular attention to patterns or circumstances that are similar—loss of balance when walking on uneven ground, exiting a building, walking uphill, or when getting out of bed in the dark. The subjective information should match what you find during your objective evaluation.

Functional Mobility and Gait

Functional mobility and gait tests evaluate performance on functional tasks that depend on postural control (Shumway-Cook & Woollacott, 2007). Functional mobility and gait assessments are a regular component of nursing and therapy evaluations. An assessment tool should be appropriate for your client population, reliable, evidence based, repeatable, and—most of all—fast and easy to use. Many assessment tools are available but a few stand out for their ease of use and reliability. Although by no means a comprehensive list, the Berg Balance Scale, the Timed Get up and Go, and the Functional Reach Test are reliable, useful tools for elderly clientele.

Berg Balance Scale

The Berg Balance Scale (BBS) was developed in 1989 by Kathy Berg and has emerged as a reliable clinical tool for assessment of functional mobility and gait—especially in the ambulatory elderly. The BBS consists of 14 tasks scored from 0 to 56, which assess a variety of functional activities. Each task is scored on a 1–4 scale; a score of 0 indicates an inability to perform the task while a score of 4 means the patient is independent with that task. The BBS scale has excellent internal consistency and good test-retest reliability and requires little specialized training. It can be performed with minimal equipment, in a small space, and can be used in any clinical setting.

In a recent study of 655 physical therapists working with stroke patients the BBS was identified as the most commonly-used assessment tool for assessment of functional mobility following stroke (Blum and Korner-Bitensky, 2008). This and other studies have shown the BBS to be a good predictor of length of stay, discharge destination, and disability levels after discharge.

The Berg Balance Scale includes the following activities:

- Sit to stand
- Stand unsupported
- Sit unsupported
- Stand to sit
- Transfers
- Stand with eyes closed
- Stand with feet together
- Reach with outstretched arm
- Retrieve object from floor
- Turn to look behind
- Turn 360 degrees
- Alternate stepping on stool
- Standing with one foot in front of the other
- Standing on 1 foot

Functional Reach Test

Pamela Duncan and colleagues developed the Functional Reach test in 1990. In a busy clinic the Functional Reach test has the benefit of being fast and repeatable with good test-retest reliability. The test defines functional reach as "the maximal distance one can reach forward beyond arm's length, while maintaining a fixed base of support in the standing position" (Duncan et al., 1990). It is a dynamic rather than a static test and measures a person's "margin of stability" as well as the ability to maintain balance during a functional task. In older clients with a reach of 6 inches or less the test has been shown by Duncan to be predictive of falls (Duncan et al., 1990).

Functional reach was originally testing using a force platform and an electronic measure of forward reach. In a clinical setting it is tested by placing a yardstick or tape measure on the wall, parallel to the floor, at the height of the acromion of the subject's dominant arm. The client stands with the feet a comfortable distance apart, makes a fist, and reaches the dominant arm to approximately 90 degrees. The client then reaches forward as far as possible without taking a step or touching the wall. The distance between the start and end point is measured using the head of the metacarpal of the third finger as the reference point (Duncan et al., 1990).

Get Up and Go Test

The Get Up and Go Test was developed by Mathias and Nayak as a tool to screen for balance problems, primarily in the frail elderly. The test measures how long it takes for a person to rise from a chair, walk 3 meters to a line on the floor, and return to the chair. The test correlates well with the Berg Balance Test, the Barthel Index of activities of daily living, and gait speed tests. Timed Up and Go (TUG) modified the earlier test by adding a timing component. An adult who is independent in balance and mobility can perform the TUG in less than 8 seconds (Shumway-Cook and Woollcott, 2007).

In a study with older adults with a range of neurological pathologies, persons taking 30 seconds or more to complete this task were more likely to need an assistive device, walk too slowly for community ambulation, and to score lower on the Berg Balance test (Podsiadlo and Richardson, 1991). In contrast, a person completing the test in less than 20 seconds was more likely to be independent in daily living activities, score higher on the Berg Balance test, and walk at a speed sufficient for community mobility (Podsiadlo and Richardson, 1991).

Shumway-Cook, Brauer, and Woollacott found that in addition to predicting functional mobility, the TUG could be used to predict the risk of falls in the elderly. Thirty community-dwelling frail elderly adults were tested using the TUG; researchers found that those taking longer than 14 seconds to complete the task were at high risk for falls (Shumway-Cook, Brauer, and Woollacott, 2000).

In the same study the TUG was modified by adding a cognitive task (counting backward by threes) and a manual task (carrying a full cup of water). The performance of an additional task increased the time needed to complete the TUG test. The addition of a secondary task increase the time need to complete the TUG by 22 to 25% (Shumway-Cook, Brauer, and Woollacott, 2000).

In another study, researchers wanted to determine if the TUG can be used to **predict** falls following hip surgery during a 6-month follow up period. Fifty-nine patients were tested using the TUG at discharge and then 6 months later. Of these, 19 (32%) had one or more falls in the 6 months following surgery. Kristensen found that 95% of the subjects who fell had a score of \geq 24 seconds on the TUG test (Kristensen MT, Foss NB, and Kehlet H, 2007).

Performance Oriented Mobility Test (Tinetti Tests)

The Performance Oriented Mobility Assessment (POMA) was developed by Mary Tinetti, a physician and researcher at Yale University. It is divided into two parts: balance tests and gait tests. Along with the Berg Balance Test, it is one of the most widely used mobility and gait assessment tests. At least one study has shown POMA to have the best test-retest reliability when compared to the TUG, On-Leg Stand, and Functional Reach. It was also shown to have good predictive value for fall risk when compared to the other tests (Shumway-Cook and Woollacott, 2007).

The first part of the tool, the Tinetti Balance Test, is scored on a scale of 0 to 16; it assesses sitting balance, sit to stand, standing balance, standing balance when nudged, standing balance with eyes closed, balance while turning, and stand to sit. The second part to the tool, the Tinetti Gait Test, is scored on a scale of 0 to 12; it assesses initiation of gait, step length, height, symmetry, and continuity, deviation from a straight path when walking, and trunk sway and stance when walking. When taken together the maximum score on the Tinetti tests is 28; a client that scores between 19 and 24 is at risk for falls and a client that scores below 19 is at high risk for falls.

Gait is a functional task that is closely related to balance and postural control. Functional gait can be assessed with a number of reliable tools. In a task-oriented approach advocated by Shumway-Cook and Woollacott (2007) gait and mobility assessment are related to examination at the functional level. In one approach, gait can be assessed as a function of velocity, a measure that combines time and distance. This can be compared to normative values such as 80 m/min.

Musculoskeletal Assessment

Musculoskeletal assessment includes strength, range of motion, posture, and the presence of pain or abnormal tone. Many studies have shown that improving strength, especially in the lower extremities and trunk, can lead to improvements in balance.

Strength is usually tested on a 1–5 scale (with 5 meaning full strength) using manual resistance by the evaluator. This type of testing can show gross muscle weakness but test muscles in isolation. Studies have shown that strength in an individual muscle can be severely impaired and not adversely affect balance.

Another drawback of manual testing of individual muscles is that the findings are not valid in person with abnormal tone. Tests of functional strength such as standing on one leg to test the gluteus medius muscle of the stance leg, or performing a semi-squat, are better indicators than individual muscle tests for balance deficit.

Manual muscle testing should be used to identify gross muscle weakness, keeping in mind that balance may be more adversely affected by abnormalities in the sequence and timing of muscle contraction than by localized muscle weakness (Shumway-Cook and Woollacott, 2007).

Movement Strategies for Balance

Our nervous system simplifies movements by using patterns of movement called synergies or strategies. A **movement strategy** is a flexible, repeatable pattern of movement that can be quickly accessed by the central nervous system. This allows us to store and reuse patterns of movement that have been successful in the past. Strategies are efficient, automatic movement patterns that evolve over time. Each time a loss of balance threatens, the nervous system can draw on these pre-programmed movement strategies to assure the maintenance of balance. Three anterior-posterior movement strategies used to maintain balance will be discussed: the ankle, hip, and stepping strategies.

Ankle Strategy

The ankle strategy—also called ankle sway—is used in response to small perturbations or losses of balance. When a small loss of balance occurs—as when standing on a moving bus—the foot acts as a lever to maintain balance by making continuous automatic adjustments to the movement of the bus. When a small balance adjustment is needed muscles close to the floor activate first and flow upward in a **distal to proximal** pattern.

If your body sways forward the toes dig into the floor and the ankle, calf, and posterior leg muscles contract to prevent you from falling forward. If your body sways backwards the toes lift up and the anterior tibialis muscles at the front of the lower leg—as well as other muscles on the anterior surface of the body—contract, thus preventing you from falling backwards. The ankle strategy is automatically utilized a thousand times a day in response to small losses of balance. There's no need to think about the toes lifting or the calf muscles contracting—the central nervous system does the work automatically.

In older adults studies have shown that during quiet stance sway increases with age; when quiet stance is perturbed, older adults have slower contractions of the leg muscles and—in some cases—activate proximal muscles first followed by distal muscles (Shumway-Cook and Woollacott, 2007).

Older adults also tended to co-activate agonist and antagonist muscles, effectively stiffening the joint. Others bend at the waist (hip strategy) rather than using the ankle strategy possibly due to ankle weakness or sensory changes (Shumway-Cook and Woollacott, 2007).

Hip Strategy

The hip strategy is needed if a perturbation is too large to be successfully handled by the ankle strategy. In the bus example, when the movement of the bus is steady, the ankle strategy works just fine. But what happens when the bus driver slows or accelerates suddenly? If we only had the ankle strategy we would fall over the moment our center of gravity passed the limits of the ankle range of motion. Instead we use the hip strategy—bend a bit at the waist or arch our backs as much as is needed to keep our center of gravity over our base of support.

When the hip strategy is needed, movement is centered about the hip and the ankle muscles (anterior tibialis and gastrocnemius) are largely inactive. The muscles in the trunk activated first as activation flows downward to the legs in a **proximal to distal** pattern. So if the bus stops suddenly and you are thrust forwards, your low back and hamstrings will contract in that order to bring you back upright.

When the hip strategy is used, the muscles of the lower leg are almost silent. Studies have shown that when a walker is used, the body largely abandons the ankle strategy and relies heavily on the hip strategy for balance. This dependence on the hip strategy for balance paradoxically may lead to a decrease in ankle sway and contributes to further decline in balance arising from loss of ankle strength and flexibility. For this reason the pros and cons of walker use must be carefully considered before a walker is recommended for fulltime use.

Stepping Strategy

The stepping strategy is used when neither the ankle or hips strategies are sufficient to regain balance. When your center of gravity moves well past your base of support it is necessary to take a forward or backward step to regain balance.

Sensory Organization for Balance

Understanding how sensory changes contribute to balance disorders is challenging. Of the many systems and organs that provide sensory input, the somatosensory, visual, and vestibular systems are the most directly involved with balance.

The **somatosensory system**, which consists of touch and proprioception, has perhaps the strongest influence on balance. Sensory signals from touch, temperature, pressure, joint and muscle stretch, and pain sensations, among others, are continuously fed to the brain where the information is automatically processed and used to make quick adjustments that keep us upright. Input from the somatosensory system provides critical feedback to the CNS about our position in space, body sway, and changes in terrain. This allows our muscles to make constant, automatic adjustments to maintain balance and avoid falls.

The **visual system** is a key component of motor control. It allows us to determine the movement of objects in our environment; it tells us where we are in relation to parts of our own body and to other objects (Shumway-Cook and Woollacott, 2007).

Our eyes have both central and peripheral vision. Central vision is processed mostly through the macula, part of the retina and allows us to see clearly. Peripheral vision provides information to the brain about general spatial orientation and is more important for postural control and balance than central vision. The eyes work in conjunction with the vestibular system, comparing information about velocity and rotation from the vestibular system with actual visual information (Shumway-Cook and Woollacott, 2007).

Our eyes don't always provide accurate information to our brains. We've all had the experience of being stopped at a stoplight and the car next to us starts to move—we think we are moving and slam our foot on the brake. As soon as our foot touches the brake we instantly know that we weren't moving and even feel a little foolish. For a split second the brain gave preference to sensory input from the visual system, causing a sensory conflict. The sensory conflict is quickly resolved thanks to the somatosensory system and vestibular systems. The touch of our foot on the brake and the receptors in our back and legs told us that we were in fact sitting still. At the same time the hair cells in the vestibular system let us know that there is no forward motion and we relax.

The **vestibular system** is responsible for processing information about movement in relation to gravity—specifically, rotation, acceleration/deceleration, and head stabilization during gait. The vestibular system works with the visual and somatosensory systems to help us maintain our orientation in space. The vestibular system works in conjunction with the visual system to stabilize the eyes and maintain posture during walking (vestibulo-ocular reflex). Vestibular disorders cause a feeling of dizziness and unsteadiness and affects the ability of the CNS to mediate intersensory conflicts such as in the example given above.

Sensory Disruption and Balance

Sensory organs important from posture control and balance can be damaged by certain disease processes. How balance is affected depends on several factors, including the extent of the nervous system damage, the number and extent of sensory losses, and the ability of the other senses to compensate for the damage. If more than one sensory system is impaired—as occurs with diabetes and stroke—it may be difficult to compensate for sensory losses.

Sensory Loss

Sensory loss can cause severe disruptions in balance as mentioned earlier. This includes:

- Bilateral lower-leg peripheral neuropathy
- Impaired vision (cataracts, macular degeneration, hemianopsia)
- Vestibular damage
- Hemiparesis

Somatosensory loss leads to compensation—depending more on visual and vestibular input for balance. For example, if there is sensory loss in the feet, a person will be unable to adjust easily to changes in the support surface (uneven ground, grass, inclines or declines). An assistive device may help because it widens the base of support and provides somatosensory input through the hands, which is often enough to compensate for loss of input through the feet.

Other changes in the somatosensory system include:

- Loss of vibratory sensation in the great toe and ankle
- Decline in fine touch and pressure/vibration
- Decline in the sensory nerves innervating sensory receptors (Shumway-Cook and Woollacott, 2007)

A person with impaired vision depends less on vision and more on touch and vestibular feedback for balance. They may have difficulty in complex visual situations that demand rapid visual interpretation of multiple visual cues. For example, a person may be safe walking in a quiet environment such as their home but be unable to negotiate a busy, noisy street filled with people and cars.

Age-related changes in the visual system include:

- Declining vision—including loss of visual acuity
- Narrowing of visual fields
- Loss of ability to adapt quickly to changes in light intensity
- Increased sensitivity to glare
- Loss of peripheral vision and depth perception

The vestibular system declines with age and there may be as much as a 40% loss of vestibular nerve and hair cells by age 70 (Shumway-Cook and Woollacott, 2007). Vestibular decline has a profound effect on balance and postural control. It is used as a reference system by the visual and somatosensory systems when those systems are in conflict. Vestibular impairment can lead to problems with gaze stabilization, blurred vision, and vertigo (Shumway-Cook & Woollacott, 2007).

Improper Sensory Selection

Sensory loss may lead to inflexible or improper sensory weighting. A person may depend on one particular sense for postural control even if that sense leads to further instability (Shumway-Cook and Woollacott, 2007). You may notice a person walking with head down, carefully watching every step. In this case, vision is the dominant sense being used for balance. Retraining would involve improving the use of somatosensory and vestibular input to reduce dependence on visual input.

Sensorimotor Adaptation

The nervous system is very good at compensating for disabilities. Once an injury has occurred, the nervous system immediately goes to work attempting to compensate for neurologic changes, weakness, and loss of function. But the brain doesn't always choose the best (or even a good) compensation; it chooses the fastest and most efficient in an attempt to continue functioning. One of the immediate goals of therapy is to help the nervous system develop strategies and compensations that minimize musculoskeletal damage and maximize function.

Other Age Related Changes in Balance and Postural Control

Many changes in balance relate to normal aging. As was discussed in earlier sections, changes such as slowed gait, decrease in lower-extremity strength, and decreased range of motion can be addressed with a daily exercise program. Other changes such as declining visual ability, including loss of visual acuity, declining visual fields, light-dark adaptation, increased sensitivity to glare, loss of peripheral vision and depth perception are more complex and require assessment by an optometrist or ophthalmologist.

Studies have shown age-related changes in stepping and reaching reactions in the elderly. Compared to younger people elderly adults initiate the stepping strategy in response to smaller losses of balance and tend to take several small steps rather than one larger step (Maki and McIlroy, 2006). Older adults also reach for a support surface more readily than younger adults but the reach reaction is slower. Increased tendency to reach for support and a slowing of these reactions have been found to be predictive of falling in daily activities (Maki and McIlroy, 2006).

Changes to the white matter of the brain—called leukoaraiosis—can affect balance. A study with 639 men and women showed that those with severe changes in the white matter were twice as likely as those with mild changes to score poorly on gait and balance tests and to have a history of falls.

Conclusion

Falls are a leading cause of morbidity and mortality in the elderly in the United States. In recent years research is leading us to new clinical interventions that help reduce the risk of falls and lessen the number and severity of injuries caused by falls. Assessment tools such as the Berg Balance test and the Up and Go test are helping clinicians accurately assess and treat balance problems in their elderly clients. An understanding of the factors associated with poor balance such as impaired strength, decreased flexibility, and sensory dysfunction help clinicians understand and treat the source of balance disorders in the elderly.

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Post Test

Circle one answer per question. (Passing grade is 70% or greater.)

1. Balance is:
 - a) The ability to maintain your center of mass over your base of support.
 - b) The ability to maintain the segments of our body in relation to one another and to maintain stability and orientation in space.
 - c) An unplanned and unexpected contact with a supporting surface.
 - d) A skill that is not affected by age-related changes or cognitive changes.
2. The National Database of Nursing Quality Indicators defines a fall as "an unplanned descent to the floor (or extension of the floor) with or without injury to the patient".
 - a) True
 - b) False
3. Fall injuries:
 - a) Are the most common cause of nonfatal injuries and hospital admissions for trauma.
 - b) Are 2–3 times higher for older men than for older women.
 - c) Rarely result in hospitalization or death.
 - d) That result in death have decreased significantly over the past decade.
4. Medical consequences of falls include:
 - a) Fatal head injuries that are seen more often in older women than older men.
 - b) Hip fractures which are more common in men than in women.
 - c) Bruises, hip fractures and head trauma that can limit independent living and increase the risk of early death.
 - d) Hip fractures which are more often seen in black women than white women.
5. All of the following are true except:
 - a) The use of physical restraints may lead to substantial adverse outcomes.
 - b) Most hip fracture patients are hospitalized for about 1 week and as many as 20% of those die within 1 year of their injury.
 - c) Restrained patients appear to have a modest increase in fall risk or injury according to several studies.
 - d) There was a large increase in falls with a reduction in side rail use according to a 2007 study.
6. Polypharmacy is a well-established risk factor for falls. Medications associated with increased fall risk include:
 - a) Penicillin
 - b) Aspirin
 - c) Acetaminophen
 - d) Antihypertensives
7. Some of the most common risk factors for falls include:
 - a) Age over 40 years.
 - b) Cough or other respiratory symptoms.
 - c) Muscle weakness, gait or balance deficit.
 - d) Hearing deficit.

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8. Which of the following is an extrinsic risk factor for falls?
- Muscle weakness
 - Visual dysfunction
 - Polypharmacy
 - Gait disturbance
9. A breakthrough study by Mary Tinetti, M.D.:
- Reviewed 6 programs that targeted community-based interventions for the prevention of falls.
 - Used four randomized controlled trials of muscle-strengthening and balance-retraining exercises of increasing difficulty.
 - Used a combination of intervention strategies based on an assessment of each participant's fall risk factors.
 - Showed that there was only a 5% reduction in falls in those who participated in the study when compared to people who did not receive the intervention.
10. The PROFET (Prevention of Falls in the Elderly Trial) was a British falls prevention program that resulted in a 60% decrease in falls compared with those who did not receive the intervention. The intervention:
- Used a series of small group sessions to teach fall prevention strategies.
 - Used a 15 week program of Tai Chi classes.
 - Provided medical assessments for fall risk factors with referrals to relevant services and home assessment with home modifications.
 - Evaluated the effectiveness of group-based exercise in preventing falls by increasing strength and balance.
11. Multifaceted intervention programs:
- Are geared toward adults 55 years and older who have a history of hip fractures.
 - Have been shown to be less effective in preventing falls than the use of restraints.
 - Are designed to improve balance and decrease falls in community-dwelling adults age 65 and up.
 - Are physical therapy programs used for hip fracture patients in skilled nursing facilities to facilitate the transition to self-care at home.
12. A balance assessment can be divided into 4 parts. The first part is the subjective assessment which includes:
- Functional mobility and gait tests that depend on postural control.
 - Information provided by the patient including medical history and medications.
 - The Berg Balance Scale.
 - The Functional Reach test.
13. The Berg Balance Scale:
- Is used for assessment of the maximal distance one can reach while maintaining a fixed base of support.
 - Is the most commonly used tool to assess functional mobility following stroke.
 - Is not a good predictor of length of hospital stay or disability levels after discharge.
 - Should be performed only in the acute care setting.

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14. The Functional Reach test:

- a) Should be used only in the home setting when therapists are able to spend long periods of time assessing patients.
- b) Is a tool to screen balance problems, primarily in the frail elderly.
- c) Is a reliable for functional mobility and gait in the ambulatory elderly.
- d) Is a fast and reliable test that measures a person's "margin of stability" and balance during a functional task.

15. The Get Up and Go Test:

- a) Screens for balance problems by measuring the time it takes to rise from a chair, walk 3 meters and return to the chair.
- b) Is used primarily in the healthy elderly to predict future falls.
- c) Was later modified by adding a timing component and called the Tinetti test.
- d) Does not correlate well with the Berg Balance test.

16. The Tinetti Performance Oriented Mobility Assessment (POMA):

- a) Is divided into three parts: balance tests, gait tests and visual acuity tests.
- b) Is rarely used tests because of the time required to complete them.
- c) Is divided into balance tests and gait tests.
- d) Has poor predictive value for fall risk

17. A flexible, repeatable pattern of movement that can be quickly accessed by the central nervous system is called:

- a) Posture
- b) Range of motion
- c) Abnormal tone
- d) A movement strategy

18. Movement strategies used to maintain balance:

- a) Include the hip strategy, which is used when there is a small loss of balance.
- b) Include the stepping strategy in which the posterior leg muscles contract to prevent a fall.
- c) Include the hip strategy that is used for a perturbation too large to be successfully handled by ankle sway.
- d) Are strengthened when a walker is used.

19. The system that consists of touch and proprioception is called the:

- a) Visual system.
- b) Vestibular system.
- c) Somatosensory system.
- d) Stepping system.

20. The vestibular system:

- a) Processes information on rotation, acceleration/deceleration, and head stabilization during gait.
- b) Tells us where we are in relation to parts of our own body and other objects.
- c) Includes central vision processed mostly through the macula that allows us to see clearly.
- d) Consists of touch and proprioception which has perhaps the strongest influence on balance.

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21. Somatosensory loss:
 - a) Includes declining vision-including loss of visual acuity and narrowing of visual fields.
 - b) Includes problems with gaze stabilization.
 - c) Includes macular degeneration.
 - d) Leads to compensation—depending more on visual and vestibular input for balance.
22. Problems with gaze stabilization, blurred vision, and vertigo:
 - a) Occur with age-related changes in the visual system.
 - b) Are problems related to macular degeneration.
 - c) Can be caused by vestibular impairment.
 - d) May cause increased sensitivity to glare.
23. An immediate goal of therapy for a person with sensory loss is to:
 - a) Allow the brain to choose the best means of compensation which is the fastest and most efficient way to continue functioning.
 - b) Prevent fall-injury by the use of appropriate medications.
 - c) Help the nervous system develop strategies and compensations that minimize musculoskeletal damage and maximize function.
 - d) Prevent fall-injury by the use of restraints when necessary.
24. Changes to the white matter of the brain can affect balance. These changes are called:
 - a) Sensorimotor adaptation
 - b) Macular degeneration
 - c) Peripheral neuropathy
 - d) Leukoaraiosis

Answer Sheet

Balance and Falls in Older Adults

Name (Please print your name): _____

Date: _____

Passing score is 80%

1. _____
2. _____
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23. _____
24. _____

Evaluation Learning Activity

Please answer each of the following questions. Questions with an asterisk (*) are required.

* 1. This course met the goals and learning objectives.

Yes No

* 2. The author was well prepared to write about the content in a way that facilitated my learning.

Yes No

* 3. This course was free from commercial bias.

Yes No

* 4. The learning activity met my continuing education needs.

Yes No

* 5. The learning activity took me 60 minutes per contact hour.

(If you answer "No", please enter the total time it took to finish the course, test, and evaluation.)

Yes

No. How long did it take to finish the course, test, and evaluation? _____

6. My professional educational level is (check one):

Nursing

Nurse Aide LVN/LPN RN (diploma) RN (AD)

BSN MSN Nurse Practitioner / Advanced Practice Nurse

PhD / DNSc

Therapy

OT Aide COTA OT MOT OTD

PT Aide PTA PT MPT MSPT DPT PhD

Other (please specify): _____

7. I heard about ATrain Education from:

- Search engine
- Government or Board website
- Friend
- Advertisement
- Returning customer
- Other _____

8. I found the ATrainCEU.com website easy to use:

- Yes No_____

9. Comments or suggestions (optional): _____

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Please answer all of the following questions (*required).

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*Address: _____ City _____ State _____ Zip _____

*Phone: _____

*Professional Designation: _____

*License Number and State: _____

*Please e-mail my certificate: Yes No

*Email: _____

(Note: If you request an email certificate we will not send a copy of your certificate by US Mail.)

Payment Options

You may pay by credit card or by check.

Fill out this section only if you are **paying by credit card**.

3 contact hours - \$24

Fill out this section if paying by credit card

Name _____

Address: (if different) _____ City _____ State _____ Zip _____

Card type: Visa MC American Express Discover

Card number _____ CVS _____

Expiration date _____

Test Completion and Mailing Instructions

1. Complete all forms:

- Answer Sheet
- Evaluation Learning Activity
- Registration Form (this page)

2. If you are **paying by check**, prepare a check for \$24 made out to ATrain Education, Inc.

3. Mail the completed forms and your payment to:

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5171 Ridgewood Rd
Willits, CA 95490

Once we receive your forms and payment, we will mail (or email, if you request it) your certificate of completion. If you have any questions or concerns, please call or contact us at sharon@ATrainCEU.com. And thanks for taking the ATrain!