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Falls in older persons: Risk factors and patient evaluation

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INTRODUCTION

Falls in older persons occur commonly and are major factors threatening the independence of older individuals. As is the case for many geriatric syndromes, falls usually occur when impairments in multiple domains compromise the compensatory ability of the individual [1].

Falls often go without clinical attention for a variety of reasons: the patient never mentions the event to a healthcare provider; there is no injury at the time of the fall; the provider fails to ask the patient about a history of falls; or either provider or patient erroneously believes that falls are an inevitable part of the aging process. Often, treatment of injuries resulting from a fall does not include investigation of the cause of the fall.

Significant morbidity and mortality may result from falls in older individuals, and falls are a leading cause of injury, both fatal and nonfatal, among older adults in the United States. The importance of preventing falls is emphasized by a study that found that 80 percent of older women preferred death to a "bad" hip fracture that would result in nursing home admission [2].

A number of the physical conditions and environmental situations that predispose to falls are modifiable. Clinicians caring for older patients need to routinely inquire about falls, assess for fall risk, and address modifiable underlying risk factors.

This topic focuses on risk factors and patient evaluation for falls. Measures to prevent falls in older persons are discussed separately. (See "Falls: Prevention in community-dwelling older persons".)

EPIDEMIOLOGY

The incidence of falls increases with age and varies according to living status [3-8]. In 2020 in the United States, 27.6 percent of adults aged ≥65 years reported at least one fall in the past year [9]. Falls were more common among non-Hispanic White and non-Hispanic American Indian or Alaska Native persons than among people of other racial or ethnic groups.

A 2022 systematic review reported that the prevalence of falls among persons aged 60 years or older was lowest in Asian adults, greater in Hispanic and Black adults, and highest in White adults [10].

Approximately 50 percent of individuals in the long-term care setting fall yearly [3,4]. Almost 60 percent of those with a history of a fall in the previous year will have a subsequent fall [5].

Falls often result in an injury of some type, usually minor soft tissue injuries such as bruises and scrapes. In one study of women over age 70 followed for two years, 41 percent of falls resulted in minor, and 6 percent in major, injuries [11]. Earlier studies had also found that 5 to 10 percent of falls among community-dwelling older adults result in major injuries: fracture, head trauma, or major lacerations [8,12]. Rates of fall-related major injuries for nursing home residents are higher (10 to 30 percent) [13,14]. Falls accounted for 62 percent of non-fatal injuries leading to US emergency department visits for people over 65 years [15]. Approximately 5 percent of falls in older persons will lead to hospitalization [16].

The number of fall-related hospitalizations is likely to increase substantially with ongoing aging of the population. In the Netherlands, the number of hospitalizations for falls more than doubled between 1981 and 2008, although the average length of stay decreased and offset the total number of fall-related hospital days [17]. In the United States, fall-related injuries are an important cause of hospital readmission in older adults, particularly among those discharged to home after an initial hospitalization for a fall-related injury and those with cognitive impairment [18].

Morbidity and mortality — Fall-related injuries are associated with significant subsequent morbidity: decline in functional status, increased likelihood of nursing home placement, and greater use of medical services [19-22]. Compared with hospitalization due to other conditions, hospitalizations from falls resulting in hip fracture or other injuries lead to worse outcomes and a greater chance of nursing home admissions [23]. Nearly 95 percent of hip fractures are caused by falls [24]. Among community-living older adults who sustain hip fractures, 25 to 75 percent do not recover pre-injury functional status [12]. In an Australian study, 9.5 percent of patients hospitalized for falls became first-time residents of a long-term care facility at

discharge [25]. In a 14-year prospective study of community-dwelling adults over age 70, recovery following a serious fall (requiring hospitalization) was related to prehospitalization functional status and trajectory [26]. Rapid recovery was seen only in patients who had no or only mild disability prior to falling, and substantial recovery was unlikely for individuals with progressive or severe disability prior to the fall. Higher executive function, but not overall cognition or memory, prior to a fall has been associated with less decline in mobility [27].

A sample of 1100 independent-living individuals over the age of 71 were followed prospectively for three years to evaluate the incidence and impact of falls. The following results were reported:

- Those who had suffered at least one fall experienced a decline in basic and instrumental activities of daily living [19]. Activity restriction was reported in 24 percent of those with recent falls versus 15 percent of those without falls.

- A total of 133 participants (12 percent) had long-term admissions to nursing homes. After adjustment for other risk factors, the risk of nursing home admission increased progressively for subjects with a single non-injurious fall, two or more non-injurious falls, or at least one fall causing serious injury (relative risk [RR] 3.1, 5.5, and 10.2, respectively) [21].

Only one-half of older individuals who fall are able to get up without help, resulting in the so-called "long lie." Those who are unable to get up are more likely to suffer lasting declines in activities of daily living than those who are able to get up (35 versus 26 percent in one series) [28].

Death after a fall occurs far less frequently than injuries. However, in 2021 in the United States, 38,742 (78 per 100,000) unintentional fall–related deaths occurred among older adults. The fall-related death rate was higher among men (91.4 per 100,000) than among women (68.3) [9]. Complications resulting from falls are the leading cause of death from injury in adults older than age 65 [29], and the fifth leading cause of death in older adults. In a large study of older adults seeking emergency care after a fall, 2.2 percent of injurious falls resulted in death [30]. The death rate attributable to falls increases with age. A report from the National Trauma Data Bank noted that mortality was three times higher for older adults sustaining ground level falls, compared with younger individuals with falls, and that older adults were more likely to sustain long bone and pelvic fractures [31]. The rate of fatal falls in people aged 65 years and older increased in the United States between 1993 and 2003 [32]. Fatality rates are highest in White men (48.3 per 100,000 population).

The estimated cost of fall-related injuries for individuals older than age 65 in the United States in 2015 was USD $50 billion [33]. This figure can be expected to increase with an expanding geriatric population.

Fear of falling — Fear of falling, also called the post-fall anxiety syndrome, is a well-recognized syndrome in older persons. In a study of over 1000 community-dwelling women aged 70 to 85 years, fear of falling, as determined by questionnaire, was found in one-third of women at baseline, and affected 46 percent of the sample at three year follow-up [34]. In another study of 673 community-dwelling older adults, 60 percent reported moderate activity restriction and 15 percent severe activity restriction due to fear of falling [35]. A systematic review found that fear of falling may affect 50 percent or more of patients following hip fracture [36].

Fear of falling was associated with living alone, cognitive impairment, depression, and balance and mobility impairments, as well as a history of falls [22,34]. Fear of falling following hip fracture was associated with increased risk for institutionalization and mortality [36]. New-onset fear of falling was predicted by obesity and impaired mobility.

RISK FACTORS

Falls in older individuals are most often due to multiple causes, when a threat to the normal homeostatic mechanisms that maintain postural stability is superimposed on underlying age-related declines in balance, gait stability, and cardiovascular function [1]. This threat may involve an acute illness (eg, fever, dehydration, arrhythmia), a new medication, an environmental stress (eg, unfamiliar surrounding), or an unsafe walking surface. The older person is unable to compensate for the additional stress (figure 1) [12,13].

Clinicians commonly refer to some falls as “mechanical falls.” However, studies of risk factors for falls do not use this term because it is ill-defined and carries no special significance. In addition, dismissing a fall as “mechanical” may impede the appropriate assessment for risk factors because the fall is attributed to factors that are not modifiable. The use of this designation should be discouraged, especially as the electronic medical record perpetuates this non-useful phrase.

The impact of challenges to postural control varies according to the risk-taking behavior of an individual and his or her opportunity to fall. Thus, individuals who are completely immobile may not be at risk of falling despite multiple predisposing factors, and those who are either vigorous or somewhat frail may be at increased risk [37]. Vigorous older individuals may take more risks,

while the frail older persons may not be able to compensate for relatively minor threats to postural stability.

Multiple community-based prospective cohort studies of risk factors for falls have been published [5,38-49]. Risk factors that were found in at least two of the studies include:

- Past history of a fall
- Lower-extremity weakness
- Age
- Female sex
- Cognitive impairment
- Balance problems
- Psychotropic drug use
- Arthritis
- History of stroke
- Orthostatic hypotension
- Dizziness
- Anemia

Factors associated with increased risk for falls with major injuries (fracture, dislocation, or laceration requiring suture) include [5]:

- Fall associated with syncope
- History of previous fall with injury
- Decreased executive function, measured by Trail Making B time (figure 2)

Studies differed significantly in the types of risk factors evaluated, the populations studied (eg, past fall history was sometimes an entry criterion), and the defined outcomes (one fall, two or more falls, injurious falls). Since recurrent falls may have worse outcomes, studies that consider all the falls (fall rate) as an outcome may be more informative than studies that consider time-to-first fall. In one systematic review of 18 longitudinal cohort studies, age itself was found to be an independent risk factor in only 4 of the 11 studies that considered age in a multivariate analysis [49]. The fact that different risk factors were found across studies highlights the multifactorial nature of falls. Gait and balance impairment was the most consistent risk factor, followed by medications, in this systematic review that evaluated six potential risk factor domains: gait/balance, medications, orthostatic hypotension, visual impairment, limitations in activities of daily living (ADL), and cognitive impairment.

The site of falling, whether indoors or outdoors, may also be a factor in identifying risk factors. Studies have suggested that indoor falls tend to occur in frail persons, while outdoor falls tend

to occur in younger active persons [50-53]. This was corroborated in a prospective study of falls in a population-based sample of community-dwelling older adults in the Boston area that used fall calendars and individual follow-up of those with falls to ascertain the location of falls [54]. Indoor falls were associated with disability, indicators of poor health, and an inactive lifestyle, while outdoor falls were associated with an active lifestyle and average or better-than-average health. Although most studies of risk factors have not considered fall location, failure to do so may obscure important risk factors. As an example, if slow gait increases risk for indoor falls and decreases risk for outdoor falls, an analysis that combines indoor and outdoor falls may find no association for gait speed with falls. Additionally, if risk factors are dependent on the site of falling, specific intervention strategies to prevent falls may differ for indoor and outdoor falls.

Although some falls occur in individuals with no risk factors, the risk of falling generally increases with the number of risk factors [5,38,40]. The rate of falls is increased in recently hospitalized patients with other risk factors for falls [55].

Postural control — The clinical approach to fall prevention in older persons requires knowledge of age-related changes that affect postural control and increase the risk of falls.

Sensory systems — The ability to maintain the upright posture is dependent upon sensory input from several systems, including proprioceptive and vestibular systems. Declines occur with aging:

- Proprioceptive sensitivity loss occurs in the lower extremities and leads to an increased risk of falling [56].
- The vestibular system is impaired by the loss of labyrinthine hair cells, vestibular ganglion cells, and nerve fibers.

Loss of function in these sensory organs is compounded by age-related changes in the central nervous system, including loss of neurons and depletion of neurotransmitters (eg, dopamine) within the basal ganglia, causing further loss of postural control [57].

It is difficult to quantify the age-related changes in postural control that are independent of disease. Testing of postural stability (measured sway) in young and old subjects with no apparent musculoskeletal or neurologic impairment reveals age-related differences when moderately severe perturbations of stance are administered (changing the support surface, changing body position, altering the visual input, or moving the support surface horizontally or rotationally) [58]. These perturbations stress the redundancy of the sensory systems in their ability to maintain postural stability. Hearing loss has also been associated with an increased risk of falling [59], but whether this represents concomitant vestibular dysfunction or an

independent risk is uncertain. Audiometrically defined hearing loss, compared with normal hearing, in older adults was associated with a 1.7 times greater odds of falling in a meta-analysis of six studies [60].

Muscle activation and composition — Some of the most striking postural control differences between young and old relate to the order or grouping of muscle activation patterns.

- Older individuals tend to activate proximal muscles, such as the quadriceps, before more distal muscles, such as the tibialis anterior, in response to perturbations of the support surface [61]. This strategy may not be an efficient way to maintain postural stability.
- There may be greater contraction of antagonistic muscles in older persons, leading to a delay in the onset of muscle activation [62].
- Balance recovery during a postural disturbance may be compromised by an age-related decline in the ability to rapidly develop joint torque using muscles of the lower extremity [62,63].
- Decreased muscle cross-sectional area and increased muscle adiposity are related to declining physical function and disability in older adults. A study has identified a correlation between fatty infiltration of muscle and risk for hip fracture [64].
- Decreased total body muscle mass measured using the D3-creatine dilution method was associated with a greater risk of injurious falls [65].

These age-related changes in muscle use potentially undermine upright posture.

Visual impairment — Visual impairments result from decrease in visual acuity, depth perception, contrast sensitivity, and dark adaptation. Impaired vision has been associated with both falls and hip fracture [66-70]. The use of multifocal lenses also increases the risk of falls [71].

History of falls — A previous history of falls is a significant risk factor for future falls [41,72-74]. In a prospective study of community-dwelling Medicare beneficiaries, 63 of 736 subjects reported a fall, and 67 reported two or more stumbles without a fall in the past month [72]. On follow-up one year later, 127 subjects (22 percent) reported one or more additional falls. Independent baseline predictors of a fall at the second interview included two or more stumbles and one or more falls (adjusted odds ratio [OR] 2.3 and 5.9, respectively).

Patients who have sustained a hip fracture are at increased risk of a second hip fracture [75]. Among 481 participants in the Framingham Study who had sustained one fracture, 14.8 percent

had a second hip fracture during a median four-year follow-up; risk increased with older age and higher functional status. Mortality was greater for the second, compared with the first, hip fracture, even after correcting for older age. Following a major osteoporotic fracture (hip, forearm vertebra, humerus), the risk of a second major osteoporotic fracture was highest immediately after the first fracture and thereafter decreased with time [76].

Systemic blood pressure — Regulation of systemic blood pressure is an important contributor to the maintenance of upright posture [77]. Postural hypotension may lead to failure to perfuse the brain, thereby increasing the risk of a fall. Many older individuals have underlying vascular disease, which compromises resting cerebral perfusion. One study confirmed an association between more severe compromise in cerebral vasoreactivity and increased the risk for falls [78]. Falls arising from postural hypotension may be distinguished from other types of falls by the patient's history of lightheadedness or presyncopal complaints.

Causes of hypotension in older individuals include:

- Age-related decline in baroreflex sensitivity to hypotensive stimuli, manifested by a failure to increase the heart rate when blood pressure falls.
- Normal daily patterns, such as postural change related to eating a meal [79]. (See "Mechanisms, causes, and evaluation of orthostatic hypotension".)
- Age-related reduction in total body water, placing older individuals at increased risk of hypovolemia with acute illness, diuretic use, or hot weather. Progressive decline in basal and stimulated renin levels, leading to reduction in aldosterone secretion, may promote the development of volume depletion in the face of dehydrating stresses.

Chronic diseases — Several age-related chronic conditions are associated with an increased fall risk.

- Parkinson disease increases the risk of falls via several mechanisms: rigidity of the lower extremity musculature, inability to correct sway trajectory due to slowness in initiating movement, hypotensive drug effects, and (in some cases) cognitive impairment [80].
- Chronic musculoskeletal pain increases the risk of falls, and the risk correlates with pain severity and number of sites involved [81,82].
- Osteoarthritis of the knee affects mobility, the ability to maneuver and step over objects, and postural stability because of the tendency to avoid complete weightbearing on a painful joint. Chronic pain may also interfere with attention and cognitive reactions to impending falls. It is unknown if improved pain management would decrease the fall risk.

- Falls rates are higher for older patients with diabetes compared with individuals without diabetes [83].

- The risk of falls is increased in patients with cerebrovascular or cardiovascular disease [24].

The risk for falls increases with increasing numbers of chronic diseases [84].

Cognitive impairment — Mild to moderate cognitive impairment is associated with a higher risk of falls and hip fractures. A systematic review and meta-analysis found that global cognitive impairment, and specifically executive dysfunction, was associated with fall risk and risk of injurious falls [85]. In one study of 1600 persons aged 75 years and above, the risk of hip fracture over six-year follow-up was twice as high when the score on the mini-mental status examination was suggestive of mild impairment (score 18 to 23) compared with those with no impairment [86].

Anatomic changes associated with cognitive impairment have also been correlated with fall risk. In one prospective study, the volume of white matter lesions in the cerebral cortex was directly associated with the risk for falls [87].

In one prospective study, in which 51 hip fractures occurred over nine years, the presence of diffuse white matter lesions on baseline brain magnetic resonance imaging (MRI) study was significantly correlated with increased risk of hip fracture in study participants who were 65 to 80 years old (hazard ratio [HR] 2.7, 95% CI 1.1-7.1) [88]. White matter lesions were not an independent variable for patients over 80 years. Though the clinical significance of white matter lesions is uncertain, and these findings need to be confirmed by other studies, older people found to have diffuse lesions on incidental brain MRI scanning may benefit from interventions for fall prevention.

There is also some evidence that better social integration through family and friendship social networks may reduce the risk of falls among community-dwelling older adults [89].

Medication use — Medication use is one of the most modifiable risk factors for falls. (See "Drug prescribing for older adults".)

In addition to specific types of medications, greater numbers of medications of any type, and recent changes in the dose of medication, are associated with increased fall risk [90-92]. Poor adherence to medications has also been shown to be a risk factor for falls [93].

Drugs affecting the central nervous system — Central nervous system (CNS) active drugs, such as neuroleptics, benzodiazepines, and antidepressants, appear to be the most common drugs associated with falls [84,92,94-97]. There is uncertainty whether the risk for falls using

these medications arises during the initiation or chronic use of these medications. In a meta-analysis of 22 studies involving multiple classes of drugs, the likelihood of falling was increased with the use of sedatives and hypnotics (OR 1.47, 95% credible interval [CrI] 1.35-1.62), neuroleptics and antipsychotics (OR 1.59, 95% CrI 1.37-1.83), antidepressants (OR 1.68, 95% CrI 1.47-1.91), and benzodiazepines (OR 1.57, 95% CrI 1.43-1.72) [92]. There was no increased risk of falls with narcotics (OR 0.96, 95% CrI 0.78-1.18). The "credible interval" in Bayesian modeling is analogous to the standard confidence interval. (See "Glossary of common biostatistical and epidemiological terms".)

The effect of short- versus long-acting benzodiazepines on the risk of falling is not straightforward. Some studies have suggested a higher risk associated with long-acting drugs [94,96], while others have suggested that the dose or recent use, and not the drug half-life of benzodiazepine, is the important risk factor [97-100]. However, a significant (55 percent) overall decrease in benzodiazepine prescriptions in New York State, following an administrative measure, did not lead to a change in hip fracture rate and may suggest a weaker association between benzodiazepine use and hip fractures than has been previously considered [101].

The selective serotonin reuptake inhibitor (SSRI) antidepressants have been less well-studied than older tricyclic drugs, although several reports suggest that they offer no advantage over tricyclic antidepressants in their effects on falls [97,102,103]. In one report, for example, 2428 nursing home residents who were new users of tricyclic antidepressants, SSRIs, or trazodone were retrospectively compared with nonusers of antidepressants [103]. The new users of each type of antidepressant had higher rates of falls than the nonusers, with adjusted rate ratios of 2.0, 1.8, and 1.2 for each drug, respectively. The rate ratios increased with the daily dose of the tricyclic antidepressants and SSRIs. Daily use of SSRIs in adults 50 years and older has also been associated with a twofold increased risk clinical fragility fracture, after adjustment for potential covariates [104].

It remains to be established whether the risk for falls related to antidepressants occurs only during drug initiation and dose titration or is seen with stable chronic use.

There have been several studies of anticholinergic medications being associated with falls [105,106] and evidence that the degree of anticholinergic input using the Anticholinergic Cognitive Burden scale was associated with an increase falls in those patients with underlying mild cognitive impairment and dementia [107].

Antihypertensives and cardiovascular medications — Vasodilators have been associated with an increased risk of falling [73]. In a meta-analysis of 22 studies involving multiple classes of drugs, there was an association between antihypertensive drugs and risk of falls (OR 1.24,

95% CrI 1.01-1.50), but the association was not significant for beta blockers (OR 1.01, 95% CrI 0.86-1.17) and was only marginally significant for diuretics, which could have been given for edema as well as hypertension (OR 1.07, 95% CrI 1.01-1.14) [92]. Further, in a 2021 meta-analysis of randomized trials which had more than 650 patient years of follow-up, there was no increase in the risk for falls among those who used antihypertensive drugs [108].

Alcohol use — The relationship between alcohol use and falls appears to depend on the amount of alcohol consumed. In a study of 6000 men aged 65 years and older, light drinkers (less than 14 drinks per week) had a decreased risk of two or more falls in one year compared with abstainers (relative risk [RR] 0.77, 95% CI 0.65-0.92) [109]. However, men with problem drinking had a higher risk of two or more falls than those without problem drinking (RR 1.59, 95% CI 1.30-1.94).

Footwear — Footwear may be an important factor affecting the risk of falls. In one small study evaluating balance and footwear in older men, shoes with thin, hard soles were associated with the best balance, although these shoes were perceived as less comfortable than thick, soft, mid-soled shoes, such as running shoes [110].

In contrast to the results from such gait laboratory studies, a nested case-control study found a lower risk of falls associated with athletic shoes or sneakers and a higher risk of falls with other footwear (RR 1.3, 95% CI 0.9-1.9); going barefoot or in stocking feet appeared to be particularly risky [111]. Although the study adjusted for other factors in a multivariate model, confounding factors may still have affected results, and healthier patients may be more likely to wear athletic shoes or sneakers. In a companion study, footwear with greater heel height was associated with an increased risk of falling, while footwear with greater contact area between the sole and the floor was associated with a lower risk [112]. Data from the MOBILIZE Boston Study confirmed the protective effects of athletic shoes on falls and the increased risk associated with going barefoot [113].

Given the conflicting results from laboratory studies and clinical studies, it is uncertain what type of footwear provides the lowest risk of falls, although low-heeled shoes are advisable.

Environmental factors — Environmental factors frequently interact with intrinsic risk factors, and so their relative importance in fall risk has not been clearly defined. Intervention studies have generally focused upon improving the overall risk factor profile of the individual [114] or have combined individual interventions with environmental manipulation [115], making it difficult to partition out the contributions of the environmental factors.

One study, for example, investigated the utility of a home visit by an experienced occupational therapist who assessed the home for potential environmental hazards and facilitated any

necessary modifications [116]. Patients who were at high risk of falling (history of one or more falls in the year prior to the study) had a significantly reduced risk of falling during the study period compared with controls (RR 0.64). However, this effect may not have been due to home modifications alone, since the therapist visit may also have led to changes in behavior that reduced the risk of falling.

The efficacy of hazard reduction was more directly assessed in a study of people ages 70 and older who were randomly assigned to a control group or an intervention group that included a home hazard assessment, information on hazard reduction, and the installation of safety devices [117]. Both groups had a single home visit from a research nurse. The intervention resulted in a small reduction in the mean number of hazards per house but no reduction in falls compared with the control group [118].

Nevertheless, attention to safety hazards in the home environment appears to be worthwhile, especially in those at highest risk for falls. Whether a home assessment by a physical or occupational therapist is cost-effective for this purpose is not clear.

Institutional settings — Falls in the hospital and nursing home settings occur more frequently and are associated with greater morbidity than falls that occur in the community. In a cross-sectional study of nursing homes in the United States (230,730 patients), 21 percent of newly admitted residents who stayed in the nursing home at least 30 days had at least one fall within 30 days of a post-admission assessment [119].

Use of bed rails has been associated in some reports with an increase in injuries and deaths and does not appear to significantly reduce the likelihood of falls in nursing homes [120]. Reducing the use of bedrails does not appear to change the total number of falls that occur in the hospital but can decrease the number of serious falls [121].

Other — Adults over age 65 years with low serum 25-hydroxyvitamin D concentrations (<10 ng/mL [25 nmol/L]) are at greater risk for loss of muscle strength and muscle mass [122]. Serum 25-OHD concentrations below 20 ng/mL are also associated with poorer physical performance and a greater decline in physical performance in older adults [123]. (See "Falls: Prevention in community-dwelling older persons", section on 'Vitamin D supplementation'.)

FALLS RISK ASSESSMENT

An assessment of fall risk should be integrated into the history and physical examination of all geriatric patients, including those not specifically being seen for a problem with falling. Guidelines issued by the American Geriatrics Society, British Geriatrics Society, and American

Academy of Orthopedic Surgeons panel on falls prevention include the following (algorithm 1) [124]:

- All older patients (or their caregivers) should be asked at least once a year about falls, frequency of falling, and difficulties in gait or balance.
- For persons who report a single fall, gait and balance deficits should be evaluated as a screen for identifying individuals who may benefit from a multifactorial fall risk assessment. A multifactorial fall risk assessment should be performed for community-dwelling older persons who:
  - Report recurrent (two or more) falls
  - Report difficulties with gait or balance
  - Seek medical attention or present to the emergency department because of a fall

EVALUATION FOR PATIENTS WITH INCREASED FALL RISK

A targeted history and physical examination can identify patients at risk for falling. In particular, a history of previous fall and a physical finding of lower-extremity weakness are important risk factors. Although several fall risk tools have been developed for specific populations, such as patients undergoing rehabilitation, no tool has an optimal balance between sensitivity and specificity [125]. A large study from Sweden found that the Downton Fall Risk Index predicted fall injury, hip fracture, head injury and all-cause mortality in a population of older persons assessed in a variety of locations that provide care with skilled professionals, including residential care facilities, primary health care, and home health care [126]. The Index was developed in residential care and rehabilitation facilities, and it is not clear how the individual components can be standardized for non-health facility settings. Thus, we suggest risk factor assessment be performed as described below, using the American Geriatrics Society Fall Prevention Guideline.

History — Several studies report that the most important consideration in the history is a previous fall, which places the patient at increased risk of future falls [41,49,72,73].

For patients presenting with a fall, important components of the history include the activity of the faller at the time of the incident, prodromal symptoms (lightheadedness, imbalance, dizziness), and where and when the fall occurred. Loss of consciousness is associated with injurious falls and should raise important considerations such as orthostatic hypotension, cardiac disease, or neurologic disease.

Identification of underlying chronic diseases that increase falls risk is important. Examples of these age-related chronic conditions include Parkinson disease, chronic musculoskeletal pain, knee osteoarthritis, cognitive impairment, dementia, stroke, and diabetes. Visual impairment should also be assessed.

Information on previous falls should be collected to identify patterns that may help target risk factor modification strategies. A complete medication history should be taken, with specific focus on psychotropic medications, sedative hypnotics, antidepressants, and antihypertensive medications. Specific questions should be asked about the timing of medication administration to past falls. Alcohol use should be determined. Environmental factors that may have contributed to the fall should also be identified; information on lighting, floor covering, door thresholds, railings, and furniture may add important clues.

Musculoskeletal function — The most important aspect of the physical examination in the patient who has fallen is an assessment of integrated musculoskeletal function. This can be obtained by performing one or more tests of postural stability.

Performance Oriented Mobility Assessment — The Performance Oriented Mobility Assessment tool (POMA, or Tinetti Assessment Tool) is a scored instrument that assesses balance (nine items) and gait (seven items), using an ordinal scale from 0 to 2 ("0" for the most impaired performance, "1" if slight impairment, and "2" if independent) [127]. The POMA tool is available here. The items range from being able to maintain balance when someone slightly pulls on an individual, to walking normally with assessment of step continuity and path deviation. No reliable cutpoint has been established for the POMA score in the prediction of falls.

'Get Up and Go' test — One of the best known tests is commonly referred to as the "Get Up and Go" test, originally described using a graded 1 to 5 scale (where 1 is normal and 5 is severely abnormal) [128]. Later versions employed a timed performance approach [129]. A 2013 meta-analysis of 53 studies (n = 12,800) showed that the timed "Get Up and Go" test in adults ≥60 years of age did not show a difference in scores between those with falls and those without falls who were living independently [130]. While the test showed a mean difference of 3.59 seconds between institutionalized persons with falls and those without falls, cutoff points distinguishing these groups showed considerable variation between studies, and the diagnostic accuracy in most studies was poor to moderate. The "Get Up and Go" test is best used as part of a global assessment of an individual's fall risk.

The test is performed by observing the subject rising from a standard arm chair, walking a fixed distance across the room, turning around, walking back to the chair, and sitting back down.

Observation of the different components of this test may help to identify deficits in leg strength, balance, vestibular dysfunction, and gait. The timed part of the test records the mean time (in seconds) from initial getting up to re-seating. Patients are compared with the mean time of adults in their age group, 60 to 69, 70 to 79, and 80 to 99 years of age.

In practical terms, the observation of deficiencies in various individual components may isolate areas for targeted intervention (table 1).

Functional reach test — The "functional reach" test is another practical approach to testing integrated neuromuscular base of support [131,132]; it has predictive validity for falls in older males [133]. In its original description, the functional reach correlated with other physical performance measures, including walking speed, tandem walking, and standing on one foot [131].

This test is performed using a leveled yardstick secured to a wall at the height of the acromion. The person being tested assumes a comfortable stance without shoes or socks and stands so that his or her shoulders are perpendicular to the yardstick. The individual makes a fist and extends the arm forward as far as possible without taking a step or losing balance. The total reach is measured along the yardstick and recorded (figure 3).

Short Physical Performance Battery — The Short Physical Performance Battery (SPPB) characterizes lower-extremity function. It includes measures of standing balance (timing of tandem, semi-tandem, and side-by-side stands; four-meter walking speed and ability; and time to rise from a chair five times). The SPPB captures a wide range of functional abilities, and summary scores <9 have independently predicted disability in activities of daily living (ADLs) and mobility at one to six years of follow-up [134,135]. Components of the SPPB (eg, chair stand, gait speed, and tandem stance) are also predictive of falls [136].

Other tests — The Berg Balance test is performed easily in the rehabilitation setting or outpatient clinic [137]. The scale predicted risk of multiple falls in older patients in one study [138].

A more comprehensive performance-oriented assessment of balance includes measures of sitting and standing balance, ability to withstand a nudge on the sternum, and ability to reach up, bend down, and extend the back and neck [127]. Each of these performance measures attempts to identify components of postural stability that complement the standard physical examination.

Another test for multisensory integration is based on completing a reaction time test under three conditions of visual input alone, somatosensory input alone, and both visual and

somatosensory together. The evaluation has been translated into a cell phone application that can be used by older adults [139,140].

Difficulty in performing divided attention tasks (simultaneous manual and cognitive tasks such as walking while talking) may also identify individuals at high risk for falling. A preliminary study in 60 older people found that those who had difficulty walking while reciting the alphabet or walking while reciting every other letter of the alphabet were at significantly increased risk for falls (odds ratio [OR] 7.02 and 13.7, respectively) [141].

General physical examination — Other aspects of the physical examination in the individual who has fallen should focus upon fall risk factors.

- Postural vital signs should be obtained to rule out orthostatic hypotension [142]. The blood pressure and heart rate should be taken supine and after one and three minutes of standing. Some information may be derived from sitting vital signs if the patient is unable to stand.

- An assessment of visual acuity should be performed; visual acuity should be checked with glasses if the patient was wearing corrective lenses at the time of the fall.

- Hearing may be assessed using the whisper test or a hand-held audiometer [143] (see "Evaluation of hearing loss in adults", section on 'Office hearing evaluation'). Eighth cranial nerve deficits may be associated with vestibular dysfunction.

- Examination of the extremities may uncover deformities of the feet that contribute to the risk of falling, such as bunions, callouses, and arthritic deformities. Sensory neuropathies also increase the risk of falls [56].

- A targeted neurologic examination (including evaluation of lower-extremity strength, gait, and postural stability) may identify persons with an increased risk of falls. Individuals who report a history of falls in the past year tend to have a greater number of abnormalities on a neurologic examination [144].

  One systematic review of 16 studies found that lower-extremity weakness had a higher correlation with fall risk than a history of prior falls [12]. In this study, leg weakness increased the risk of falling by more than fourfold and a history of falls by threefold [8].

Diagnostic testing — Diagnostic testing may be indicated based upon the history and physical examination, including evaluation of postural stability, gait, and mobility. There is no standard diagnostic evaluation of an individual with a history of or at high risk for falls.

Laboratory tests such as a hemoglobin concentration and serum urea nitrogen, creatinine, and glucose concentrations can help to rule out causes of falling such as anemia, dehydration, and autonomic neuropathy related to diabetes. Serum 25-hydroxyvitamin D levels can identify individuals with vitamin D deficiency who will benefit from vitamin D supplementation. (See "Falls: Prevention in community-dwelling older persons".)

There is no proven value of routinely performing Holter monitoring in individuals who have fallen [6]. Similarly, the decision to perform echocardiography, brain imaging, or radiographic studies of the spine should not be considered routine but should be driven by findings during the history and physical examination. Thus, an echocardiogram could be considered for those with heart murmurs believed to contribute to the maintenance of blood flow to the brain, and spine radiographs or magnetic resonance imaging (MRI) may be useful in patients with gait disorders, abnormalities on neurologic examination, lower-extremity spasticity, or hyperreflexia to rule out cervical spondylosis or lumbar stenosis.

One study found that carotid sinus massage was helpful in identifying patients with carotid sinus sensitivity as a cause of falls [145]; fall rates were decreased in patients who received pacemakers for carotid massage-induced electrocardiogram pauses of three seconds or longer [146]. The subjects in this study had a history of multiple falls (more than seven per year).

SOCIETY GUIDELINE LINKS

Links to society and government-sponsored guidelines from selected countries and regions around the world are provided separately. (See "Society guideline links: Falls".)

INFORMATION FOR PATIENTS

UpToDate offers two types of patient education materials, “The Basics” and “Beyond the Basics.” The Basics patient education pieces are written in plain language, at the 5th to 6th grade reading level, and they answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials. Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are written at the 10th to 12th grade reading level and are best for patients who want in-depth information and are comfortable with some medical jargon.

Here are the patient education articles that are relevant to this topic. We encourage you to print or e-mail these topics to your patients. (You can also locate patient education articles on a

variety of subjects by searching on “patient info” and the keyword(s) of interest.)

- Basics topics (see "Patient education: Preventing falls in adults (The Basics)")

SUMMARY AND RECOMMENDATIONS

- **Epidemiology** – Between 30 and 40 percent of community-dwelling people over the age of 65 years, and 50 percent of those in long-term facilities, fall each year. Major injuries result from 5 percent of falls in the community and 10 percent of falls in institutions. (See 'Epidemiology' above.)

- **Risk factors** – Falls in older persons are due to extrinsic stresses working in conjunction with age-related intrinsic factors that increase vulnerability to falls. Multiple risk factors have been identified, including past history of a fall, lower-extremity weakness, age, female sex, cognitive impairment, balance problems, psychotropic drug use, arthritis, history of stroke, orthostatic hypotension, dizziness, and anemia. There is no value in classifying falls as being “mechanical” because it obscures the true underlying contributors. (See 'Risk factors' above.)

- **Medications** – Medication use is one of the most readily modifiable fall risks. Multiple medications of any type, and psychotropic drugs in particular, are associated with increased falls; benzodiazepine dose is more strongly correlated with risk than short- or long-acting formulation. (See 'Medication use' above.)

- **Falls risk assessment** – All older patients should be asked at least once yearly about falls. Further evaluation is indicated for patients who present with a fall or have a history of recurrent falls. (See 'Falls risk assessment' above.)

- **Evaluation** – Evaluation for those who have sustained a fall should include postural vital signs, assessment of visual acuity, hearing, and muscle function. The value of a complete neurological examination is uncertain. Diagnostic testing may include a complete blood count (CBC), serum blood urea nitrogen (BUN) and creatinine, glucose level, and vitamin D. Holter monitoring, echocardiograms, and radiologic studies are indicated only when suggested by findings on history of exam. Assessment of carotid sinus sensitivity may be indicated in people with unexplained multiple falls. (See 'Evaluation for patients with increased fall risk' above.)

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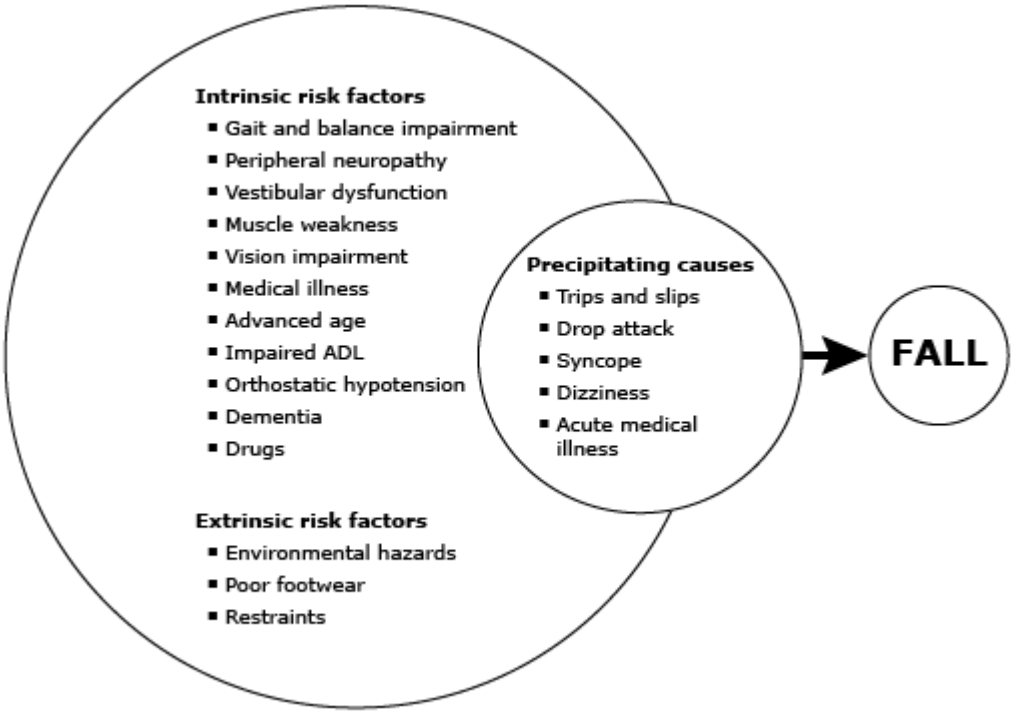
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Topic 3012 Version 53.0

GRAPHICS

The multifactorial and interacting causes of falls

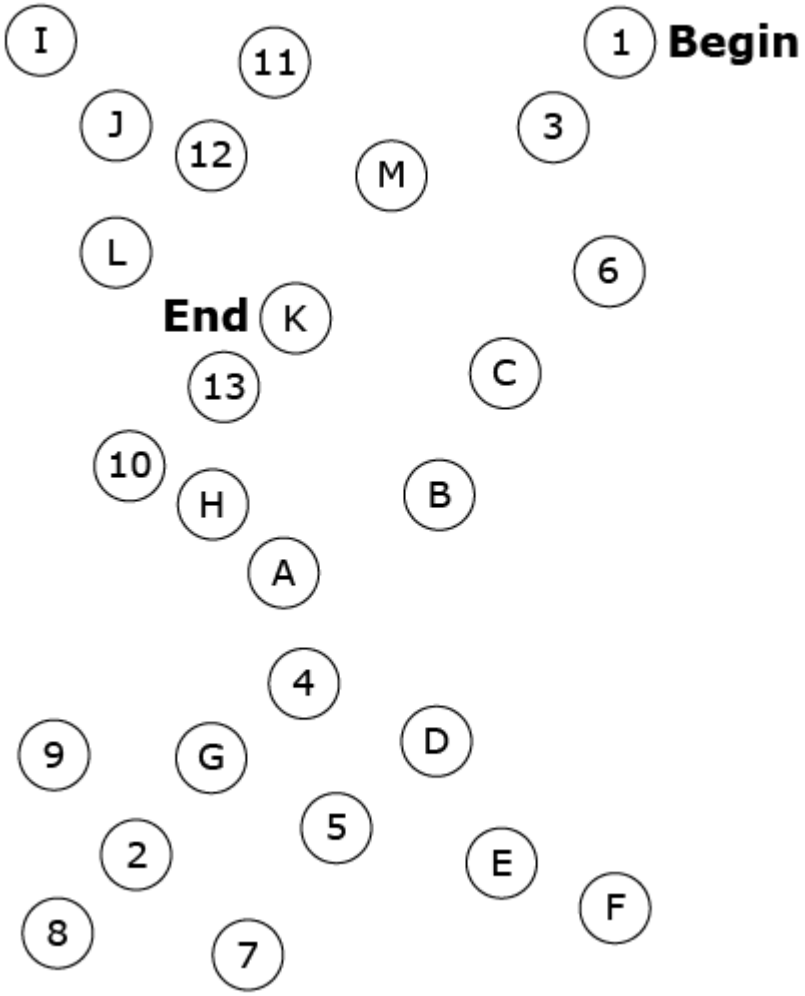


ADL: activities of daily living.

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Graphic 63126 Version 3.0

Trails test (B version)



Trail-making tests assess visual attention.

In the "A version" of the test, the subject connects 25 consecutive targets, each numbered (1, 2, 3, etc).

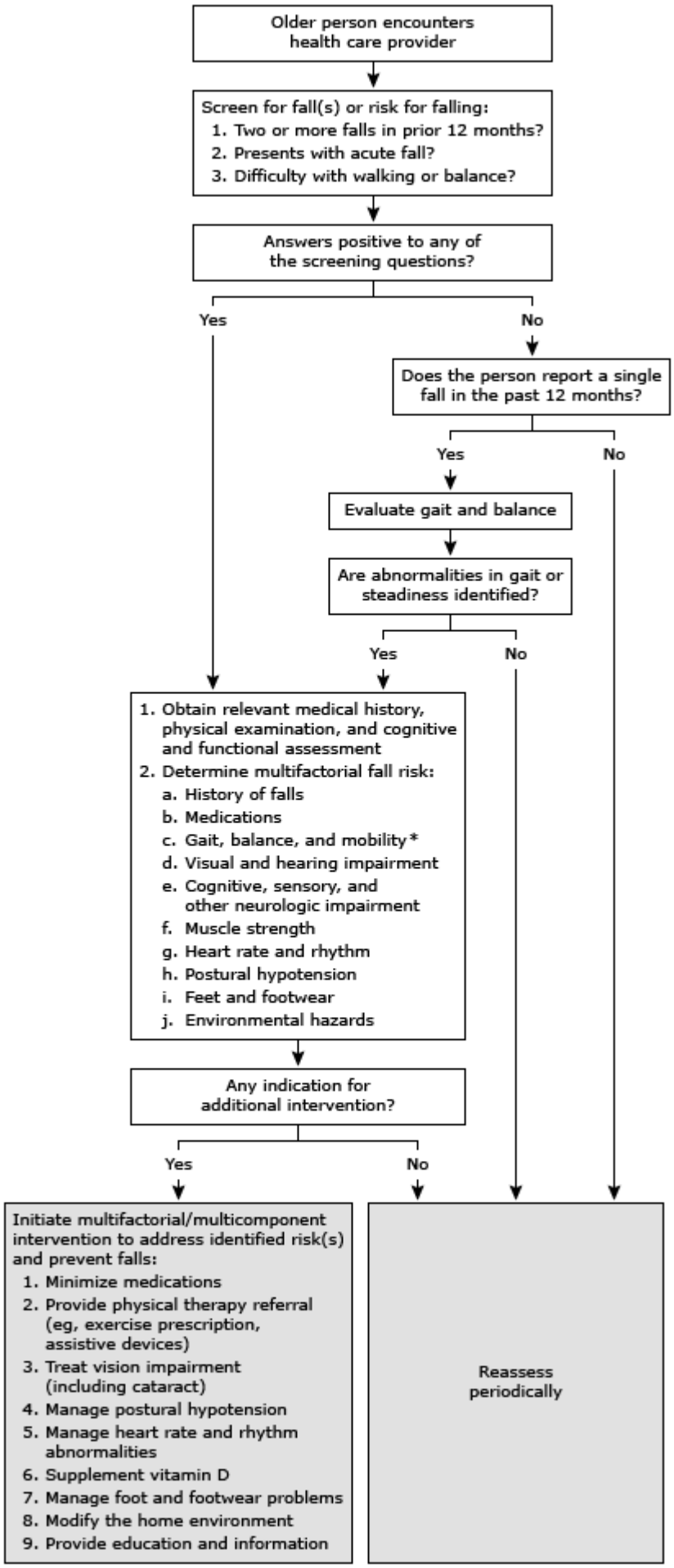
In the "B version" of the test, shown here, the subject alternates between numbers and letters (1, A, 2, B, 3, C, etc).

The test is scored in speed and accuracy.

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Graphic 66230 Version 9.0

Prevention falls algorithm


Older person encounters health care provider
Screen for fall(s) or risk for falling:
1. Two or more falls in prior 12 months?
2. Presents with acute fall?
3. Difficulty with walking or balance?
Answers positive to any of the screening questions?
Yes
No
Does the person report a single fall in the past 12 months?
Yes
No
Evaluate gait and balance
Are abnormalities in gait or steadiness identified?
Yes
No
1. Obtain relevant medical history, physical examination, and cognitive and functional assessment
2. Determine multifactorial fall risk:
a. History of falls
b. Medications
c. Gait, balance, and mobility*
d. Visual and hearing impairment
e. Cognitive, sensory, and other neurologic impairment
f. Muscle strength
g. Heart rate and rhythm
h. Postural hypotension
i. Feet and footwear
j. Environmental hazards
Any indication for additional intervention?
Yes
No
Initiate multifactorial/multicomponent intervention to address identified risk(s) and prevent falls:
1. Minimize medications
2. Provide physical therapy referral (eg, exercise prescription, assistive devices)
3. Treat vision impairment (including cataract)
4. Manage postural hypotension
5. Manage heart rate and rhythm abnormalities
6. Supplement vitamin D
7. Manage foot and footwear problems
8. Modify the home environment
9. Provide education and information
Reassess periodically

* Refer to UpToDate topic on risk factors and patient evaluation for falls in older persons.

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Graphic 69682 Version 6.0

The "Get up and go" test for gait assessment in older adult patients

The "Get up and go" test for gait assessment in older adult patients[1]	
Have the patient sit in a straight-backed high-seat chair	
Instructions for patient:	
Get up (without use of armrests, if possible)	
Stand still momentarily	
Walk forward 10 feet (3 meters)	
Turn around and walk back to chair	
Turn and be seated	
Factors to note:	
Sitting balance	
Transfers from sitting to standing	
Pace and stability of walking	
Ability to turn without staggering	
Modified qualitative scoring[2]	
(1) No fall risk	Well-coordinated movements, without walking aid
(2) Low fall risk	Controlled, but adjusted movements
(3) Some fall risk	Uncoordinated movements
(4) High fall risk	Supervision necessary
(5) Very high fall risk	Physical support of stand by physical support necessary
Timed test reference values (record time from initial rising to re-seating)[3]	
Age (years)	**Mean time in seconds (95% CI)**
60 to 69	8.1 (7.1 to 9.0)
70 to 79	9.2 (8.2 to 10.2)
80 to 99	11.3 (10.0 to 12.7)

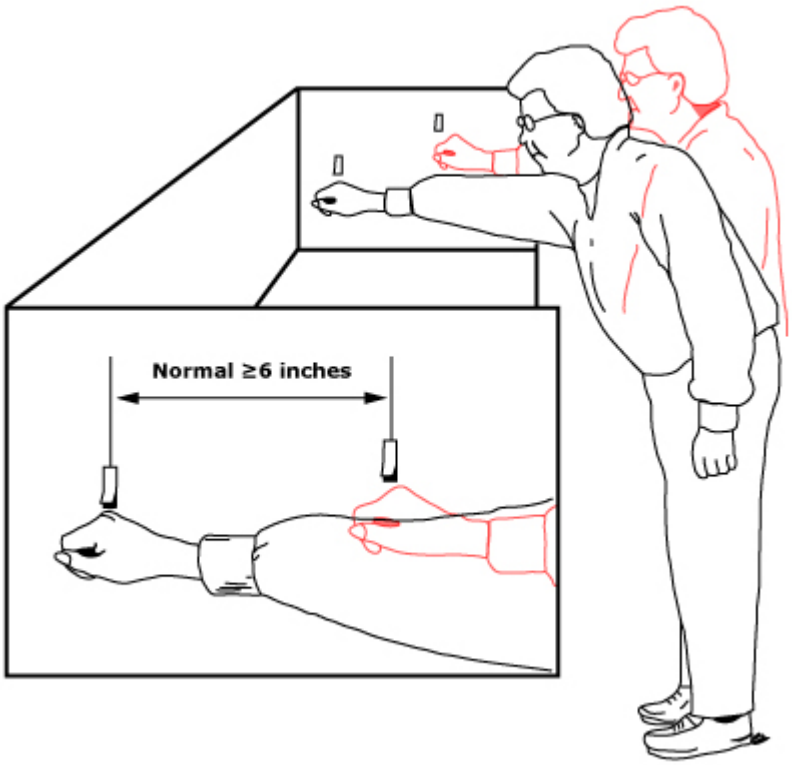
Sources:

1. *Reproduced with permission from: Fleming KC, Evand JM, Weber DC, Chutka DS. Practical Functional Assessment of Elderly Persons: A Primary-Care Approach [Symposium on Geriatrics-Part III]. Mayo Clinic Proceedings 1995; 70:890. Copyright © 1995 Mayo Foundation.*
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3. *Data from: Bohannon RW. Reference Values for the Timed Up and Go Test: A Descriptive Meta-Analysis. J Geriatr Phys Ther 2006; 29:64.*

Graphic 66046 Version 11.0

Diagram of functional reach test to assess balance in elderly persons



Subject stands with fist extended alongside a wall. Subject leans forward as far as possible, moving fist along wall without taking a step or losing stability. Length of fist movement is measured. Distances of less than 6 in (15 cm) indicate an increased risk of falling.

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Graphic 54071 Version 5.0

Contributor Disclosures

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