REVIEW

CME CREDIT

JANE E. MAHONEY, MD
Geriatrics Section, Department of Medicine, University of Wisconsin School of Medicine, and William S. Middleton Memorial Veterans Hospital, Madison, Wisconsin

Falls in the elderly: Office-based evaluation, prevention, and treatment

ABSTRACT

Falls are serious and relatively common, and can result in significant morbidity and mortality for older adults. The office evaluation should focus on detecting underlying risk factors, adjusting high-risk medications, modifying unsafe behaviors, assessing home safety, and referring for physical therapy. Recent randomized trials have demonstrated successful interventions to decrease falls.

KEY POINTS

If a patient has experienced a fall, the physician should first determine if the fall was due to syncope.

If a fall was not due to syncope the workup centers on five key questions: Is anything acute? Is anything reversible? Can any medications be changed? Can physical therapy help? Can any environmental or behavioral modifications be made?

A brief performance evaluation can detect abnormalities in balance that can lead to falls. This consists of observing the patient while he or she performs various simple maneuvers.

The thyroid-stimulating hormone level is the only routine laboratory test indicated for all patients who fall.

TOO MANY OLDER ADULTS die or are injured as a result of falling down. Accidental falls are the leading cause of death from injury in elders.[1] Even in the absence of injury, patients who fall are at three to five times increased risk for nursing-home placement.[2]

But falls are not an inevitable part of aging—physicians can help prevent them. Accidental falls in older adults may be harbingers of underlying diseases, many of which can be reversed if diagnosed and treated early, possibly preventing further falls. Even when the underlying disease is irreversible, physicians can often decrease the risk of falling by adjusting the patient's medications, modifying his or her behavior, and prescribing physical therapy. Recent randomized trials have demonstrated that such interventions can decrease the incidence of falls in community-dwelling elderly.[3–7]

This article discusses underlying risk factors for falls, and suggests an office-based strategy for evaluation and treatment in the community setting. Risk factors for falls in the hospital and institutional settings are similar, but are beyond the scope of this review.

PREDICTING WHO WILL FALL

An accidental, nonsyncopal fall is defined as "an event which results in a person coming to rest inadvertently on the ground or other lower level not due to loss of consciousness, stroke, seizure, or sustaining a violent blow."[8]

Older adults who are likely to fall can be readily identified.[9–13] Based on epidemiologic

TABLE 1

Treatable causes of falls

- **Disorders of sensory input**
  - Visual
    - Cataracts
    - Myopia
  - Proprioceptive
    - Vitamin B_{12} deficiency
    - Neurosyphilis
    - Cervical spinal stenosis
    - Certain neuropathies
  - Vestibular
    - Cerumen impaction
    - Serous otitis media
    - Alcohol use
    - Acoustic neuroma
    - Benign positional vertigo
    - Chronic vestibular pathology
- **Cardiovascular disorders**
  - Orthostatic hypotension
  - Postprandial hypotension
  - Arrhythmia
- **Central processing disorders**
  - Normal pressure hydrocephalus
  - Subdural hematoma
  - Parkinson disease (bradykinesia)
  - Hypothyroidism, reversible dementias
  - Depression
  - Sedating medications, alcohol
- **Effector output disorders**
  - Lower motor neuron
    - Lumbar spinal stenosis
    - Reversible neuropathies
  - Muscle strength
    - Polymyositis
    - Endocrinopathies
    - Vitamin D deficiency
    - Protein-calorie malnutrition
    - Deconditioning/catabolic illness
  - Biomechanical
    - Leg length discrepancy
    - Foot deformities
    - Joint instability

studies, risk factors for falls and hip fractures include:

- Vision impairment[10,11,13]
- Muscle weakness[10,11,13]
- Balance and gait abnormalities[9–11]
- Use of psychotropic medications[9,13]
- Impaired cognition[9]
- Foot problems[9]
- Lower extremity arthritis[11,12]
- Neurologic diagnoses such as stroke[12] and Parkinson disease.[11]

Risk factors for falls are additive—a person with several risk factors is at greater risk for falling than a person with only one.[9,11,13]

A theory of postural control

A bit of theory provides a framework for evaluating risk factors for falls in the clinical setting. In brief, postural control depends on three factors:

- Sensory input (visual, vestibular, and proprioceptive);
- Central (neurologic) processing; and
- Effector output via the neuromuscular and musculoskeletal systems (TABLE 1).[14]

All three factors are affected by age, and the net effect of age-related changes is to decrease reserve in the system. However, healthy older adults should have enough reserve to maintain balance except during difficult physical maneuvers or in the presence of overwhelming environmental hazards.

Thus, falls in healthy elderly persons tend to occur during activities that challenge their balance such as racquetball or other sports, or as a consequence of an environmental hazard such as clutter or a loose throw rug.[15,16] However, as pathology becomes superimposed on age-related changes, older adults begin to fall with little or no environmental hazard, or during basic daily activities that normally present little motor challenge.[15,16]

Good postural control requires a fast reaction time.[17] To walk about upright and not fall down, humans must constantly and quickly generate responses to a stream of sensory information. Reaction time slows significantly with age, primarily due to a delay in central processing.[18] Anything that further slows response speed will impair the ability to respond to a postural challenge. Psychotropic medications,[9,13,19–22] alcohol,[12] cognitive impairment,[9] and depression[19] all interfere with alertness, slow reaction time, and increase the risk of falls and fractures.

CLINICAL APPROACH TO FALLS

Begin by classifying the fall as syncopal or nonsyncopal

In assessing a patient who has experienced a fall, the clinician should begin by classifying the fall as syncopal or not syncopal. Although this classification is often straightforward, syncope can be underreported. In a study examin-

ing carotid sinus syndrome,[23] some patients suffered syncope during carotid sinus massage but did not recall it when questioned later by a physician. It can be helpful, therefore, to elicit a history from witnesses of the fall. If the fall was not syncopal, further cardiac workup including Holter monitoring is of low yield and not recommended unless there are symptoms such as light-headedness or presyncope.[24]

Once you determine that a fall was not syncopal, the office evaluation can be organized around five key questions:

- Is anything acute?
- Is anything reversible?
- Can any medications be changed?
- Can physical therapy help?
- Can any environmental or behavioral modifications be made?

IS ANYTHING ACUTE?

Among community-dwelling elderly, about 10% of falls occur during an acute illness.[9] Any acute process that clouds the sensorium or causes weakness can increase the risk of falls. Indeed, in the elderly, a fall may be the initial manifestation of an infection, silent myocardial infarction, worsened congestive heart failure, or metabolic derangement such as hypoglycemia or hyperglycemia. Physicians should keep these causes of falls in mind, and ask about any symptoms of intercurrent illness.

IS ANYTHING REVERSIBLE?

Looking for reversible risk factors

Multifactorial interventions to modify or reverse risk factors can decrease the risk of falls.[3,5] TABLE 2 shows key elements of the evaluation.

The history should elicit the circumstances of the fall; the type of fall (trip, slip, other); any accompanying symptoms such as light-headedness or vertigo; any prior history of falls, gait impairment, or balance disturbance; and fear of falling or symptoms of depression.

The physical exam should focus on orthostatic changes in blood pressure and pulse, vision, the vestibular system, the nervous system, and the musculoskeletal system of the lower extremity. In addition, the physician should assess cognition with an instrument such as the mini-mental state examination.[25]

A brief performance evaluation should follow to detect any abnormalities in balance that can lead to falls. For example:

TABLE 2

Office-based evaluation and treatment of falls

History
- Circumstances, type of fall (trip, slip, etc)
- Accompanying symptoms
- Prior history of falls
- Gait impairment or balance disturbance
- Fear of falling
- Symptoms of depression

Medication review

Physical examination
- Orthostatic blood pressure and pulse
- Distance vision
- Vestibular exam as appropriate
- Neurologic exam
- Lower extremity musculoskeletal exam

Cognitive screen
- Mini-mental state examination

Performance evaluation
- Rise from chair without arms, walk short distance, turn, walk back, sit down
- Romberg test
- Turn head and look up, reach, bend
- Resist sternal nudge
- Ability to walk while talking

Diagnostic tests
- Thyroid-stimulating hormone level
- Other tests as suggested by history and physical examination
  - Vitamin B_{12}
  - Rapid plasma reagin
  - Complete blood count
  - Head CT

Physical therapy
- Assistive devices, balance training, strengthening, vestibular rehabilitation

Home safety evaluation
- Lighting
- Stairs
- Clutter
- Cords
- Tripping hazards
- Bathroom safety
- Floor surface
- Footwear
- Lifeline

- Ask the patient to get up from a chair without using his or her arms.[26] Needing the arms to arise from a chair is abnormal and suggests significant weakness in the hip extensors and quadriceps.[11]
- After the patient rises, ask him or her to walk a short distance, turn, walk back, and sit down.[26] With age, people normally walk slower and take shorter steps. Pathologic changes include a gait that is broad-based, hesitant, uneven in stride length or tempo, or irregular in path. When evaluating turns, look for smoothness of movement, tempo, and foot placement. Subtle changes in balance often are not apparent with simple walking but are evident with turns.
- Ask the patient to reach up, bend down, turn the head and look up, and resist a backward nudge.[27]
- Ask the patient to walk and talk at the same time. If a patient stops walking when talking, he or she is at increased risk for falls.[28]

Laboratory and imaging tests. The thyroid-stimulating hormone (TSH) level is the only routine diagnostic test recommended (TABLE 2). Other diagnostic tests, including a vitamin B_{12} level, an RPR (rapid plasma reagin test for syphilis), and a computed tomography (CT) scan of the head, should be guided by clinical findings.

Ask the patient to stand up without using his or her arms

In general, the history, physical exam, performance evaluation, and laboratory tests evaluate systems that contribute to postural control, from sensory input (visual, proprioceptive, and vestibular), to central processing, to effector output (including muscle strength and biomechanics). Most patients have multiple risk factors in multiple systems. These systems are addressed below and are summarized in TABLE 1.

Disorders of vision

Falling due to tripping or falling on stairs, ramps, or curbs suggests vision impairment as a contributing factor. Particular vision impairments that are associated with hip fractures include loss of contrast sensitivity, poor depth perception, and decreased distant vision.[10,11,13,29] Poor depth perception and loss of contrast sensitivity make it difficult to distinguish edges, and thus impair performance on ramps, curbs, steps, and uneven ground. Cataracts can affect both contrast sensitivity and depth perception. Because even unilateral vision impairment increases the risk of hip fracture,[29] in a patient with a history of falls, consider removing a cataract that is affecting vision in one eye, even if acuity is intact in the other.

Disorders of proprioception

Patients with proprioceptive loss become more reliant on vision for maintaining balance,[17] and may give a history of significantly worsening balance in the dark or in the shower with the eyes closed. Clinical evaluation of joint-position sense is insensitive for detecting proprioceptive loss. In contrast, loss of vibratory sensation is more easily detected, serves as a proxy for loss of joint position sense, and is associated with falls.[10] Loss of vibratory sensation at the great toe occurs even in healthy older adults.[30] However, its absence at the level of the ankle suggests significant pathology and is usually associated with a positive Romberg sign (ie, significantly increased swaying with the eyes closed).

Treatable or partially treatable causes of neuropathic proprioceptive loss include vitamin B_{12} deficiency, neurosyphilis, and cervical spinal stenosis (frequently causing upper motor neuron weakness as well).[31] Other causes of neuropathy should be considered on the basis of clinical findings.

Nonneuropathic proprioceptive loss can occur after joint replacement or as a result of osteoarthritis.[32] In one study, an elastic sleeve around the knee improved the proprioceptive deficit in patients with knee joint replacement or degenerative joint disease.[32] Osteoarthritis in the facet joints of the cervical spine can cause a proprioceptive cervical dizziness that is brought on by head or neck movements.[33]

Vestibular dysfunction

Patients with vestibular dysfunction do not always have classic symptoms of vertigo, but may report a nonspecific dizziness or disequilibrium.[33,34] They may have oscillopsia (a sensation that the environment is moving when they move their heads or walk). Like patients with proprioceptive loss, they are more reliant on vision for maintaining their balance, and can have increased unsteadiness in the dark.

Office tests of vestibular function include:

- The head thrust test (look for rapid small eye movements elicited by quick, brief, passive movements of the patient's head to the right and left, with the patient instructed to look at the examiner's nose)
- Dynamic visual acuity (look for a drop of more than 1 line on the Snellen chart while the head is moving back and forth)
- The Hallpike maneuver (look for vertigo and nystagmus brought on by rapid positioning of the patient's head from a seated position to a head-hanging position, tilted 30 degrees to either the right or left)
- The Romberg test (look for an increase in sway when the patient is standing with feet together and eyes closed).[33,34] Patients can also be asked to march in place with the eyes closed and arms held straight ahead; rotation of more than 45 degrees in 30 seconds of marching is suggestive of unilateral peripheral vestibular hypofunction.[33]

Reversible or treatable causes of vertigo or dizziness include cerumen impaction, serous otitis media, acoustic neuroma, and alcohol use.[33] High doses of nonsteroidal anti-inflammatory drugs, loop diuretics, and quinine can cause vertigo. Aminoglycoside toxicity, which is typically irreversible, may cause vestibular dysfunction in the absence of hearing impairment.[34] Benign positional vertigo is a common vestibular disorder that remits spontaneously, but vestibular rehabilitation exercises can hasten resolution of symptoms.

Interventions. Patients with vestibular disease should be counseled regarding the need for heightened awareness in the dark. In general, meclizine and sedative-hypnotics should be avoided because of a high incidence of adverse effects in the elderly.

Cardiovascular disorders

Arrhythmias and orthostatic and postprandial hypotension more typically cause syncope than accidental, nonsyncopal falls.

Orthostatic hypotension. In a large, cross-sectional study, orthostatic hypotension (defined as a 20-mm Hg drop in systolic blood pressure when standing up after lying down) was not associated with falls, and postural dizziness (defined as symptoms of light-headedness with standing) was only weakly related.[35] In general, an asymptomatic orthostatic drop in blood pressure is unlikely to be the cause of a fall. Postural hypotension may be implicated if the fall occurred in a setting consistent with orthostasis (eg, shortly after arising from a chair *and* with symptoms of light-headedness) and if symptomatic orthostasis can be documented on examination.[36]

If postural or postprandial hypotension is a likely cause, review the dose and timing of antihypertensive and cardiac medications. Short-acting nitrates and antihypertensives are commonly taken around meals and can contribute to postprandial hypotension. Treatment options for orthostatic hypotension include pumping the hands and feet before arising, increased fluid intake, Jobst stockings, fludrocortisone, and midodrine.

Disorders of central processing

Patients who present with multiple, rather than single, falls frequently have a deficit in central processing. Reversible or partially reversible neurologic disorders associated with falls include acute and chronic subdural hematoma and normal-pressure hydrocephalus. Other neurological conditions that may be associated with falls include neoplasms, strokes,[12,36] and subcortical white matter changes.[37]

Check vibratory sense at the great toe and ankle

Parkinson disease is associated with falls. Unfortunately, dopaminergic therapy usually does not improve postural instability.[38] However, levodopa is more effective in treating bradykinesia, and therapy to treat bradykinesia may decrease the rate of falls for some patients.[38]

Cerebellar atrophy occurs in patients with a long history of alcohol or high-dose anticonvulsant use. Anticonvulsants should be adjusted to the lowest therapeutic dose, and alcohol and other sedatives should be avoided.

Dementia increases the risk for falls by slowing the reaction time, impairing judgment, and frequently, causing motor apraxia. An office-based evaluation for falls should include a cognitive screen such as the mini-mental state examination.[25] Therapy should be directed to detecting and treating the underlying cause of the dementia, avoiding

TABLE 3

Medications associated with falls

Strong association*
- Alcohol
- Antipsychotics
- Benzodiazepines
- Narcotics
- Tricyclic antidepressants

Potential association†
- Anticholinergics
- Antihistamines
- Barbiturates
- Other sedating agents

*Based on epidemiologic literature
†Based on epidemiologic literature or pharmacologic profile

centrally-acting medications, encouraging exercise, and encouraging the use of an assistive device, if necessary. Physicians should work with caregivers to provide the patient a supportive and safe environment.

Always check the TSH in a patient who fell

Slowed reaction time increases the risk of falls,[10] even in the absence of dementia. Hypothyroidism is an easily-overlooked, treatable cause. The TSH level should be checked in any patient who is being evaluated for falls. Depression is also associated with both slowed reaction time and falls.[19] Serotonin reuptake inhibitors such as sertraline, fluoxetine, and paroxetine do not, in general, cause sedation, orthostasis, or psychomotor slowing, and are good first-line agents for patients with depression who are at high risk for falls.

Disorders of effector output

Disorders of effector output include lower motor neuron defects and biomechanical deficits.

Lumbar spinal stenosis is the most important reversible cause of lower motor-neuron disease implicated in falls. Lumbar spinal stenosis may present with weakness or pain with ambulation and, frequently, radicular findings on examination. In one series, surgery resulted in partial or complete improvement in 84% of patients.[39]

Disuse is a more common cause of effector output impairment. A program of weight training (which should be progressive) can reverse weakness and atrophy due to disuse, and increases in strength are directly proportional to the intensity of the weight training.[40]

Biomechanical deficits, often the residual effects of arthritis, are common in older adults and can contribute to gait abnormalities and falls. Orthotic devices and appropriate footwear can alleviate foot deformities and discrepancies in leg length. An antalgic gait (an abnormal gait due to pain with walking) often improves with use of an assistive device.

CAN ANY MEDICATIONS BE CHANGED?

In general, any drug that carries precautions for driving should be viewed as potentially contributing to falls (TABLE 3). Review all the medications the patient takes, including those sold over-the-counter. In addition, ascertain the patient's alcohol intake—consuming seven or more alcoholic drinks per week is associated with an increased risk of hip fracture.[12]

Psychotropic medications

Psychotropic medications that are sedating or decrease alertness should receive particular attention. There is strong evidence that benzodiazepines (especially long-acting), tricyclic antidepressants, antipsychotics, and narcotics increase the risk of falls and hip fractures.[9,12,13,19–22,36] In general, the risk is dose-dependent, and is greater with new use or dosage increase.[20,21]

Benzodiazepines. Long-acting benzodiazepines such as diazepam, chlordiazepoxide, and clonazepam should be avoided in older adults, and short-acting benzodiazepines should be used with caution, as they have been associated with fractures as well.[21]

Tricyclic antidepressants. The risk for falls may be greater with the first-generation agents amitriptyline, doxepin, and imipramine, which are more sedating and more anticholinergic than are second-generation agents. If a tricyclic agent is needed, an agent with a low anticholinergic profile is preferred (eg, desipramine or nortriptyline).[41]

Antipsychotic drugs. Both high-potency and low-potency agents are associated with

increased risk for fractures.[20] Risk may be due to extrapyramidal side effects in high-potency drugs such as haloperidol, and to anticholinergic and sedating side effects in low-potency drugs such as chlorpromazine.

Drugs that cause sleepiness such as antihistamines,[42] anticholinergic agents, barbiturates, and sleep-aids such as zolpidem have less evidence implicating them than do the agents listed above. However, they would be expected to increase the risk of falls.

Cardiac medications

In specific circumstances, diuretics, antihypertensive drugs, and other cardiac medications may be associated with falls. An association has been found in some epidemiologic studies,[19] but not in others.[9,12,13] Cardiac medications should be evaluated when clinical circumstances clearly indicate a fall is due to orthostasis or an arrhythmia.

CAN PHYSICAL THERAPY HELP?

Patients with a history of two or more falls in the past year or with abnormalities of balance or gait should be referred to physical therapy for evaluation for an ambulation assistive device.

The choice of an assistive device is based on an empiric trial, and may be best determined in the home. In general, patients with sensory deficits will benefit from a cane[42–44] or three-wheeled walker. A four-wheeled walker provides further stability for someone with central balance deficits or multiple sensory impairments, while a wheeled walker with a seat is useful for patients with decreased endurance. A wheelchair or scooter may be necessary for patients with cerebellar disease or brainstem cerebrovascular accidents.

Exercises to improve balance and strength, either alone or in combination with other risk-reduction measures, are successful in decreasing the rate of falls.[3–7] Balance training can improve integration of sensory input and teach patients awareness of movements and balance limitations. Frail older adults can learn functional balance exercises to perform in the home; for healthier older adults, tai chi or water exercise is appropriate.[4,45] In a meta-analysis of a number of exercise interventions, balance training appeared superior to strengthening in decreasing falls.[46]

Physical therapy can also help elderly patients with vestibular deficits.[33,34] The goals of vestibular rehabilitation exercises are to habituate the vestibular system through repeated performance of rapid head and eye movements, and increase sensory integration of input from visual and proprioceptive stimuli.[34]

CAN BEHAVIORAL OR ENVIRONMENTAL MODIFICATIONS BE MADE?

Behavioral modification has been a component of most successful fall-intervention trials.[3,5,7] Most persons who fell say they could have avoided falling by being more cautious or by modifying their behavior.[47] Therefore, it is important to elicit and discuss behavioral contributors to falls. For example:

- Did the patient forget to use an assistive device?
- Does he or she walk in stocking feet, or forget to wear glasses?
- Does the patient attempt activities that are unsafe or risky, such as carrying items up and down stairs?
- Is his or her footwear appropriate? Shoes with thin, hard soles improve balance compared to walking barefoot or in shoes with thick, soft soles.[48]

Any drug that can impair driving can cause falls

Environmental modifications are important. Up to 50% of falls are environmentally related[9]: 20% occur on stairs, steps, or entrances,[47] and one fourth involve tripping over objects.[9] If a patient falls at home, an occupational or physical therapist can perform a home safety assessment, which should focus on lighting, stairs, clutter, cords and other tripping hazards, bathroom safety, and floor surface (TABLE 2). In addition, patients should be evaluated to see if they need a monitoring system such as Lifeline, so that they do not have to lie on the floor a long time undiscovered if they do fall.

Environmental recommendations should be tailored to the circumstances of the fall and the risk factors present. Patients with vision impairment face a significant hazard from clutter, glare, poor lighting, and poorly marked steps. Stairs can be made safer by

installing handrails on both sides, a roughened surface to prevent slips, and brightly colored tape on the stair edges to improve depth perception. For patients with decreased foot clearance, thick carpeting may increase the risk of tripping. For patients with lower extremity weakness, toilets, chairs, and sofas may be too low. Providing a raised toilet seat and grab-rails around the toilet, and raising chair and sofa seats to the height of the popliteal fossa may improve both safety and mobility.

SUMMARY: A MULTIFACTORIAL APPROACH TO FALL PREVENTION

TABLE 2 summarizes the key elements of an office-based evaluation for falls. Whether a fall is the sentinel event of an acute medical illness or a marker for underlying disease, it warrants medical evaluation. The approach to the unsteady patient should be multifactorial, with attention paid to the environment, medications, and underlying pathology. Even when the underlying disease is irreversible, medication adjustment, behavior modification, attention to the home environment, and physical therapy can decrease the risk of falls for high-risk individuals.

Balance exercises may prevent falls better than strengthening exercises

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ADDRESS: *Jane E. Mahoney, MD, VA Hospital GRECC, 2500 Overlook Terrace, Madison, WI 53705.*