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Physical Therapy Interventions for Falls in the Elderly

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PHYSICAL THERAPY INTERVENTIONS FOR FALLS IN THE ELDERLY

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This Independent Study, submitted by Melanie Benson in partial fulfillment of the requirements for the Degree of Master of Physical Therapy from the University of North Dakota, has been read by the Faculty Preceptor, Advisor, and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

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ABSTRACT

The elderly in America represent a population that is continually growing. As part of the aging process, various changes occur that contribute to falls. Therefore, as the number of elderly people in America increases, the possibility of falls in the elderly also increases.

The consequences of falls in the elderly are significant. Some of the more serious consequences include functional decline, increased medical cost, and death. Therefore, the scope of the problem is clear; strategies to prevent falls and treat those who have fallen are indicated.

The purpose of this independent study is to review the literature pertaining to falls in the elderly and to describe the physical therapy interventions for this problem. The definition of falls and the major causes of falls are presented. Components of a physical therapy evaluation for falls in the elderly, common clinical and laboratory tests, and preventive and treatment strategies are also covered. Finally, the efficacy of physical therapy in the management of falls in the elderly and possibilities for future research relating to this problem are presented.

CHAPTER I

INTRODUCTION

For most elderly, falls are a definite reality. Many have actually experienced a fall and the resulting consequences. Others have developed a fear of falling and limit their activities accordingly to decrease the possibility of falling. Aging itself contributes to falling, as age related changes occur that make an individual more susceptible to falling.

Given the fact that the elderly population in America is on the rise and the fact that falling for these people is a major concern, physical therapists are likely to encounter more and more elderly who either have fallen or who are at risk of falling. The problem of falls in the elderly is complex, and a number of factors must be considered if physical therapists are to effectively treat those who have fallen and assist in preventing future falls.

The significance of falls in the elderly is indicated by numerous incidence reports. Consequences of falls, which include fear of falling, decreased self efficacy, functional decline, fractures, soft tissue injuries, increased medical costs, and death also give an indication of the scope of this problem.

Falls and their causes must be understood in order for prevention and treatment strategies to be implemented effectively. Indeed, a description of the

fall and its causes aid physical therapists in assessing and evaluating people who have fallen or who are at risk of falling. Included in the assessment are various laboratory and clinical tests which assist physical therapists in developing prevention and treatment interventions.

This independent study describes the factors mentioned above that must be understood when dealing with the problem of falls in the elderly. It concludes with a summary of the findings, a report on the efficacy of physical activity, the efficacy of physical therapy in fall prevention and treatment for elderly, and recommendations for further research.

CHAPTER II

SIGNIFICANCE OF FALLS IN THE ELDERLY

Incidence

In 1993, approximately 21 million Americans were 65 years old or older.[1] By the year 2000, this number is expected to increase to 31 million.[1]

Due to the expected increase in the elderly population by the year 2000 and the fact that falls occur frequently in older persons,[2-5] falling among the elderly is of significant importance. Falls are well known to be one of the most serious problems associated with aging[6,7] as they impose serious health and socioeconomic problems for elderly individuals.[8-10] In addition, falls constitute a significant threat to elderly people's independence, well being, and quality of life.[7,11]

Falling is a well recognized clinical and public health problem.[12-14] Clinically, the scope of the problem can be seen in hospital admissions. Hospital admissions from falls are uncommon before age 65, but increase exponentially after this age.[15] Between the ages of 60 and 65, the incidence rate for admissions to hospitals secondary to falls is 1% per year.[16] This rate reaches 4% per year for men and 7% per year for women over age 85.[17] For people over age 90, the percentage of hospital admissions due to falls is 10.4%

per year.[16] In addition, it is the general consensus that falls in hospitals are frequent, due to the fact that the number of reports of falls occurring in hospitalized elderly has increased steadily over the last 30 years.[18,19]

Publicly, the scope of the problem can be seen in the incidence of falls in community dwellers over age 65. This incidence ranges from 20% to 39%.[20-27] Of these percentages, about half of the elderly who fall experience multiple falls per year.[20,21,23,28] Falling in community dwellers over the age of 65 is definitely significant, especially since 95% of people over age 65 do reside in communities.[29]

Institutionalized frail elderly people have the highest risk of falling.[30] One article reports the average fall rate for residents of nursing homes is three times greater than for community dwellers. This high incidence could be due to more accurate reporting of falls and also to the nature of nursing home residents.[2] Other articles are more conservative and state the incidence for falls for nursing home residents is two times greater than that of community dwellers.[21,22,24,31] Some long-term care facilities report 15% to 25% of residents fall per year.[32,33] Others report as many as 50% have falls.[24,34,35] Evidently, the previous reports are of all falls, injurious or noninjurious, because up to 11% of nursing home residents fall severely per year.[26] Rates of falls per 100 admits to long-term care facilities range from 20 to 45.[32,33,36] One longitudinal study reports a fall rate of 668 per 1000 and states this rate increases in successive age groups after age

75.[36] In addition, it is common for institutions providing geriatric or rehabilitative care to document one fall per day.[6]

Finally, articles not specifying whether elderly people reside in communities or in nursing homes indicate 28% to 50% of people older than 65 fall annually.[37] These percentages may be low, because about 75% of falls in the elderly go unreported.[39] The incidence of falls and the severity of complications increases with age.[26] One article states 34% of people ages 65 to 79, 45% ages 80 to 90, and 56% of those 90 years and older fall at least once per year.[37] Another article agrees that the tendency to fall increases between the ages of 65 to 85, but it also states that the tendency to fall declines after age 85.[17]

Consequences of Falls

Among the elderly, the high frequency of falls and their adverse effects on the quality of life are more severe than in the young.[40] Falls have serious consequences for physical functioning and quality of life.[2] Falls are associated with increased morbidity and mortality in elderly individuals.[4,41-43] Results of falls include adverse clinical, social, and economic consequences.[39]

Based on the literature, there appear to be several consequences of elderly falling that can be specifically discussed. These include fear of falling, decreased self efficacy and functional decline, fractures, other injuries or conditions, increased medical costs, and death.

Fear of Falling.—

Various articles report that most falls are trivial, result in no serious morbidity, and are unreported.[20,21,23,44] Another study states that half of all falls cause no injury.[45] Graham[38] surveyed 293 people over age 65 and reports that only 26% sought medical aid following a fall.

Although most falls may not cause serious physical injury, fear of falling is a serious consequence.[9,20] Fear of falling refers to a concern about falling, such that the individual tends to avoid activities that he or she remains physically capable of performing.[46] This fear of falling leads to and is a part of a debilitating post-fall syndrome. The post-fall syndrome is a frequent sequel to a severe fall.[21,23,42,46,47] The syndrome is characterized by hesitancy, tentativeness, and loss of confidence, mobility, and independence.[7,23,25,34,42,45] Anxiety and depression may be evident as well.[45]

While the fear of falling may be greater in those people who fall and are not able to get up without help,[44] it can also develop in individuals who have not experienced any falling episodes.[7] The presence of disease and a deteriorating sense of balance and postural control can contribute to the fear of falling.[3] The latter may result in a cycle in which the fear of falling due to a deterioration in the sense of balance actually contributes to a real deterioration in balance caused by self imposed restrictions on physical activity. The actual deterioration in balance due to the self imposed restrictions ultimately may result in a fall, which increases the fear of falling even more and contributes to the continuation of the

cycle. In addition, the self-imposed restrictions reduce the independence and quality of life of the elderly individual.[25,27] Certain activities, such as shopping and cleaning, and social events, such as coffee parties and visiting friends, are avoided due to the fear of falling.[27] (See fig. 1)

Fear of falling is not easily eradicated. In middle age people who have suffered a hip fracture, the fear remains for at least two years after the fall, even though in other aspects these individuals have been well rehabilitated.[27]

Decreased Self Efficacy and Functional Decline.—

In addition to the fear of falling, fallers also experience a decrease in self efficacy.[9] Self efficacy pertains to the amount of self confidence a person has in his or her ability to perform a specific group of activities.[46] Self confidence is strongly linked to function because people tend to avoid activities in which their confidence is low.[46] Decreased confidence in the ability to ambulate safely can lead to depression, feelings of helplessness, and social isolation as well as functional decline.[2]

Older persons who fall typically limit their activities, which in turn contributes to further deterioration of their physical function.[21,22,25,41,44,47] For many individuals, the fear of falling is the primary cause of functional decline.[2,27,44] For others, even minor injuries from a fall may result in some degree of disability which leads to activity restriction.[25] Immobility or decreased mobility may lead to additional falling episodes.[21,45,47,50]

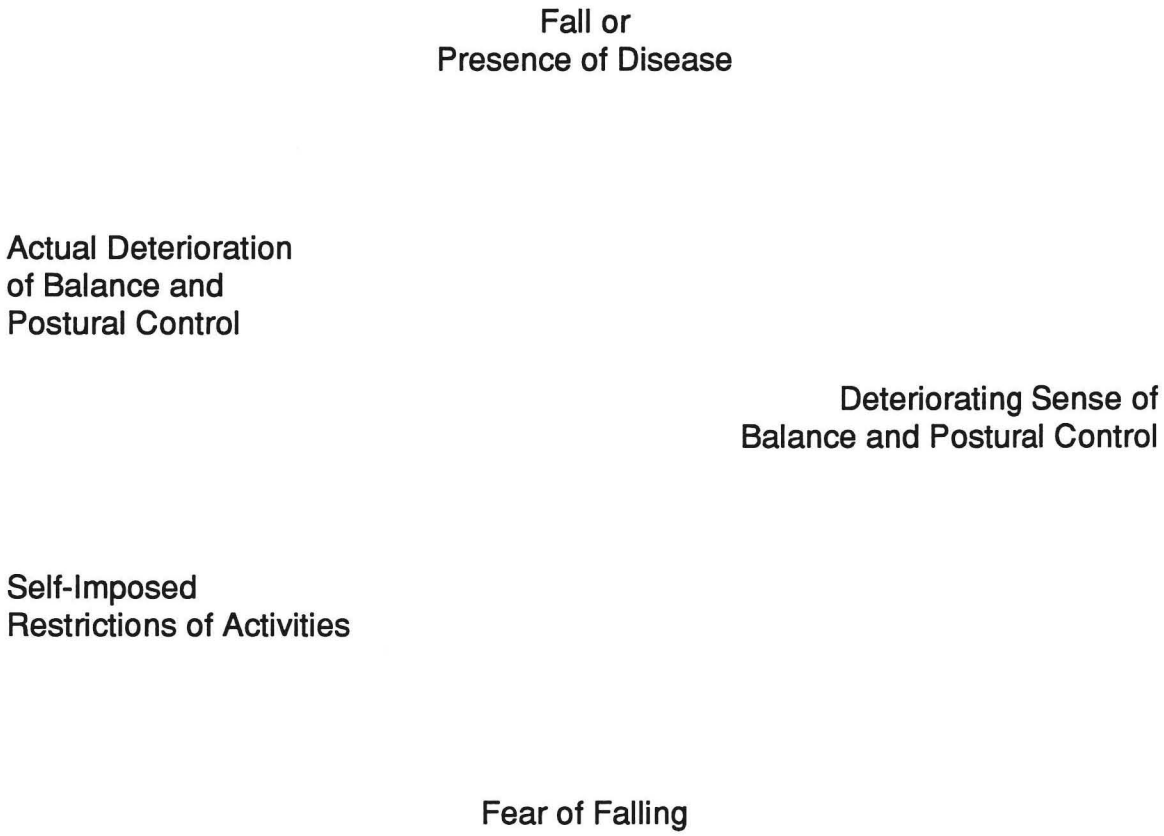

Fig 1.—"Fearing of Falling" Cycle

The previous two consequences, fear of falling and decreased self efficacy, are primarily social consequences. The next three consequences are basically physical consequences of elderly falls.

Fractures.—

Fractures are one of the serious consequences of falls.[3,4,7,20,21,23,25,36,44] One study of a series of falls in nursing home residents reports that 69% of all falls do not result in injury, 28% result in mild to moderate injury, and 3% result in hip fractures.[48] Another study reports that 50% of all falls are noninjurious, 40% cause minor injury, and 4% cause fractures.[45] This study is consistent with other studies that report only about 4% to 6% of falls result in fractures.[33,36,46,49,50]

One study reports the incidence of hip fractures at 42.6%, with rib fractures at 21.4%.[49] Other bones fractured as a result of a fall include the wrist, pelvis, tibia, fibula, metatarsals, skull, femur, coccyx, and nose. This study concludes that fractures of the hip, wrist, humerus, and pelvis constitute 58.5% of all the fractures.

The care of elderly people with hip fractures is important form humanitarian, medical, social, and economic aspects.[27] Hip fractures are one of the most frequent causes of decreased mobility and independence in older adults and are a contributing factor in 40% of all admissions to nursing homes.[21] In addition, Miller[51] investigated hip fractures and found that 20% of people who sustained hip fractures were unable to walk again and 15% died within one year.

Other Injuries and Complications.—

Other injuries that result from falls include head trauma, soft tissue injuries, and severe lacerations.[2,20-23,25,44] The percentage of these types of injuries occurring as a result of a fall ranges from 6% to 11%.[2,34]

After a severe fall, elderly people are often unable to get up without help, which leads to prolonged periods of time on the floor or ground.[42,44] Complications resulting from long periods on the floor or ground include hypotension, dehydration, pressure necrosis, pneumonia, hypothermia, and rhabdomyolysis.[25,42,44]

Increased Medical Costs.—

The economic costs of falls in elderly individuals are great and encompass acute care, long-term care, and home care concerns. The yearly cost for acute care for all fall-related fractures is $10 billion.[41] The estimated cost of medical care for hip fractures is $2 billion per year.[15,52] Falls contribute to the placement of older persons in nursing homes[25,53] and add significantly to long-term bed occupancy and long-term care dollars.[54] About 50% of elderly who receive medical treatment for fall-related injuries are discharged to nursing homes.[11] In addition to the costs of hospitalization and nursing home admissions, home health costs need to be considered.[44] The yearly total cost for health care related to falls is unknown[41] as figures which encompass all the costs resulting from falls are currently not available.

Death.—

Falling is the leading cause of accidental death in people age 65 and older.[10,26,37,41,42,45] An elderly person who has fallen has a much higher case fatality than does a younger person.[2] Individuals older than age 65 account for more than 70% of deaths due to falls.[54]

The scope of the problem of falls in the elderly is obviously significant. Clearly, there is a high incidence of falls, and severe consequences can result. The next chapter reports how "falls" have been defined in the literature. It also discusses changes that occur as a part of aging and how these changes contribute to causes of falls in the elderly.

CHAPTER III

FALLS

Definition of Falls

In order to study falls, a "fall" must be defined. Several articles define a fall similarly. One article states a fall is any unplanned "touch to the floor" of any part of a person's body, excluding the feet.[35] Other articles define a fall as unintentionally coming to rest on the ground, floor, or some level lower than the waist.[21,46,55,56] Another article states, "A person has a fall if they end up on the ground or floor when they didn't expect to. Most often a fall starts while a person is on their feet, but a fall could also start from a chair or bed. If a person ends up on the ground either on their knees, their belly, their side, their bottom, or their back, they have had a fall."[57] Falls were defined as above, regardless of whether or not the individual sustained an injury.[56]

The previous definitions are the most prevalent in the literature. However, other research define falls slightly differently. A fall is "any disturbance of balance that results in a failure to maintain an upright posture during routine activities."[58] "A fall in which injuries sustained are substantial enough to warrant admission to a hospital" alludes to the possibility that a fall means a person falls heavily, does not employ any corrective strategies, and

may have predispositions to falling.[53] In another study, falls are defined as all events for which nursing home staff file an incident report.[4,5] Inclusive in this definition are all kinds of unintended circumstances in which there is a displacement of the resident's body to the floor, such as out of bed, out of a chair, or while walking or transferring.[45]

Several research articles do not consider or include falls that were caused by external forces, such as a moving vehicle or an overwhelming hazard.[21,55] (An overwhelming hazard is a hazard that would result in a fall by most healthy young persons, such as slipping on the ice.)[59] In addition, those falls that occur because of loss of consciousness (syncope/seizures) or sudden paralysis are excluded.[21,45]

Along with defining a fall, two articles classify them according to the biomechanical perturbation that had preceded the fall.[6,56] There are three classes of falls, based on a model in which equilibrium requires the center of mass (COM) to be positioned over the base of support (BOS).[6,56] First, in base of support (BOS) falls, the perturbation somehow prevents the base of support from being realigned under the moving center of mass. Base of support falls are the result of difficulties in aligning the feet or buttocks, such as occurs during transfers, trips, tangling of feet, slips, and overstepping a curb or step. In center of mass (COM) falls, the perturbation acts to displace the center of mass beyond the existing base of support. This can be either self induced, as in bending, reaching, turning, or transferring, or can be externally applied, as in a push or

collision. Finally, no obvious perturbation (NOP) falls are thought to involve a transient physiological event that disrupts the postural control mechanisms. These studies report the percentage of BOS falls at 54%, COM falls at 32%, and NOP falls at 14%.[6,56]

"Fallers" are also defined. "Fallers" are those who have fallen on one or more occasions in the six months to one year prior to the study being conducted,[7,15,58,60] in the absence of syncope, acute illness, or an unusual environmental event.

Causes of Falls Associated with Aging

Falls in the elderly are rarely due to a single cause.[57] Several articles agree that falls involve complex interactions of physiological structure, physical functioning, and environmental factors.[29,36,37,61] In addition, behavioral, psychosocial, pathologic, and pharmacologic factors are also cited as causes of falls.[21-24] There are five general categories of causes of falls: environmental, physiologic, pharmacologic, pathologic, and miscellaneous.[48]

Environmental Causes.—

Falls are common in community living elderly persons as a result of environmental hazards.[20-23] Indoor environmental hazards include scatter rugs, poorly arranged furniture, slippery floors, dimly lit hallways, and pets underfoot.[42,48] Outdoor environmental hazards include steps and snow packed or icy walkways.[48]

Some of the same environmental hazards for community dwellers are also environmental hazards for nursing home residents. Hazards include poor lighting and wet floors, with wet floors in nursing homes most likely to be due to a resident's incontinence.[2] Bed rails and improper bed height are also environmental hazards.[2] Recently admitted nursing home residents may fall due to a still unfamiliar environment.[42] Resident falls also occur when staff supervision is low, such as during shift changes and staff breaks.[45] The incidence of falls in nursing homes increases between 2:00 and 3:00 p.m. (shift changes) as well as between 8:00 and 9:00 a.m. (wake-up and breakfast).[45]

The location of the individual and the activity he or she is performing influences the risk of a fall. Sixty-three percent of falls resulting in hip fractures occur indoors.[27,49] Also, for community dwellers, most falls occur at home, possibly because most elderly stay at home due to a fear of falling.[23] Several studies report attempts to move to and from the bathroom and nocturia are associated with falls and fall-related fractures.[2,23,36,42,49] However, two other studies report more falls occur in the afternoon than at night,[27] and fewer fractures occur in the bathroom than elsewhere.[49]

Physiologic Causes.—

Normal aging brings deterioration in many functions which may produce an increased tendency to fall.[48] Physiologic functions that deteriorate with age include the sensory components of vision and vestibular function, balance, strength, flexibility, and gait.

Sensory Impairments.—Several studies report visual impairments increase with age.[2,10,15,43,55] One study reports fallers over age 70 have significantly poorer vision than nonfallers, and when vision is deprived at night, many people become unsteady and fall.[42] In addition, visual impairments may interfere with depth perception and prevent people from seeing obstacles or judging distances correctly. As a result, individuals fall.[8]

The vestibular system deteriorates with age.[15,42,43,55] There seems to be a loss of cells in both the peripheral and central parts of the vestibular system;[60] this decrease of vestibular function and nerve cells seems to accelerate around age 70.[60] Compensation for vestibular dysfunction is delayed and, in some cases, less effective in elderly persons[60] so falls may result. In agreement with the above statements, the subjective ability to keep good equilibrium is significantly decreased in elderly people over age 65.[21]

Balance.—Older people have poorer balance than younger people.[43] A decline in sensorimotor function,[53] as well as a decrease in physical and cognitive abilities, contribute to deterioration of balance and stability.[4] This deterioration impairs the body's ability to correct for postural disturbances, such as slips, trips, or pushes, as well as self induced placements that occur during turning, reaching, and transferring.[27,45] The inability to correct for postural disturbances results in overbalance and a fall.[45]

One of the components of balance is body or postural sway. Many studies indicate postural sway increases with age.[2,27,43,55,62] Additional studies

report the frequency of falls increase as sway increases.[43,63,64,66] Elderly have slightly higher measures of sway in double stance when compared with younger people.[58,62] Age differences in sway are significantly accentuated in single stance, with sway three times greater in older subjects as compared to younger subjects.[22] Despite the above statements, not all articles report postural sway increases with age. Another article reports no relationship between postural sway and increasing age.[27]

Strength.—There is a decline in muscle mass[30] and strength with age, which occurs in both sedentary[8] persons and to a lesser extent in active persons.[2,10] With each decade of life after age 30, there is a 10% decrease in strength;[8,67] Larrsen and Barges[27] report a significant decrease in muscular strength after age 50. Additionally, healthy elderly score 20% to 40% lower on strength tests than do young adults.[2]

With age, most individuals decrease their occupational and leisure activities.[30] As a results of disuse, there is a decrease in sarcomeres,[8,30] an increase in subcutaneous and intramuscular fat,[30] preferential atrophy of fast twitch (type II) fibers,[8,30] less oxidative enzyme capacity,[30] a decrease in glycogen storage,[30] and muscle atrophy.[30] These physiologic changes result in lower force production,[65] decreased muscle endurance, and decreased explosive power.[30]

The previously mentioned muscle changes contribute to musculoskeletal problems which may cause falls.[8,42] Loss of muscle strength limits functional

capacity[42] and reduced muscle strength in the lower extremities impairs mobility[8] and control when changing body positions.[27,42] For example, the first lower extremity muscles to decrease in strength due to aging are the quadriceps and hamstrings.[8] These muscles are crucial for ambulation and stair climbing. During stair climbing, when all the body weight is on one leg, there is an increased risk of falling. This risk is greater for women than men because decreased muscle strength is more prevalent in elderly females than elderly males.

Flexibility.—Aging also affects flexibility. Changes in collagen alignment decrease the flexibility of the skin, soft tissue, connective tissue, ligaments, and joint capsules.[67] Inactivity and the effects of diseases like arthritis also contribute to the decline in flexibility that occurs with aging.

Gait.—The incidence of gait disorders increases with age,[28] with gait disorders affecting 20% to 50% of elderly individuals.[2] Indeed, nearly 75% of all nursing home residents either need assistance to ambulate or cannot ambulate.[2]

Gait problems along with muscle weakness[2] and pain[2,42] are associated with 25% of all falls. An unsteady gait is often associated with accidental slips or trips.[45] The potential for falling also increases if a person demonstrates any of the following: decreased stride length, decreased step height, uneven steps, increased guardedness, or nonsynchronous arm swing at heel strike.[45] Various studies report that decreased walking speed is associated with aging and falls.[2,27,45]

Pathologic Causes.—

Various pathologic conditions associated with increasing age may increase the incidence of elderly falls.[48] These conditions include orthopedic, cardiovascular, nervous, metabolic, hematologic, and mental conditions.

Orthopedic Conditions.—The effects of aging on bones include increased fragility,[51] decreased density,[67] increased mineral loss,[67] and increased porosity.[8] Osteoporosis is a risk factor for falls and fall-related fractures in women over age 55 secondary to post-menopausal changes that occur.[8] Additionally, degenerative conditions such as arthritis and degenerative joint disease are implicated in the etiology of falls[2,8] as they decrease the agility of the elderly.[42]

Cardiovascular Conditions.—As mentioned previously, elderly people often live relatively sedentary lifestyles. This affects the cardiovascular system, causing the heart to accumulate more fibrous and fatty tissues.[8] Other age related cardiovascular changes include decreased cardiac output, decreased blood flow to the heart, and decreased maximal heart rate.[8] These changes are evidenced in the elderly as decreased endurance, fatigue, and lightheadedness.[8]

Research is unclear on the role orthostatic (postural) hypotension plays in falls in the elderly. Various articles report its contributing association with falls in the elderly.[2,8,48] In contrast, there are reports that orthostatic hypotension infrequently causes falls, especially outside of nursing homes.[2] Regardless, it is difficult to establish this condition as a definite cause of falls because of its

transient nature and the fact that most people who feel lightheaded sit down before falling.[2]

Other cardiovascular problems associated with falls include arrhythmias, aortic stenosis, and carotid atherosclerosis.[48] Syncope, which is a loss of consciousness that may result in falls,[2] can be caused by some of these conditions, including arrthymias,[2,42] aortic stenosis,[42] and orthostatic hypotension.[2,42]

Neurologic Conditions.—There are a number of neurologic conditions that may cause falls. Cerebrovascular accidents,[42,48] TIAs,[48] Parkinson's,[42,48] and normal pressure hydrocephalus contribute to falls by causing dizziness, orthostatic hypotension, and gait problems.[42]

Neurologically related drop attacks are sudden falls that occur without a loss of consciousness and without dizziness.[2,48] Drop attacks are associated with vertebrobasilar insufficiency,[2] but other minor conditions, such as increased body sway and vestibular disorders, may also cause them.[42] Early articles pertaining to geriatric falls report drop attacks cause 12% to 25% of all falls.[2,42] Current literature, however, reports a smaller percentage.[2] This could be due to greater accuracy with diagnosing the actual causes of falls as well as the decreased tendency to attribute falls of unclear causes to drop attacks.[2]

Mental Conditions.—A number of mental impairments contribute to falls in elderly.[54] In mentally impaired individuals, loss of attention during ambulation may contribute to falls.[42] People who are confused may attempt to ambulate

without an assistive device.[45] They may not recognize and avoid environmental hazards which can result in a fall.[2]

Cognitive deficits interfere with accurate perceptions of the abilities needed to perform various activities.[54] One article reports people with increased cognitive impairments generally have poor balance, but positive perceptions of balance; people with depression have good balance, but poor perceptions of balance.[54] As noted, people with depression have good balance, but may not pay attention to their surroundings and may fall as a result of this inattention.[54] Therefore, depression as a cause of falls is controversial.[54]

Dementia may be a major factor in elderly falls.[42] It impairs judgment, visual spatial perception, and the ability to geographically orient one's self to the surroundings.[2] Demented individuals may wander, attempt to get out of their wheelchairs, or climb over bed rails and therefore increase their chances of falling.[2]

Psychological conditions prevalent in those who fall include depression, anxiety, and poor subjective health ratings.[48] Psychiatric problems result in altered moods, preoccupation, and denial of limitations, all of which contribute to falls.[44,48]

Pharmacologic Causes.—

Medication intake increases the risk of falls in elderly; this is especially evident in the individual taking three or more medications.[42] Hypnotics and tranquilizers decrease a person's level of alertness and increase reaction time.[42]

In fact, major tranquilizers increase the likelihood of falls by over 50%.[42] Side effects of various drugs increase the likelihood of falls.[42] Tricyclic antidepressants may cause postural hypotension.[42] Antihypertensives may also cause hypotension and cardiac arrhythmias.[15,28] Anticholinergics may cause blurred vision.[42] Sedatives,[27] antidepressants, diuretics, antihypertensives,[15,28] vasodilators, and beta blockers,[2,10] may cause impaired thinking, instability, and gait problems.[2] Psychotropic drugs have consistently been associated with increased fall risk,[20-22,24,53,6] increased hip fracture risk,[48] decreased quadriceps strength, and impaired balance.[15] Psychotropic medications as a cause of falls in the elderly is serious, as 50% of nursing home residents in the United States take this type of medication.[8,48]

Miscellaneous Causes.—

Although most causes of falls can be classified as environmental, physiological, pathological, or pharmacological, there are some additional conditions that contribute to falls in the elderly. Foot problems, including bunions, nail dystrophies, and calluses[42] as well as improper footwear[48] are associated with falls.

Metabolic problems associated with falls include hypoglycemia, hyponatremia, dehydration, and malnutrition.[48] Hematological problems, such as anemia, are also implicated with fall risk.[42] Diabetes and obesity increase the risk of falling.[42]

Dizziness has been reported as a cause in 25% of nursing home falls.[2] Dizziness may imply a number of different conditions, including cardiovascular problems, hyperventilation, orthostatic hypotension, and gait disorders.[2] It may also indicate a vestibular problem.[2] All of these conditions have been discussed as potential causes of falls. This could indicate why dizziness is often reported as a common cause of falling.

Alcohol is another area associated with elderly falls.[42] Those who are "closet" alcoholics are especially prone to falls.[48] In addition, the negative side effects of alcohol can be compounded when it is consumed with some medications. For example, when alcohol is combined with tranquilizers, the risk of falling increases.[42]

Now that the definition of falls has been discussed and related to the elderly population, the following chapters will discuss physical therapy intervention for falls. Evaluation of the problem is crucial to all physical therapy interventions and is the initial step in the treatment process. Therefore, the components of a fall evaluation will be explained and clinical tests will be covered.

CHAPTER IV

ASSESSMENT OF FALLS IN THE ELDERLY

Preventive and Post Fall Assessment

There are two basic assessments that pertain to falls in the elderly. They are the preventive fall assessment and the post fall assessment.

Optimally, the assessment should be preventive and focus on identifying risk factors for falling that are present in the elderly individual. Screening will include physiology, environment, neurological, neuromuscular, musculoskeletal, cardiovascular, and cognitive factors. It will also identify a history of previous noninjurious falls, as once an elderly person has fallen, he or she is more likely to fall again.[48]

The second assessment is the post-fall treatment. This assessment is a crucial part of treatment for an elderly person who has fallen.[49] Studies show that elderly subjects who receive a post-fall assessment are less likely to be hospitalized.[68] They are also less likely to fall in the future when compared to controls not receiving a post-fall assessment.[55] Like the preventive fall assessment, the post-fall assessment identifies risk factors for falls.[2] It can also identify the cause(s) of the fall that the elderly person experienced. In fact, various studies report that a focused history and physical examination can

identify over 90% of the causes of falls.[42,68] Therefore, the importance of an accurate assessment is clear.

As previously mentioned, identifying the risk factors associated with falls is a key element of both the preventive fall and post-fall assessments. Elements of both assessments are similar with the exception of the history portions. The preventive fall assessment's history will focus on a history of noninjurious falls. In contrast, the post-fall assessment's history must focus on a detailed account of the injurious fall. Obtaining a full report of the circumstances surrounding the fall is crucial.[2,42,48,49] Therefore, if the elderly individual cannot remember the circumstances of the fall, a relative or other witness should be questioned about the fall.[2,42] The following paragraphs describe the history taking in more detail.

History

Information that should be obtained pertaining to the fall includes the health status of the individual and the medications he or she was taking during the week prior to the fall.[2,49] It is especially important to note what these two conditions were like during the 24 hours immediately preceding the fall.[49] In addition, information about the time the individual remained on the ground or floor after the fall and how the fall influenced the person's self confidence and fear of future falls should also be obtained.[2] A list of pertinent circumstances and symptoms pertaining to elderly falls is located in Appendix A.

The history portion of both assessments should include relevant comorbid conditions, such as stroke, parkinsonism, joint dysfunction, and

depression.[2,42,44,56,69] A list of additional comorbid conditions is located in Appendix A.

Medication use, as well as alcohol intake, is a pertinent part of history taking. Particular medications that need attention are those that have hypotensive or psychoactive effects.[2] A more complete list of medications that increase the risk of falls is located in Appendix A.

Physical Examination

After a complete history is obtained, a physical examination of the elderly individual should be performed. Components that need to be evaluated include: neurological status, neuromuscular status, musculoskeletal status, gait, balance, cardiovascular status, cognitive capability, and functional status.

Neurological Status.—

A neurologist should be consulted for a complete and detailed neurologic examination.[42] However, there are a number of sensory tests a physical therapist can perform.[2,11,42,43,48,53] These include superficial sensations of pain (sharp/dull discrimination), temperature, light touch, and pressure as well as the proprioceptive sensations of position and kinesthesia.[70]

A gross hearing assessment can be performed by observing the response of the elderly individual to different spoken volumes and tones.[70] Tests for visual impairment should include visual acuity, depth perception, and peripheral field vision.[42,70]

Vestibular function can be assessed grossly by determining whether neck movements cause dizziness or nystagmus.[42] Nystagmus is a constant, involuntary, cyclic movement of the eyeball in any direction.[71] Peripherally induced nystagmus has a latency of 5 to 45 seconds, while centrally induced nystagmus (a cerebellar problem)[70] has no latency.[42] The presence of a peripheral vestibular lesion can be determined by having the individual perform the Romberg and Tandem Romberg signs. A positive Romberg is indicated by an individual's inability to maintain his or her balance while the eyes are closed and the feet are close together. The Tandem or Sharpened Romberg is similar, but the heel of one foot touches the toe of the other.[42] A normal Romberg, but an abnormal Tandem Romberg, may indicate a peripheral vestibular lesion.[42] The presence of the neurologic symptoms of rigidity and tremor is indicative of basal ganglia dysfunction.[70]

Neuromuscular Status.—

The neuromuscular component of the physical evaluation includes evaluating the elderly individual's strength and range of motion.[39] Numerous studies report assessing general lower extremity strength,[8,11] while others test only specific muscle groups such as the plantarflexors,[22,67] hip extensors, hip abductors,[67] quadriceps,[4,53] and dorsiflexors.[4,11] Other studies report assessing both lower extremity strength and upper extremity strength.[5,38,48,67] One study reports evaluating the muscle groups most important for function and mobility.[5] A list of these muscle groups is located in Appendix A.

Range of motion needs to be assessed.[5,8,37,69] Range of motion of the manually tested muscle groups should be evaluated. This should be done after the manual muscle testing to insure that optimal range of motion is attained because the joint capsule will have been stretched during the muscle testing.[5] In addition to the muscles listed in Appendix A, range of motion of the neck and spine should also be assessed.[8] Staley and Richard[8] advocate testing range of motion at different velocities because individuals must be able to generate movement quickly in order to maintain their balance.

Musculoskeletal Status.—

Various musculoskeletal problems must be assessed. These primarily include podiatric problems,[2,69] such as ingrown toenails, calluses, bunions, and corns.[48] However, joint dysfunction that causes pain must also be evaluated.[48]

Balance.—

Poor static or dynamic balance is an important contributor to falls.[53] Good standing balance is the result of proprioceptive, vestibular, and visual inputs that are integrated into postural adjustments.[58] These adjustments decrease body sway and maintain the body's center of mass over its base of support.[58] Proprioceptive, vestibular, and visual senses have been discussed as part of the neurologic component of the assessment. Aspects of the balance component that are important to assess include an elderly individual's degree of postural

sway, his or her ability to rise from a chair,[2] and his or her ability to balance while sitting, standing, carrying objects, and bending.[69]

Gait.—

One of the critical determinants of the quality of life in the elderly is their ability to walk.[42] Therefore, assessing gait is an essential component of either the preventive or post-fall assessment. Gait velocity, rhythm, stride length, and height of stepping are aspects of gait that need to be assessed.[2] Double limb support time,[2] as well as single limb support time, must be evaluated.[42] Symmetry or asymmetry of gait should be noted.[2,66]

When assessing a person's ambulation abilities, it is important to note the type of assistive device used.[42] The device, such as a wheelchair or walker, should be documented specifically. The quality of the ambulation also needs to be evaluated. For example, the distance at which the person begins to fatigue and whether that distance is appropriate must be determined.[2]

When assessing gait, it is important to have the individual ambulate on even and uneven surfaces.[69] Other components such as turning, walking on heels, walking on toes, and walking heel to toe should be evaluated.[69]

There are four abnormal gait types.[42] The first one is a shuffling gait. It is demonstrated by low foot carriage, high sway, and slow speed. When it is combined with decreased or absent arm swing, it resembles a parkinsonism gait.[42] The second one is called senile gait.[42] Its pattern is seen mostly with advancing age. This gait frequently leads to loss of independence. Typical

features of the senile gait include a flexed posture, wide based gait, slow speed, and increased sway. In addition, individual with this gait pattern demonstrate slowed cognition, impaired ability to look forward, absent ankle jerks, and intention tremor.[42] The third abnormal gait pattern is march a petit pas and is a shuffling small stepping gait that is seen in multiple cerebral infarcts.[42] The fourth gait pattern demonstrates cerebellar dysfunction and may be wide based with steps that are irregular in amplitude and timing. Another characteristic of this gait is a sideways lean.[42] Any of these abnormal gait patterns can contribute to falls in the elderly.

Cardiovascular Status.—

An elderly person's blood pressure and pulse should be taken frequently.[2] In fact, blood pressures should be taken while the individual is lying supine, sitting, and standing.[48] Postural hypotension that may result from the change from supine to standing should be noted.[68] Taking an individual's pulse can aid in determining the presence of cardiac arrhythmias and valve abnormalities.[42]

Cognitive Capability.----

The elderly person's mental function must be evaluated in both the preventive and post-fall assessments. Mental function should be assessed formally with a standardized test.[42] An example of a standardized test is the Mini Mental State Examination.[42] Information about this test and other published tests will be covered in the next chapter.

A "quick" evaluation for mental status is especially helpful clinically. Simple tests to determine mental orientation include questions pertaining to person, place, and time.[70] Short- and long-term memory questions such as "What did you have for breakfast today?" and "Where were you born?" are useful in determining the individual's mental state.[42,70] The ability to think abstractly should be assessed. However, it is important to consider the individual's initial level of intelligence, since all people function at various levels.[42]

Functional Status.—

There are a number of functional skills that need to be assessed in either the preventive fall or post-fall assessment. These include the individual's ability to perform bed mobility and transfers[2,45,69] and the level of independence and safety he or she displays while bathing, dressing, and performing other activities of daily living.[2,69] The amount, extent, and nature of personal assistance should also be evaluated.[2] If the person needs to be restrained for his or her safety, the type of restraint and when it is used should be noted.[2]

This chapter discussed subjective components as well as some objective components of the preventive and post-fall assessments. Appendix A is a supplement to the information contained in this chapter. Objective clinical tests are also a pertinent part of any physical therapy evaluation. The next chapter discusses some of these measurements as well as laboratory and functional clinical measurements.

CHAPTER V

OBJECTIVE LABORATORY AND CLINICAL TESTS

One purpose of research pertaining to falls in the elderly is the development of objective, quantitative measures of balance and mobility.[39] Many methods of assessing balance capacity have been developed since Romberg's observations more than a century ago.[39] These methods range from sophisticated, technical measurements only applicable in laboratory settings to quick and simple clinical tests easily applied in various physical therapy settings.[27] This chapter will focus on the various objective tests as they apply clinically. Of these measures, laboratory tests will be discussed first.

Laboratory Measures

A number of articles present laboratory measures used to identify elderly individuals at risk for future falls.[43] Risk is measured by identifying possible causes of falls, such as the inability to maintain balance during postural perturbations or by identifying an individual's fear of falling.[7,43,56]

Body sway, which is the amount of natural unintentional movement during quiet standing, increases with age.[73] Increased body sway is correlated with an increased frequency of falls.[43,63,64,66] For this reason, most laboratory tests use body sway to identify individuals at risk for falling.[7,8,11,49,52,56,74] This is called

posturography, and it is defined as the measurement of spontaneous postural sway during quiet, unperturbed standing.[6]

Postural sway tests indicate the integrity of the corrective postural control mechanisms.[56] Postural platform systems have been developed specifically for this purpose.[54] The laboratory tests that assess postural sway require the individual to step onto a platform or force plate.[37,63] While the individual is standing on the platform, it moves in various directions (i.e., forward, backward, or sideways). The platform can also be moved continuously or suddenly to enable the researcher to observe postural sway in either of these conditions. Throughout the tests, the individual experiences the different positions of the force plate for various time periods both with and without visual input.

Some studies use electromyography (EMG) during posturographic analysis to assess an individual's muscle activation during the movement of the force plates.[60,74] Two definitions are pertinent to the discussion of EMG studies. These are latency and sequence. Latency is the measure of the speed of response.[60] It is defined as the time from the onset of the platform or force plate movement to the first evidence of the burst of electrical activities in the monitored muscles.[60] Sequence is a measure of the order of muscle activation.[60] Normal sequence for a small displacement of the supporting surface is rotation around the ankle joint first.[60] A correction by more proximal leg muscles, such as the knee or hip muscles, is less efficient.[60] Delayed latency and loss of distal sequencing is found in normal elderly individuals.[60] It is postulated that fallers

display these abnormalities to an even greater extent than normal elderly. Therefore, using EMG studies along with posturography tests may help predict an increased risk of falling in elderly individuals.[60]

The use of laboratory measures in assessing the risk of falls in elderly individuals has been described. The cost and complexity of some laboratory measures makes them impractical for clinical use.[58] In addition, the lack of portability of these laboratory measures demonstrates the importance of measures of balance and mobility that can be used clinically.[21-24,30,52]

Clinical Measures

Objective clinical measures will now be discussed. First, relatively simple and popular clinical measures will be presented. These measures have been used often in the clinic and can be described as "special tests" for balance and mobility. An example is the single leg stance. Later, functional scales pertaining to balance and mobility will be discussed. Examples of these tests include Functional Reach and Tinetti's Assessment Tool.

Special Tests.—

Single leg stance is reported by multiple authors.[7,11,27,30,39,75,76] Lichenstein and colleagues[63,64] report that single leg stance is the most important static stance to measure body sway, as 20% to 40% of gait is spent on one foot.[63.64] This test is a traditional measure performed in physical therapy practice[27] to detect balance impairment, and it significantly distinguishes fallers from nonfallers in the elderly.[11,76]

Literature presents a variety of ways single leg stance is measured. For example, one study recommends documenting the amount of time (in seconds) a person remains on the supporting leg while the opposite foot is positioned half way up the calf of the supporting leg.[76] This is recorded both with the eyes open and then with them closed.[76] Another study describes the test performed in the following way:[11] The individual stands on the preferred leg, which is the leg he or she chooses to stand on when instructed to kick an imaginary ball.[11] The individual then raises the opposite leg two inches above the ground and holds it there. The test is timed and is performed both with the eyes open and then closed. The number of seconds (up to 30) the subject holds the position is then recorded. Disqualifications include touching the ground with the elevated leg, grabbing the clinician for support, or opening the eyes during the eyes closed portion of the trial.[11] Additional variations of this test include testing both legs and recording the best time[75] and shaking or rotating the head while performing the test.[27,75] Thirty seconds is considered normal for single leg stance time.

Double leg stance[15,30,37,46,67,69,75] is also a clinical test of balance. As a measure of static balance, the individual's ability to maintain his or her balance while standing on both firm and compliant surfaces is graded.[15] In this test, a grade I is given if the individual cannot maintain his or her balance on a firm surface for any period of time without support. A grade V is given if the individual is able to maintain his or her balance without difficulty while standing on the floor or the foam, both with the eyes open and then closed for a time

frame of 30 seconds.[15] Another study reports a similar technique, but uses a three-point grading system.[69] Various studies also measure double limb support in the Romberg and Sharpened (tandem) Romberg[30,46,67,75] positions. The tests are timed and the "normal" time length ranges from 10 seconds to 30 seconds.[46,75] The individual's arms can be in any position; the individual is tested both with eyes open and closed, and the head is either stationary or moved in a nodding fashion.[30,75]

Two articles describe a test for dynamic balance.[14,45] The individual walks in place for one minute, both with the eyes open and then closed. A grade I is given if the individual's dynamic balance is so poor that the test could not be given; a grade V is given if the individual does not have any difficulty maintaining good balance. Additional tests of dynamic balance include walking toe to heel backwards between two lines, walking heel to toe forward on a line, and walking backwards on a line.[30,74,76] The clinician observes the individual's performance for hesitancy, deviations in gait, or mistakes in the performance.

Gait assessment is recommended for early identification of mobility problems and risk factors for falls in the elderly.[77] Walking speed is a fundamental measure of mobility.[2,30,39,46] An individual should be observed and timed while he or she walks a certain distance (10 feet to 30 meters); the distance should include turning 180 degrees.[27,74] The presence or absence of corrective or erroneous steps as well as the need for an assistive device should be documented.[46,74]

In addition to the above clinical measures, observing an individual's ability to turn in a circle, bend to pick up an object from the floor, and climb stairs are functional mobility maneuvers that assess gait and balance.[30] These activities can give a clinician clues to a person's ability to perform various functional skills.

The next part of this chapter discusses objective clinical measures that are functional scales. A brief description of each measure is presented; reliability and validity information for each measure is summarized in Table 1.

Functional Scales.—

When published clinical measures are discussed, there are a number of clinometric characteristics that are used to describe the test's effectiveness.[57] These include reliability, validity, and sensitivity to change.[57] Reliability refers to the ability of the measuring method or device to produce reproducible data or information.[71] Validity refers to the extent to which a measure reflects the true situation.[71] Sensitivity to change is used to determine the ability of a measure to accurately assess clinical change after intervention has been implemented.

A number of published clinical tests pertain to cognition, depression, balance, and functional abilities in the elderly. Five of the most frequently discussed clinical tests include the Folstein Mini Mental State Exam,[3,30,41,43,44,46,60,69,76,78] the Berg Balance Scale,[40,52] the "Get-up and Go"

Table 1.—Reliability and Validity of Functional Scales

TEST	RELIABILITY Intra	 Inter	VALIDITY
Folstein Mini Mental State Exam[78]	Pearson r = .887[80]	Pearson r = .827[80]	Content: established via construction Concurrent: Verbal: Pearson r = .776[79] Performance: Pearson r = .660[79]
Berg Balance Measure[40]	Cronbach's Alpha = .96[80]	Cronbach's Alpha = .99[80]	Content: Established via construction[80]
Tinetti Assessment Tool[59]	Not reported[80]	85%[80]	Not reported[80]
"Get up and Go"[79]	Not reported[80]	Kendal's coefficient greater than would be expected by chance[80]	Not reported[80]
Functional Reach[57]	Established[72]	Established[72]	Concurrent construct, criterion, predictive validity all established

test,[50,55,60,67,79] the Tinetti Assessment Tool,[3,7,6,39,43,48,50,59,67] and Functional Reach.[8,37,55,67]

A description and score interpretation are discussed for each of the five tests mentioned above. Reliability and validity information is summarized in Table 1 after the tests are presented. Appendix B contains examples of each of these tests.

Folstein Mini Mental State Exam.—As mentioned elsewhere in this study, cognition plays an important role in the risk of falls in the elderly. The Folstein Mini Mental State Exam measures the cognitive abilities of a person.[80] It is "mini" for at least two reasons. The first is it consists of 11 questions requiring only five to ten minutes to complete.[78] The second is it concentrates only on the cognitive aspects of mental function and does not include questions about mood, abnormal mental experiences, and thinking form.[78]

The test interpretation is as follows: the lower the individual's test score, the lower his/her cognitive function[80] and the higher the risk of falling.

Berg Balance Measure.—The Berg Balance Measure measures the ability of the elderly person to balance.[40] It assists professionals in determining treatment goals, evaluating the effectiveness of treatments, and identifying those individuals prone to falls.[40] The test consists of 14 balance items safe for elderly to perform; it takes 15 to 20 minutes to administer.[80]

The test interpretation is as follows: the higher the patient's score, the more independent the patient[80] and the lower the risk of a fall.

Tinetti Assessment Tool.—The Tinetti Assessment tool is a performance oriented assessment of both gait and balance.[59,80] It can be used clinically to identify: 1) mobility problems during activities of daily living, 2) potential reasons for the difficulty via direct observation, 3) problems other than immobility (such as falling), 4) potential medical and rehabilitative strategies that may improve mobility, and 5) potential environmental modifications that may prevent problems.[59] The test is also used to assist individuals in adapting to mobility problems.[59]

The Tinetti Assessment tool is comprised of 12 gait components and 16 balance components.[80] The maximum possible score is 28.[80] The test takes 10 to 15 minutes to administer.[80] Scoring is ordinal, with "0" meaning the individual is maximally impaired and "2" meaning the individual is independent with performing that item.[80]

The test interpretation is as follows: people scoring less than 19 are at high risk of falling, those scoring between 19 and 24 possess a risk of falling,[80] and those scoring greater than 24 have minimal risk of falling.

"Get-up and Go" Test.—

Many frail elderly patients fall when rising from a chair, walking, turning, or trying to sit down.[79] The "Get-up and Go" test measures a person's ability to perform the above sequence and notes any deviations from a confident, normal performance.[79] There are six items to perform, and the test takes approximately five minutes to administer.[80] It is scored ordinally on a scale of 1 to 5. A score

of "1" indicates a normal performance; a "5" indicates severely abnormal performance.[80]

The test interpretation is as follows: a "1" indicates the person does not appear to be at risk for falling.[80] Scores of "2," "3," and "4" describe the patient's movement and indicate the possibility of stumbling.[80] A "5" indicates the subject is at serious risk of falling while performing the test.[80] A person with a score of "3" or more is at risk for falling; this score should alert health care workers to the individual's mobility deficits.[80]

Functional Reach.—A fairly recent measure of balance is functional reach. Functional reach is the maximal distance an individual can reach forward beyond his or her arm's length while maintaining a fixed based of support in the standing position.[57] A leveled yardstick is placed at the height of the individual's acromion of the dominant arm. The individual being tested is instructed to stand comfortably, make a fist, and raise his or her arm until it is parallel to the yardstick.[57] The arm length, from the acromion to the third metacarpal, is recorded as position one.[57] The individual is then asked to reach forward as far as possible without losing his or her balance.[57] This measurement is recorded as position two.[57] Invalid trials (stepping in any direction or touching the wall) are repeated.[57] The procedure is repeated five times, with functional reach being the mean difference between positions one and two over the last three trials.[57] For statistical purposes, scoring is ordinal. A "0" means the person was unable to reach, a "1" indicates a reach of less than six inches, a "2" indicates a

reach between six and ten inches, and a "3" indicates a reach greater than ten inches.[57]

The interpretation of the test is as follows: fallers demonstrate a shorter functional reach (at or near six inches) than do nonfallers.

Laboratory vs. Clinical Measures

Whether laboratory measures and clinical measures are in agreement in their assessment of balance is unclear. One study states force platform measures of balance have been found to be correlated with clinical measures of balance.[27] In contrast, another study failed to report such a correlation.[39] This study was carried out in nursing home residents, so the lack of correlation between laboratory balance measures and clinical balance measures may be explained by the extreme frailty of the residents.[39] Another possibility for the lack of correlation found between laboratory and clinical balance measures is different components of postural control are evaluated with each type of measure. For example, biomechanical measures of postural sway during quiet standing measure static balance, while clinical measures evaluate dynamic balance.[7,67,]

Dynamic measures of balance challenge a person's ability to maintain postural control by simulating situations that tend to displace the center of mass away from the base of support.[39] These tests put the individual at a higher risk of falling during the testing situation.[39] Therefore, they have been advocated in various articles as better predictors of fall risk.[21,56,72] In contrast, laboratory

measures using force platforms are safe, objective, and more precise.[39] However, because the etiology of falls is multifactorial, and because laboratory and clinical measures assess different aspects of balance (static vs. dynamic), a combination of clinical and laboratory measures may best predict fall risk.[39]

Laboratory and objective clinical tests have been discussed. The following chapter describes various preventive fall and treatment strategies for elderly people who are at risk of falling or who have already fallen.

CHAPTER VI

PHYSICAL THERAPY PREVENTIVE AND TREATMENT STRATEGIES

Once the possible cause(s) of the fall and/or risk factors have been identified, the most challenging aspect of the fall evaluation begins.[2] This difficult aspect is determining the most effective treatment and intervention strategy.[2] Because of the multifactorial etiology of falls, unidimensional interventions are likely to be ineffective.[61] There is a strong association between an increased number of impairments and an increase in fall prevalence, decreased self confidence, and immobility;[49] therefore, the interventions should be multidimensional and overlapping.[2,5,30,59]

There is not a standard approach to treating elderly persons who have fallen or who are at risk of falling.[2,49] The interventions should be individualized and should consider the risk factors, functional level, and how the interventions may affect the individual's quality of life.[2] When a fall is caused by an acute problem, treatment may be fairly straightforward.[2] However, most patients fall because of chronic, interacting conditions.[2] In these cases, treatment requires a combination of rehabilitative, medical, environmental, and behavioral strategies.[2,67] Each of these strategies are discussed in more detail in the remainder of the chapter.

Rehabilitative Strategies

Rehabilitative fall prevention and treatment strategies encompass a variety of aspects. General considerations, such as safety and compliance, are discussed first. Following these considerations, more specific components of rehabilitation strategies are presented. These components include: 1) balance, 2) gait, 3) functional activities, 4) strength, 5) endurance, and 6) range of motion/flexibility.

A successful fall and immobility prevention program requires that assessment and intervention strategies target the important modifiable physical impairments. Interventions must be feasible and safe in the individual's home[5,67] and realistic in terms of space, time, and possible long-term adherence.[67] It is important to avoid overburdening individuals with too many exercises simultaneously.[67] In addition to decreasing compliance, too many exercises can result in confusion and even increase the chance of injury.[67]

The atmosphere in which the fall prevention and treatment interventions take place is important. The environment should be quiet, uncluttered, and calm.[51] In addition, any cues or commands directed toward improving motor skills should be clearly stated.[5]

A specific targeted physiologic system should be identified for the interventions.[81] Training programs that identify a single target system, such as leg muscle strength, sensory input, or vestibular function, report significant balance improvements.[11] Conversely, traditional global exercise programs

including total body movement, relaxation, and stretching do not generally demonstrate significant balance improvements.[11] Finally, Hopkins et al[81] found that a low impact aerobic dance program was effective in improving balance performance in elderly women.

Often, there are many deficits that an elderly individual possesses that could contribute or have contributed to falls. In these situations, it is important to prioritize interventions based on the potential of the risk factor to contribute to a fall. One article suggests the order of priority should be as follows:[5] balance and transfer interventions, lower extremity strengthening exercises, lower extremity range of motion exercises, upper extremity strengthening exercises, and upper extremity range of motion exercises.

The following paragraphs focus on specific components of rehabilitative strategies. These components are presented in the recommended order of priority.

Balance.—

Problems relating to balance play a key role in falls in the elderly and, therefore, are addressed first. Balance impairments should be classified according to sensation impairments, central nervous system dysfunction, strength deficits, pain, decreased joint mobility, spasticity, or a combination of these problems.[2] Activities that help to improve an elderly individual's balance include: range of motion exercises, especially of the ankles, knees, and spine;

postural exercises; endurance conditioning; strength training; weight shifting activities; and functional training, such as standing and reaching.[8]

Because there are multiple factors (vestibular, somatosensory, motor, and musculoskeletal) that contribute to balance, specific systems should be emphasized in balance training.[11] Indeed, the concept of balance training has three parts.[75] The first is to increase activity of the receptor organ in the inner ear during exercise. This is done by rotating accelerations of the head in different directions to stimulate vestibular activity. The second involves activating the integrating mechanisms of the central nervous system by offering varying proprioceptive, visual, and vestibular inputs.[75] This is done by improving coordination and decreasing sway.[74]

There are differences in the strength, actions, and control needed for static and dynamic balance.[61] Because of this, prevention and treatment strategies should include both components. Static and dynamic balance training should progressively decrease a person's base of support and move his/her center of gravity outside the base of support.[82]

There are several balance activities found in the literature. In 1976, Liss[83] designed a "stand-up/step up" fall prevention program to improve body strength and balance.[83] A stretching warm up is followed by a set number of "stand ups" followed by "step ups" onto a six-inch stool.[83] A stretching cool down follows.[83]

Another article describes four progressive levels of balance exercises. "The individual is instructed to begin with level one, and perform each exercise

in that level approximately 10 times. The individual progresses to the next level when he or she can perform each exercise in a particular level correctly and safely 8 out of 10 times. Eventually, all individuals will reach a plateau at which there are no further improvements. This plateau is defined as no progress for three weeks at an exercise level. The individual is then instructed to continue performing the balance exercises at that level three times per week to maintain his or her balance abilities."[5(p294)] (See Table 2)

The following activities are also recommended as part of balance training: walking at different velocities and in different directions and performing various dance steps;[27] jumping on different surfaces;[40] walking straight forward then backward on heels then toes;[40] walking with sudden turns;[40] walking sideways;[40] standing on one leg with eyes open and closed;[40] visually fixating the eyes during neck flexion, rotation, and lateral flexion;[40] and exercising with balls (throwing, catching, and bouncing the balls).[40]

Gait.—

Although not mentioned in the priority order of interventions, gait is fundamental to balance and functional activities and is therefore discussed next.

Physical therapists play a key role in preventive fall and treatment programs relative to gait. Gait training directed by a physical therapist is especially helpful for people diagnosed with strokes, arthritis, parkinsonism, and hip fractures.[2] Orthotics, shoe modifications, crutches, and canes should be individually fitted and prescribed.[2] Specialized walkers with seats may be

Table 2.—Progressive Balance Exercises

LEVEL I	LEVEL II	LEVEL III	LEVEL IV
Sink toe stand with both hands	Sink toe stand with one hand	Sink toe stand with no hands	Standing arm/ leg march
One-leg sink stand with both hands	One-leg sink stand with one hand	One-leg sink stand with no hands	Crossover walk
Sink hip circle	Bed walk with arms out	Bed walk with arms folded	Tandem walk
Sitting arms circles	Sink side step with both hands	Sink side step with one hand	Heel-toe walk
Sitting knee lifts, arms to side	Sitting march	Sink leg cross	One-leg sink toe stand
	Sitting knee lifts, arms across chest	Sink leg swing	
		Sink leg lift	
		Heel stand	

Adapted with permission from Koch M, Gottschalk M, Baker DI, Palumbo S, Tinetti ME. An impairment and disability assessment and treatment protocol for community-living elderly persons. Phys Ther. 1994;74(4):286-294.

appropriate; this allows a person the security of being able to sit down if needed.[49] Other aspects of gait training are to increase the ambulation distance appropriately[41,55,82] and to have the individual ambulate under differing conditions, such as on ramps, uneven terrain, and around barriers.[84]

Functional Activities.—

A number of articles emphasize the functional aspect of fall prevention and treatment programs. Transfer training is fundamental.[41,44,67,82] If possible, transfers should be observed in the home.[67] Recommendations and training can then be given there. In addition, the elderly person's ability to perform household activities should be examined.[27] Recommendations and instructions can be given to ensure these activities are carried out safely.

Bed mobility can be taught to those who are more fragile and at increased risk of falling. Activities such as bridging and rolling progressions are appropriate.[82] Repetition and practice is important for the learning of these functional activities.

In addition to transfer training and bed mobility skills, all elderly should be trained to get up from a fall.[44] This includes moving from supine to prone, crawling to a strong support if available, and pulling one's self to sit or stand.[44]

Encouraging family members to frequently check up on the elderly individual who is at a significant risk of falling is also an important aspect of a fall program. Early discovery prevents or minimizes complications should a fall occur.

Strength.—

Based on the order of priority, after balance and transfer training, strength interventions should be implemented prior to range of motion interventions. Range of motion and strength are both vital in balance training.[10] However, one study reports range of motion deficits are less common than strength and mobility deficits.[82] Another article specifically states prevention and treatment for falls should focus on improving strength and endurance.[2]

Strengthening must be individualized. For example, elderly individuals who are unable to ambulate regularly can be instructed in various chair exercises that include strengthening ankle dorsiflexors and quadriceps.[61] Strengthening exercises can also be performed in the supine, prone, and sidelying positions.[54,62] Weights can be implemented to increase strength of the leg muscles and the weights can be gradually increased.[61,82] Theraband is an additional method of increasing resistance during strength training.[69,82]

To improve strength, high resistance training must be implemented.[30] Literature indicates low resistance activities, such as walking and stretching, produce little if any gains in strength.[30] Literature reports that 80% of one repetition maximum (the highest weight which can be successfully lifted properly one time) is adequately tolerated by the elderly.[30] In the case of very frail elderly, the benefit of resistance training may be questioned.[30]

Muscles that need to be trained in the lower extremities include the hip and knee extensors as these muscles are used in transfers, standing, and

ambulation.[30] Strength of these muscles is closely related to gait speed, stair climbing, and single stance abilities.[30] Literature indicates fallers are weaker in these actions than nonfallers.[23,30]

Endurance.—

Endurance is a component that must be addressed and, whenever feasible, endurance activities should be incorporated into daily routines.[61] Walking is one way to do this.[61] From the individual's beginning level, or baseline, the individual should be assisted in developing a plan to increase the frequency and duration as appropriate.[61] For the elderly, walking should be performed at a moderate level, but never intensely enough to become out of breath.[61]

Range of Motion/Flexibility.—

Flexibility is an important component of balance[27] and has been implicated in improving single stance balance.[62] Neck and shoulder girdle flexibility exercises are important, as well as trunk lateral rotation and thoracic spine extension exercises in standing.[62] In the lower extremities, knee and ankle ROM should be addressed.[8]

In addition to improving balance, range of motion intervention is indicated if range of motion is less than ideal for activities of daily living.[28] The range of motion values for these major functional actions are located in Table 3.[5]

Table 3.—Range of Motion Values for Functional Activities

Upper Extremity Motions	Degrees
Shoulder Abduction	90
Shoulder Flexion	150
Shoulder Extension	20
Elbow Flexion	140
Elbow Extension	20
Lower Extremity Motions	**Degrees**
Hip Flexion	90
Hip Extension	10
Knee Flexion	90
Knee Extension	10
Ankle	Neutral

Adapted with permission from Koch M, Gottschalk M, Baker DI, Palumbo S, Tinetti ME. An impairment and disability assessment and treatment protocol for community-living elderly persons. Phys Ther. 1994;74(4):286-294.

Medical Strategies

Some acute and chronic conditions have specific interventions that can be recommended. For example, teaching desensitization exercises[85] for dizziness may be indicated. Recommendations to prevent/treat postural hypotension can be given. Recommendations include sleeping in bed with the head elevated to minimize sudden decreases in blood pressure on rising, wearing elastic stockings to prevent venous pooling, rising slowly or sitting on the side of the bed before standing, and avoiding heavy meals and unnecessary activity in hot weather.[2]

Malnutrition should be addressed both from a medical and physical activity standpoint. Low physical activity levels are associated with decreased fat-free muscle mass, lower basal metabolic rate, and decreased energy requirements, all of which exaggerate the effects of malnutrition.[30] Unless malnutrition is treated, the effects of physical activity, such as resistance training, will not be optimal.[30] Therefore, in the case of malnutrition, nutritional intervention should be combined with physical activity interventions.[30]

Another more chronic condition of elderly people is impaired cardiopulmonary reserve. People with this problem should be encouraged to maintain their muscle mass, rather than rebuild their muscle mass.[8] Deep breathing exercises and postural exercises to strengthen back extensors and stretch abdominal muscles are also recommended.[8]

Environmental Strategies

The removal of environmental hazards is a critical component of fall prevention and treatment interventions.[5,33] Environmental modifications may include making certain rooms are well lit and removing throw rugs. Placing side rails in stairways and hand supports and non-skid bath mats in the bathrooms decrease fall risk.[8] It is beneficial to have the individual assess his or her own home to determine what modifications are needed;[61] this involves the individual in his or her treatment and helps make the person more aware of hazards in the home and elsewhere.

Behavioral Strategies

One important aspect of the individualized prevention and treatment plan is understanding the person's psychological status, because this is generally responsive to intervention.[54] It is important for physical therapists to realize that in the elderly population, especially those in nursing homes where isolation and depression are common, participation in an exercise program with a trainer may have motivating effects on spontaneous activity, appetite, affect, confidence, and functional abilities.[30] Therefore, a person's overall condition may improve even when only one physical aspect of intervention, such as strengthening, has been implemented.

It is imperative the elderly individual's perceptions of his or her abilities are consistent with his or her actual physical abilities.[56] Fear of falling must be assessed. An exercise program aimed at reducing specific causes of the fear,

such as poor strength or balance, is appropriate. Cognitive behavioral interventions may be even more appropriate. Cognitive behavioral strategies concentrate on reducing the risk of falling by improving the individual's ability to recognize environmental hazards and identifying medically related risk factors.[9] Another behavioral strategy is educating a patient on the safe way to fall.[49] This type of treatment is indicated for patients who may have Parkinson's or ataxic gait.[49] In a group situation, cognitive behavioral strategies work on improving confidence and decreasing anxiety by discussing health and safety topics, teaching relaxation exercises to reduce tension, and playing video games to improve reaction time.[9]

Behavioral interventions to prevent falls, such as limiting ambulation or using restraints, may be more detrimental to the person than an actual fall. Physical therapists must remember that to be compatible with rehabilitation goals, preventive fall interventions must strike a balance between functional autonomy and patient safety.[49]

In this chapter, many preventive fall and treatment intervention ideas have been presented. Appendix B is a quick reference for some of the exercise ideas presented in this chapter. The following chapter summarizes what has been presented in this independent study. It also examines the efficacy of physical activity and physical therapy's role in fall prevention and treatment. Recommendations for future research are also presented.

CHAPTER VII

DISCUSSION AND CONCLUSION

Although there is evidence suggesting that risk factors can be treated, there is not much evidence confirming that treatment interventions actually prevent falls.[2] In addition, the efficacy of physical therapy's involvement in fall prevention has also been questioned. The ability to identify the efficacy of fall prevention interventions and physical therapy is limited by the multiple, confounding causes of falls which require many different interventions.[2] The efficacy of activity and exercise in the elderly and of fall prevention programs in general is controversial.

As far as physical activity in fall treatment and prevention, the positions taken are conflicting. One position states activity is a positive goal that should be encouraged in order for higher function and better quality of life.[2] There is much evidence that recommends all older adults adopt some form of exercise.[86] After all, "one is never too old to exercise!"[8(p564)] Poor physical fitness and disuse lead to a number of problems, such as decreased respiratory status, shortened trunk muscles, and weak antigravity muscles needed for posture.[8] In addition, physical exercise may preserve bone mineral content, as well as increase vigor, self esteem, confidence, and zest for life.[48] Regardless of age,

physiological challenges result in improved functional status.[8] Practice of any motor activity and maintenance of physical fitness helps ensure a higher level of motor performance and speed as a person grows older.[5] Activity should be encouraged.[8]

The opposing position states activity does not alter fall risk and it may actually facilitate the opportunities for falls and injuries.[2]

A community study to prevent falls and injury in 230 people over age 60 compared individuals in exercise and cognitive behavioral programs to those in a control program.[9] There were no significant differences in strength, balance, fear of falling, and perceived health between the groups.[9] It is noted this study used the "stand-up/step-up" exercises previously described for all the subjects participating in the exercise program and did not individually assess any of the subjects. The failure of this study to identify individual deficits could be one reason no significant effects of the exercise interventions were reported.

Another study was performed on very frail nursing home residents over age 60.[82] In this study, the effects of physical therapy interventions were compared to friendly visits. The physical therapy interventions were individualized based on 17 assessed areas of possible deficits.[82] Three to five main deficits were identified in each individual, with only two to three deficits targeted during each treatment session.[81] Results indicate there were no significant improvements in overall Physical Disability Index (PDI), Sickness Impact Profile, or Activities of Daily Living scores.[82] A 15.5% improvement in the

mobility subscale of the PDI was reported, but no benefits in range of motion, strength, or balance subscales were identified.[82] The physical therapy participants were less likely to use assistive devices and wheelchairs for locomotion and less time was needed to sit up and to transfer.[82] However, there were also more falls in the physical therapy participation group.[82] A possible reason for the increased number of falls could be that these people gained more confidence in their mobility skills, participated in more physical activities, and therefore increased their chances of falling.[9,81] It was not determined from this study if active individuals had more falls per unit of activity. Because physical therapy interventions are expensive, this article concludes that further research is needed to determine its effectiveness in fall prevention strategies.

A number of articles report mixed results of various studies regarding the efficacy of fall prevention strategies or training effects on elderly subjects.[2,4,5,9,10,11,42,48,61,62,74,82] Because of the mixed review, identification of risk factors and focused treatment interventions currently appear to be the best method of fall prevention.[2] Clearly, more research is indicated to determine whether proposed fall prevention programs actually prevent falls or whether they just improve various components of a person's well being, such as increased confidence, increased strength, and improved balance ability.

Physical Therapy

As far as physical therapy is concerned, it appears interventions for fall prevention are multifactorial and must be multidisciplinary.[41,82] Obviously, components such as medical problems, environmental factors, and medications must be addressed. Therapists must work with a number of health professionals to develop effective preventive strategies.

Physical therapists can play a key role in multidisciplinary preventive fall strategies. Strategies should include an individualized assessment followed by specific interventions that target specific deficits. Physical therapists also play a key role in treating those who have fallen by treating their actual injuries and the comorbid conditions that contribute to fall risk.

Summary

The significance of falls in the elderly has been discussed. "Falls" have been defined and the five general categories of causes of falls, including environmental, physiological, pathological, pharmacological, and miscellaneous causes, have been examined. The assessment components of an elderly person who has fallen or is at risk of falling have been outlined. A number of laboratory and clinical measures used in assessing and implementing preventive and treatment strategies have also been covered, with five published clinical measures being discussed extensively. General information pertaining to preventive and treatment strategies have been presented. Finally, this chapter discussed the efficacy of activity and exercise in fall prevention programs and

affirmed the role of physical therapists in fall prevention and treatment in the elderly.

APPENDIX A

Components of Preventive and Post Fall Assessments

History Components

Circumstances of the Fall*
Trip or Slip
Location (Indoors or Outdoors)
Time (Day or Night)
Activity being Performed (Transferring, Standing, Walking)
Injuries Sustained
Environmental Hazards

Symptoms Associated with the Fall*
Loss of Consciousness (Cardiovascular or Neurologic)
Palpitations
Chest pain
Lightheadedness
Vertigo
Fainting
Weakness
Incontinence
Dyspnea

Comorbid Conditions
Arthritis
Previous CVA
Parkinsonism
Osteoporosis
Orthopaedic Conditions
Cardiopulmonary Conditions
Seizure Disorder
Metabolic Disorders
Sensory Deficits
Psychiatric Conditions
Depression
Dementia

Medication Review
Antihypertensives
Diuretics
Autonomic Blockers
Antidepressants
Hypnotics
Anxiolytics
Analgesics
Psychotropics
Sedatives
Benzodiazepines
Sleeping Pills
Antipsychotics
Hypoglycemics
Cardiac Medications
Alcohol Intake

*Pertinent to Post Fall Assessment

Physical Examination Components

Cardiovascular
Pulse
Blood Pressure
Postural Hypotension
Cardiac Arrhythmias
Valvular Abnormalities
Carotid Bruits

Neurological
Superficial Sensations
Deep Sensations
Auditory Function
Vision
Vestibular Function
Cerebellar Function
Basal Ganglia Function

Cognitive
Standardized Tests
Mental Orientation
Short Term Memory
Long Term Memory
Abstract Thinking

Musculoskeletal
Podiatric Problems
Painful Joint Dysfunction
Spasticity

Balance
Postural Sway
Chair Rise
Sitting
Standing
Carrying
Bending

Functional Status
Level of Independence
Safety
ADLs
Restraints
Bed Mobility
Transfers
Assistive Device

Gait
Velocity
Rhythm
Stride Length
Step Height
Double Limb Support Time
Single Limb Support Time
Symmetry
Heel Walking
Toe Walking
Heel/Toe Walking
Surface Variations
Stairs

Neuromuscular

Strength of L/E
Hip Flexors
Hip Extensors
Hip Abductors
Knee Flexors
Knee Extensors
Ankle Dorsiflexors
Ankle Plantarflexors

Strength of U/E
Shoulder Extensors
Shoulder Flexors
Shoulder Abductors
Elbow Flexors
Elbow Extensors

Range of Motion of Above &
Neck
Trunk

Appendix compiled from the following sources: 2, 5, 11, 23, 57, 67, 69

APPENDIX B

Folstein Mini-Mental State Exam

	Maximum Score	Score	Instructions
Orientation:			(Test is not timed.)
What is the (year)(season) (date)(day)(month)?	5	_____	One point for each correct segment of the question.
Where are we: (state)(county) (town)(hospital)(floor)?	5	_____	One point for each correct segment of the question.
Registration:			
Name three objects (bed, shoe). Ask the to repeat them.	3	_____	Name the objects slowly, one apple, second for each. Ask him to patient repeat. Score by the number he is able to recall. Take time here for him to learn the series of objects, up to 6 trials, to use later for the memory test.
Attention and Calculation)			
Count backwards by 7s. Start with 100. Stop after 5 calculations.	5	_____	Score the total number correct.
Alternate question:			
Spell the word "world" backwards.	5	_____	Score the number of letters in correct order.
Recall:			
Ask for the three objects used in question 2 to be repeated.	3	_____	Score one point for each correct answer.
Language:			
1. Naming: Name this object (watch, pencil)	2	_____	Score one point for each correct answer.
2. Repetition: Repeat the following--"No ifs, ands, or buts."	1	_____	Allow one trial only. Score one point for correct answer.
3. Follow a 3-stage command: the paper in your right fold it in half, and put it on the floor."	3	_____	Use a blank sheet of paper. "Take Score one point for each part hand, correctly executed.
4. Reading: Read and obey the following: Close your eyes.	1	_____	Instruction should be printed on a page. Allow patient to read it. Score by correct response.
5. Writing: Write a sentence.	1	_____	It must contain a noun, verb, and be sensible.
6. Copying: Copy this design	1	_____	All 10 angles must be present.
Figures must intersect. Tremor and rotation are ignored.			
Total Score		_____	(Max. 30)

Reprinted from Journal of Psychiatric Research, 12, Folstein MF, Folstein SE, McHugh PF, Mini mental state. A practical method for grading the cognitive state of patients for the clinician, pp. 189-198; 1975.

BERG BALANCE MEASURE

1. TO STAND
   ( ) 4 able to stand without using hands and stabilize independently
   ( ) 3 able to stand independently using hands
   ( ) 2 able to stand using hands after several tries
   ( ) 1 needs minimal aid to stand or to stabilize
   ( ) 0 needs moderate or maximal assist to stand

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

If a subject is able to stand 2 minutes unsupported, score full points for sitting unsupported. Proceed to item #4.

3. SITTING WITH BACK UNSUPPORTED BUT FEET SUPPORTED ON FLOOR OR ON A STOOL
   ( ) 4 able to sit safely and securely 2 minutes
   ( ) 3 able to sit 2 minutes under supervision
   ( ) 2 able to sit 30 seconds
   ( ) 1 able to sit 10 seconds
   ( ) 0 unable to sit without support 10 seconds

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

5. TRANSFERS
   INSTRUCTIONS: Arrange chair(s) for a pivot transfer. Ask subject to transfer one way toward a seat with armrests and one way toward a seat without armrests. You may use two chairs (one with and one without armrests) or a bed and a chair.
   ( ) 4 able to transfer safely with minor use of hands
   ( ) 3 able to transfer safely definite need of hands
   ( ) 2 able to transfer with verbal cuing and/or supervision
   ( ) 1 needs one person to assist
   ( ) 0 needs two people to assist or supervise to be safe

6. STANDING UNSUPPORTED (EYES CLOSED)
   ( ) 4 able to stand 10 seconds safely
   ( ) 3 able to stand 10 seconds with supervision
   ( ) 2 able to stand 3 seconds
   ( ) 1 unable to keep eyes closed but stays safely
   ( ) 0 needs help to keep from falling

7. STANDING UNSUPPORTED (FEET TOGETHER)
   ( ) 4 able to palce feet together independently and stand 1 minute safely
   ( ) 3 able to place feet together independently and stand for 1 minute with supervision

( ) 2 able to place feet together independently but unable to hold for 30 seconds
( ) 1 needs help to attain position but able to stand 15 seconds feet together
( ) 0 needs help to attain position and unable to hold for 15 seconds

8. REACH FORWARD WITH OUTSTRETCHED ARM WHILE STANDING
INSTRUCTIONS: Lift arm to 90 degrees. Stretch out oyour fingers and reach forward as far as you can. (Examiner palces a ruler at end of fingertips when arm is at 90 degrees. Fingers should not touch the ruler while reaching forward. The recorded measure is the distance forward that the finger reach while the subject is in the most forward lean position. When possible, ask subjects to use both arms when reaching to avoid rotation of the trunk.)
( ) 4 can reach forward confidently 25 cm (10 inches)
( ) 3 can reach forward 12 cm safety (5 inches)
( ) 2 can reach forward 5 cm safely (2 inches)
( ) 1 reaches forward but needs supervision
( ) 0 loses balance while trying/requires external support

9. PICK UP OBJECT FROM THE FLOOR FROM A STANDING POSITION
( ) 4 able to pick up slipper safely and easily
( ) 3 able to pick up slipper but needs supervision
( ) 2 unable to pick up but reaches 2-5 cm (1-2 inches) from slipper and keeps balance independently
( ) 1 unable to pick up and needs supervision while trying
( ) 0 unable to try/needs assist to keep from losing balance or falling

10. TURNING TO LOOK BEHIND OVER LEFT AND RIGHT SHOULDERS WHILE STANDING
( ) 4 looks behind dfrom both sies and weight shifts well
( ) 3 looks behind one side only other side shows less weight shift
( ) 2 turns sideways only but maintains balance
( ) 1 needs supervision when turning
( ) 0 needs assist to keep from losing balance or falling

11. TURNS 360 DEGREES
( ) 4 able to turn 360 degrees safely in 4 seconds or less
( ) 3 able to turn 360 degrees safely one side only 4 seconds or less
( ) 2 able to turn 360 degrees safely but slowly
( ) 1 needs close supervision or verbal cuing
( ) 0 needs assistance while turning

12. PLACE ALTERNATE FOOT ON STEP OR STOOL WHILE STANDING UNSUPPORTED
( ) 4 able to stand independently and safely and complete 8 steps in 20 seconds
( ) 3 able to stand independently and complete 8 steps > 20 seconds
( ) 2 able to compelte 4 steps without aid with supervision
( ) 1 able to complete > 2 steps needs minimal assist
( ) 0 needs assistance to keep from falling/unable to try

13. STANDING UNSUPPORTED ONE FOOT IN FRONT
INSTRUCTIONS: (DEMONSTRATE TO SUBJECT) Place one foot directly in front of the other. If you feel that you cannot place your foot directly in front, try to step far enough ahead that the heel of your forward foot is ahead of the toes of the other foot.
( ) 4 able to place foot tandem independently and hold 30 seconds
( ) 3 able to place foot ahead of other independently and hold 30 seconds
( ) 2 able to take small step independently and hold 30 seconds

( ) 1 needs help to step but can hold 15 seconds
( ) 0 loses balance while stepping or standing

14. STANDING ON ONE LEG
INSTRUCTIONS: Stand on one leg as long as you can without holding.
( ) 4 able to lift leg independently and hold > 10 seconds
( ) 3 able to lift leg independently and hold 5-10 seconds
( ) 2 able to lift leg independnetly and hold = or > 3 seconds
( ) 1 tries to lift leg unable to hold 3 seconds but r remains standing independently
( ) 0 unable to try or needs assist to prevent fall

( ) TOTAL SCORE (Maximum = 56)

Reprinted from Physiotherapy Canada, Berg K, Wood-Dauphinee S, Williams JI, et al, Measuring balance in the elderly: preliminary development of an instrukment, 1989,41:304-311.

APPENDIX C

TINETTI ASSESSMENT TOOL

Components

Initial Instructions: Subject is seated in hard, armless chair. The following maneuvers are tested.

1. Sitting balance			
	Leans or slides in chair	= 0	
	Steady, safe	= 1	_____
2. Arises			
	Unable without help	= 0	
	Able, uses arms to help	= 1	
	Able without using arms	= 2	_____
3. Attempts to arise			
	Unable without help	= 0	
	Able, requires > 1 attempt	= 1	
	Able to arise, 1 attempt	= 2	_____
4. Immediate standing balance (first five seconds)			
	Unsteady (swaggers, moves feet, trunk sway)	= 0	
	Steady but uses walker or other support	= 1	
	Steady without walker or other support	= 2	_____
5. Standing balance			
	Unsteady	= 0	
	Steady but wide stance (medial heels > 4 in. apart) and uses cane or other support	= 1	
	Narrow stance without support	= 2	_____
6. Nudged (subject at max. position with feet as close together as possible, examiner pushes lightly on subject's sternum with palm of hand 3 times)			
	Begins to fall	= 0	
	Staggers, grabs, catches self	= 1	
	Steady	= 2	_____
7. Eyes closed (at maximum position No. 6)			
	Unsteady	= 0	
	Steady	= 1	_____
8. Turning 360 degrees			
	Discontinuous steps	= 0	
	Continuous	= 1	
	Unsteady (grabs, staggers)	= 0	
	Steady	= 1	_____
9. Sitting down	Unsafe (misjudged distance, falls into chair)	= 0	
	Uses arms or not a smooth motion	= 1	
	Safe, smooth motion	= 2	_____

Balance score: _____/16_____

Gait Component

Initial Instructions: Subject stands with examiner, walks down hallway or across room, first at "usual" pace, then back at "rapid, but safe" pace (using usual walking aids)

10. Initiation of gait (immediately after told to "go")

Any hesitancy or multiple attempts to start	= 0	
No hesitancy	= 1	_____

11. Step length and height

a. Right swing foot

does not pass right stance foot with step	= 0	
passes right stance foot	= 1	_____
right foot does not clear floor completely with step	= 0	
left foot completely clears floor	= 1	_____

b. Left swing foot

does not pass right stance foot with step	= 0	
passes right stance foot	= 1	_____
left foot does not clear floor completely with step	= 0	
left foot completely clears floor	= 1	_____

12. Step Symmetry

Right and left step length not equal (estimate)	= 0	
Right and left step appear equal	= 1	_____

13. Step Continuity

Stopping or discontinuity between steps	= 0	
Steps appear continuous	= 1	_____

14. Path (estimated in relation to floor tiles, 12-inch diameter; observe excursion of 1 foot over about 10 ft. of the course)

Marked deviation	= 0	
Mild/moderate deviation or uses walking aid	= 1	
Straight without walking aid	= 2	_____

15. Trunk

Marked sway or uses walking aid	= 0	
No sway but flexion of knees or back or spread arms out while walking	= 1	
No sway, no flexion, no use of arms, and no use of walking aid	= 2	_____

16. Walking Stance

Heels apart	= 0	
Heels almost touching while walking	= 1	_____

Gait Score: _____/12_____

Balance + Gait Score: _____/28_____

Adapted with permission from Tinetti ME. Performance-oriented assessment of mobility problems in elderly patients. J Am Geriatr Soc. 1986;34:119-126.

Get-up and Go

Instructions: The patient is instructed to perform the following tasks while a trained observer watches and evaluates. The observer then gives the patient a score based on the following criteria:

1	normal
2	very slightly normal
3	mildly abnormal
4	moderately abnormal
5	severely abnormal

Tasks:

Patient is asked to sit comfortably in a chair.
Patient is then asked to rise.
Patient is asked to stand still.
Patient is asked to walk towards a wall (3m).
Before they reach the wall the patient is asked to turn without touching the wall and return to the chair.
Patient is asked to turn around and sit down.

Adapted from Folstein MF, Folstein PE, McHugh PR. Minimental state: a practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res. 1975;12:189-198.

FUNCTIONAL REACH

Instructions:

1. Secure a leveled yardstick to the wall at the height of the individual's acromion of the dominant arm.

2. Instruct the individual to stand comfortably, make a fist, and raise his/her arm until it is parallel to the yardstick.

3. Measure the distance from the individual's acromion to the third metacarpal. This is Position I.

4. Instruct the individual to reach as far forward as he/she can without touching the wall or taking a step.

5. Record the location of the third metacarpal. This is Position II.

6. Repeat this procedure 4 more times.

7. Functional Reach is the average distance between Position I and Position II over the last 3 trials.

Dominant Arm: _____

Position I	**Position II**
Trial 1 _____	Trial 1 _____
Trial 2 _____	Trial 2 _____
Trial 3 _____	Trial 3 _____
Trial 4 _____	Trial 4 _____
Trial 5 _____	Trial 5 _____
AVERAGE _____	AVERAGE _____

FUNCTIONAL REACH: _____
(DIFFERENCE BETWEEN POSITION I AND POSITION II AVERAGE)

Adapted from Duncan PW, Studenski S, Chandler J, Prescott B. Functional reach: predictive validity in a sample of elderly male veterans. J Gerontol. 1992;47(3):M93-98.

Fall Intervention Protocol Components

General Principles:

Agreement Between Patient and Physical Therapist:

After the assessment, the physical therapist discusses the individual's impairments, and explains how these impairments contribute to the risk of falling and immobility. The therapist emphasizes the likelihood that the impairments will improve with the prescribed therapy. Education of the risks the individual possesses, and the potential benefit of therapy is pertinent to the individual's continued compliance with the exercise program.

Gait Training:

Gait training consists of instructions in:

1. Appropriate footwear: Comfortable, well fitting, providing adequate support and protection; soles neither too slippery or too sticky; low, broad, or wedge-shaped heels; avoidance of backless slippers and shoes.
2. Walking: Feet should be 4 to 6 inches apart; with each step, heel should land on floor first and toes should push off as other heel lands on floor; ensure steps are of equal length; let arms swing naturally at sides, with right arm swinging forward with left foot and vice versa.
3. Turning: Avoid sharp pivots or twisting on either leg; make shorter steps during the turn.
4. Leaning: Avoid letting upper body get ahead of hips and legs; avoid rushing.
5. Losing balance: Instruct the individual to stop, readjust footing, and continue; hold on to a movable object (assistive device); or sit down when he or she begins to lose his or her balance.

Transfer Training:

Individual is instructed to perform transfer in a stepwise fashion.

Lying to sit: Individual lies flat in bed, rolls to side, pushes to sitting with both arms, swings legs off bed, sits on edge of bed for 1 minute.

Sit to stand: Individual sits n bed or chair, scoots to edge, puts feet flat on floor, bends knees, leans slightly forward so body is over feet, pushes up with arms and legs to stand, ensures he or she feels steady before walking.

Stand to sit: Individual touches back of chair with legs, leans slightly forward so body is over feet, reaches back for arms or seat, slowly sits, sits on edge of chair, scoots back.

Standing to lying: Individual turns with back to bed, touches bed with back of legs, leans slightly forward, reaches for bed with hands, slowly lowers self to sit, sits on edge of bed, scoots back, lowers self onto side using arms, swings feet up onto bed, rolls to back.

Footwear:

Recommended footwear include the following:

1. Soft uppers that allow feet to breathe.
2. Smooth interior so no pressure areas are caused by seams or rough edges.
3. Adequate arch support and conformation to heel to hold it in good position.
4. Long enough to allow a 1 inch width between longest toe and end of shoe.
5. Wide enough to comfortably support the width of the metatarsal head.
6. Rounded toe.
7. Increased depth of toe box to allow for deformities and prevent callus formation.
8. Heel height no greater than 1.5 inches to allow for proper weight distribution and ensure adequate base of support during standing and gait activities. (Exception may be women who have worn high heels all their lives. They will require a gradual decrease in heel height as well as ankle range of motion exercises.)

Reprinted from Phys Ther. Koch M, Gottschalk M, Baker DI, Palumbo S. An impairment and disability assessment and treatment protocol for community-living elderly persons. 1994;74(4):286-294.

APPENDIX D

Melanie Ray Benson
103A Selke Hall
Grand Forks, ND 58202-2009

November 20, 1995

Monte Evans
American Physical Therapy Association
1111 North Fairfax St.
Alexandria, VA 22314-1488

Dear Mr. Evans:

I am writing to request permission to retype portions of an article published in Physical Therapy. The information listed below would be used in my Independent Study report as part of my graduate requirements for a Masters of Physical Therapy, University of North Dakota, Grand Forks, North Dakota.

Retype Request:

Physical Therapy
Volume 74, Number 4, 1994
Alexandria, VA

Appendix 2 pp 293-4: Description of Intervention Protocol
Appendix 3 page 294: Progressive Balance Exercises

This information would be used only for a scholarly purpose in which due recognition shall be given to the authors: Marie Koch, Margaret Gottschalk, Dorothy I Baker, Sally Palumbo, and Mary E Tinetti.

Sincerely,

Melanie Ray Benson, B.S. P.T
Student

Approval is given to Melanie Ray Benson for retyping of the above publication for scholarly purposes as outlined above.

_____
Monte Evans
American Physical Therapy Association
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Alexandria, VA 22314-1488

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November 20, 1995

Katrina Schmitz
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Dear Ms. Schmitz:

I am writing to request permission to retype a portion of an article published in Physiotherapy Canada. The information listed below would be used in my Independent Study report as part of my graduate requirements for a Masters of Physical Therapy, University of North Dakota, Grand Forks, North Dakota.

Retype Request:

Physiotherapy Canada
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Table 3 page 308: Balance items A-N

This information would be used only for a scholarly purpose in which due recognition shall be given to the authors: Katherine Berg, Sharon Wood-Dauphinee, J.I. Williams, all at McGill University, Montreal; and David Gayton, at Royal Victoria Hospital, Montreal.

Sincerely,

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Approval is given to Melanie Ray Benson for retyping of the above publication for scholarly purposes as outlined above.

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