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The Patient Who Falls:

"It's Always a Trade-off"

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Abstract

Falls are common health events that cause discomfort and disability for older adults and stress for caregivers. Using the case of an older man who has experienced multiple falls and a hip fracture, this article, which focuses on community-living older adults, addresses the consequences and etiology of falls; summarizes the evidence on predisposing factors and effective interventions; and discusses how to translate this evidence into patient care. Previous falls; strength, gait, and balance impairments; and medications are the strongest risk factors for falling. Effective single interventions include exercise and physical therapy, cataract surgery, and medication reduction. Evidence suggests that the most effective strategy for reducing the rate of falling in community-living older adults may be intervening on multiple risk factors. Vitamin D has the strongest clinical trial evidence of benefit for preventing fractures among older men at risk. Issues involved in incorporating these evidence-based fall prevention interventions into outpatient practice are discussed, as are the trade-offs inherent in managing older patients at risk of falling. While challenges and barriers exist, fall prevention strategies can be incorporated into clinical practice.

The Patient's Story

Mr Y, an 89-year-old retired salesman, lived independently until 3 years ago. He had a right humeral fracture in 2006 and a left hip fracture 3 months later. After hip fracture repair and rehabilitation, he moved in with his daughter, a physical therapist.

Mr Y's medical history includes coronary artery bypass grafting and porcine aortic valve replacement in 2003; dementia; hypertension; gout; peptic ulcer disease; macular degeneration; and bilateral hearing aids. In 1992, Mr Y fractured his right hip in a bar brawl; he used alcohol heavily until a few years ago.

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On arrival at his daughter's home, Mr Y reported left hip pain and an unsteady gait. He became delirious when taking oxycodone ER, 10 mg every 12 hours. In June 2007, his daughter brought Mr Y to see Dr C, a geriatrician, who noted pruritus, chronic rhinorrhea, and weight loss. Mr Y scored 28 of 30 on the Folstein Mini-Mental State Examination[1]; he missed the date and recalled 2 of 3 objects at 5 minutes.[1] Mr Y's recall of 2 words, plus his abnormal clock drawing (eFigure, available at http://www.jama.com), indicated a positive screen for dementia.[2,3] Mr Y denied depressed mood or loss of interest with the 2-item depression screen.[4] He was independent in his basic activities of daily living (ADL) but dependent in his instrumental ADL (Table 1, footnote f).[5,6] His medications included aspirin, 81 mg; metoprolol XR, 100 mg; lisinopril, 40 mg; hydrochlorothiazide, 12.5 mg; simvastatin, 20 mg; omeprazole, 20 mg twice a day; allopurinol, 100 mg; acetaminophen/hydrocodone, 1 tablet as needed; docusate, 250 mg twice a day; and nitroglycerin, 0.4 mg sublingually for chest pain.

Mr Y's blood pressure was 148/61 mm Hg without orthostatic changes. He weighed 158 lb. A grade 3/6 systolic ejection murmur was present without signs of heart failure. Mr Y's strength and sensation were normal except for left hip and knee weakness. There was tenderness to palpation over the left greater trochanteric region; the hardware from his hip surgery was palpable. The Romberg test result was negative. A mobility screen (with Mr Y's results) is shown in the Box.[7]

Results of urinalysis, complete blood cell count, and routine serum chemistries were normal. A left hip radiograph revealed nonunion and bony collapse. A magnetic resonance imaging scan of the brain revealed multiple infarcts.

Dr C changed Mr Y's acetaminophen/hydrocodone to round-the-clock dosing, not to exceed 8 tablets daily, and prescribed vitamin D, 400 IU daily. In September 2007, an orthopedist injected corticosteroids in the area of the left greater trochanteric bursa. The pain decreased.

Mr Y completed 20 outpatient physical therapy (PT) sessions between October 2007 and June 2008. He was discharged from PT when he was no longer making progress. He used a 4-wheel walker.

Over the next few months, he continued to fall. One fall occurred after he took a cold medication containing diphenhydramine. Another fall occurred in July 2008 after he inadvertently took several sublingual nitroglycerin tablets and developed dizziness and headache. In the emergency department, his initial blood pressure reading while sitting was 130/60 mm Hg, with a pulse rate of 67/min; the corresponding values while standing were 90/50 mm Hg and 58/min. An echocardiogram showed an ejection fraction of 65% and an aortic valve area of 1.7 cm^2. Results of computed tomography of the head were unremarkable. Mr Y was sent home but continued to feel dizzy. Dr C subsequently stopped the lisinopril and reduced the dose of metoprolol. The dizziness resolved.

The fall in July 2008 exacerbated Mr Y's left hip pain. In November he underwent removal of his left hip fixation plate and screws and restarted PT. The dose of vitamin D was increased to 800 IU daily. He had no further falls.

Mr Y denied that his falls were a significant problem. He declined a paid attendant or referral to adult day care but agreed to a personal emergency response system when it was explained that this would give his daughter peace of mind.

A *Care of the Aging Patient* series editor interviewed Mr Y; Ms Y, his daughter; and Dr C in early 2009.

PERSPECTIVES

Mr Y: I'll be 90 this year … [my daughter] invited me to live with her… . I've fallen a couple of times. When you get old, your equilibrium doesn't work as good… . It was a big worry of my daughter and my doctors.

Dr C: He was on a lot of different medications and was having a lot of pain … a lot of medical issues… .

Ms Y: He was in a skilled nursing facility recuperating from his hip fracture when they diagnosed him with dementia and told him he couldn't live alone. We had meetings with the doctors, social workers, and therapists. He wanted to go back and live alone, but I said, 'I'm a very good gait therapist and I can help you walk better'… . I told him that it would be more of a burden … to be too far away… .

Falling can cause lasting discomfort and decreased function, imposing family and societal care burdens. While evidence indicates that assessment and intervention can reduce the risk of falls and injuries, often these interventions require trade-offs between health conditions and between the patient's desire for independence and safety concerns.

PREVALENCE, CONSEQUENCES, AND ETIOLOGY OF FALLS

More than one-third of community-living adults older than 65 years fall each year.[9-11] Approximately 10% of falls result in a major injury such as a fracture, serious soft tissue injury, or traumatic brain injury.[9-13] Injury rates are similar for elderly men and women and for African Americans and whites, although women are more likely to experience fractures, and men and African Americans are more likely to experience traumatic brain injuries.[13,14] Inability to rise without help, experienced by half of older persons after at least 1 fall, may result in dehydration, pressure ulcers, and rhabdomyolysis.[15]

Falls are major contributors to functional decline and health care utilization. Falling without a serious injury increases the risk of skilled nursing facility placement by 3-fold after accounting for cognitive, psychological, social, functional, and medical factors; a serious fall injury increases the risk 10-fold.[16] Falls and fall injuries are among the most common causes of decline in the ability to care for oneself and to participate in social and physical activities.[17,18] Diminished self-confidence may partially explain functional loss following falls without serious injury.

As with other conditions affecting older adults, such as delirium and urinary incontinence, falling is classified as a geriatric syndrome. Defining features of geriatric syndromes include the contribution of multiple factors and the interaction between chronic predisposing diseases and impairments and acute precipitating insults.[19] The ability to transfer and walk safely depends on coordination among sensory (vision, vestibular, proprioception), central and peripheral nervous, cardiopulmonary, musculoskeletal, and other systems. Falls that occur during usual daily activities generally result from diseases or impairments affecting 1 or more systems.

THE EVIDENCE: RISK FACTORS AND PREVENTION

Methods

We conducted 3 systematic reviews, focused on community-living older adults, to identify (1) multiple impairments and conditions predisposing to falls; (2) effective physical therapy and exercise interventions; and (3) effective multifactorial interventions. The search

strategies, search results, and publications resulting from each search are presented in the eAppendix, available at http://www.jama.com.

Risk Factors for Falling

The factors identified in the systematic review as contributing independently to risk of falling or experiencing a fall injury in at least 2 of the 33 studies appear in Table 1. The strongest risk factors for falling include previous falls; strength, gait, and balance impairments; and use of specific medications. Of note, falls and fractures share many risk factors.[20]

The risk of falling increases with the number of risk factors. In 1 study, the 1-year risk of falling increased from 8% to 19% to 32% to 60% to 78% (χ^2 for order in proportions, 62.7; $P<.001$) as the number of factors increased from 0 to 4 or more, suggesting that the presence of the factors listed in Table 1 can be used to both estimate an individual's risk of falling and to guide prevention efforts.[9]

Medications are particularly complex risk factors for falling. Diseases such as depression, heart failure, or hypertension may increase fall risk but so also may the medications used to treat them. Common adverse medication effects such as unsteadiness, impaired alertness, and dizziness are risk factors for falling.[21-25] The risk of falling among older adults increases with the number of medications consumed, independent of medication indications and other confounders.[9] Psychoactive medications (sedatives, antipsychotics, and antidepressants), anticonvulsants, and antihypertensive medications are most strongly linked to increased risk for falling.[23-25]

INTERVENTIONS TO PREVENT FALLS

Single as well as multifactorial interventions have been investigated in randomized controlled trials.[26,27] Single interventions evaluated include cardiac pacing, vision improvement, home safety modifications, medication reduction, and PT or exercise.

Single Interventions

The 1 trial of cardiac pacing in persons with cardioinhibitory carotid sinus hypersensitivity who had fallen was associated with a reduced rate of falling (relative risk [RR], 0.42, 95% confidence interval [CI], 0.23-0.75 [N=171]).[28] Expedited first cataract surgery significantly reduced falls (RR, 0.60; 95% CI, 0.36-0.98 [N=306 women])[29]; a trial of second cataract surgery showed no benefit.[30] A multicomponent vision intervention trial including treatment of glaucoma, referral for cataract surgery, and new refraction was associated with a nonsignificant increased risk of falling (RR, 1.74; 95% CI, 0.97-3.11 [N=616]).[31] Home safety modification was not effective as the sole intervention among participants not selected for fall risk (RR, 0.90; 95% CI, 0.79-1.03 [2367 participants, 3 trials]).[24] However, those with previous falls or fall risk factors did benefit (RR, 0.56; 95% CI, 0.42-0.76 [491 participants, 2 trials]).[27] Evidence is insufficient to determine the role of cardiac pacing in fall prevention but does support first cataract surgery and home safety modifications in at-risk individuals.

Reducing the number of medications consumed was associated with a reduction in fall risk in 1 trial, although efforts to reduce psychoactive medications were not effective.[32] In another randomized controlled trial, psychoactive medication withdrawal resulted in a 66% reduction in rate of falling (RR, 0.34; 95% CI, 0.16-0.73 [N=93]), although individuals resumed the medications after the trial.[33] A multicomponent medication strategy including academic detailing and feedback to clinicians and medication modification by clinicians

resulted in a 39% reduction in falls (95% CI, 9%-59% [N=659]).[34] Medication reduction appears effective, although withdrawal of psychoactive medications proved difficult.

Exercise is the most widely studied single intervention. Twenty-five trials of either tai chi (6 trials) or combinations of strength, gait, balance, and endurance training (19 trials) were identified in the systematic review (eAppendix). The rate of falling declined a relative 25% to 33% in the 4 of 6 tai chi trials that showed a significant difference. Nine of 14 trials of combination training showed significant relative reductions ranging from 22% to 46%. All of the positive trials included balance training as one component. Only 1 of 5 trials of a single exercise component reduced falls. The frequency and intensity of the exercise programs varied among the effective trials. Evidence supports progressive balance and strength, and perhaps endurance, training for fall prevention, although the optimal frequency and intensity remain to be determined.

Multifactorial Fall Prevention

Multifactorial trials included those in which investigators carried out the intervention components or directly ensured that the interventions occurred and those in which investigators only offered advice or referral to existing community or health care sources. Among the former group with direct interventions, at least 1 fall-related outcome was better in the intervention group than in the control group in 8 of 11 trials (Table 2). Among the latter group with advice/referral only, none of the 14 trials found a benefit.

Other systematic reviews and meta-analyses have drawn conflicting conclusions about the effectiveness of multifactorial interventions.[27,35-37] Campbell and Robertson concluded that multifactorial interventions were no more effective than single interventions such as PT,[35] while Chang et al found the multifactorial approach superior.[36] Gates et al and the Cochrane review both concluded that multifactorial interventions that actively provide treatments are more effective than those that provide only knowledge and referral.[27,37] Most of the effective trials included multiple factor risk assessment, PT or exercise, withdrawal or minimization of psychoactive and other medications, and home safety modification. Components included in the clinical trials are listed in the eTable. The preponderance of evidence supports multifactorial interventions as the most effective preventive strategy.

Fall Prevention Strategies in Cognitively Impaired Patients

The only study of cognitively impaired community-living older adults (274 individuals presenting to an emergency department after a fall) showed no significant difference between the intervention group, which received management of medical problems, modification of psychotropic medications, PT, and home hazard modification, and the control group (RR, 0.92; 95% CI, 0.81-1.05).[38] Conversely, while Mahoney et al found no intervention effect overall, among patients with a Mini-Mental State Examination score of 27 or less, those in the intervention group had a lower rate of falls than controls (RR, 0.55; P=.05).[39] The effectiveness of fall prevention in cognitively impaired older adults remains unknown.

Prevention of Fractures in Men

The eBox lists risk factors for osteoporosis and fractures, recommendations for screening, and evidence for treatment and prevention, in older men.[40-45] No consensus exists regarding screening in older men.[40-42] At least 800 IU of vitamin D is the only medication with compelling evidence of effectiveness for fracture prevention in older men.[45]

TRANSLATING EVIDENCE INTO CLINICAL PRACTICE

Screening

Ms Y: I know my Dad only tells people what he wants them to know … like why he was falling before he came to live with me; there was alcohol involved and nobody knew that but him and me… .

The first clinical issue is deciding who should have risk factors for falling assessed and treated. Evidence suggests that persons older than 65 years who present with a fall, report at least 1 injurious fall or 2 or more noninjurious falls, or report or display unsteady gait or balance (Box) should undergo fall risk factor assessment and management.[26,46] If patients report no more than 1 noninjurious fall and have no difficulty with walking or balance, no further assessment is needed. The American Geriatrics Society guideline recommends this screen at least yearly.[26] For patients with cognitive impairment, caregivers should be queried.

Assessing and Managing Fall Risk Factors

Dr C: We went problem by problem and came up with a plan to reduce his risk of falling… . He's been a very good illustration of things you can do that make a difference.

We attacked the muscle weakness by having him go through extensive physical therapy and making sure he has the appropriate assistive devices … [we did] a home safety evaluation… . We started him on calcium and vitamin D … .

The multifactorial nature of fall prevention means that care must be coordinated among physicians, nurses, physical therapists, and occupational therapists. A primary care clinician can coordinate care by assessing and managing the medical components and referring patients to home care or outpatient rehabilitation. Alternatively, interdisciplinary fall teams or clinics are available at many geriatric or rehabilitation centers. Regardless of location or disciplines involved, effective fall prevention requires assessing potential risk factors, managing the risk factors identified, and ensuring that the interventions are completed. Potential trade-offs must be considered in formulating the assessment and management strategy.

Assessing the Risk Factors

Assessment should focus on determining the circumstances of previous falls and on identifying risk factors or factors known to be the target of effective interventions (Table 1 and Table 3). The assessments of fall risk listed in Table 3 should be completed in all older patients at risk. Factors increasing Mr Y's risk of recurrent falls include past falls; cognitive, strength, gait, and balance impairments; ADL limitations; macular degeneration; pain; postural hypotension; mild aortic stenosis; alcohol (in his earlier falls); and several of his medications, specifically metoprolol, lisinopril, hydrochlorothiazide, nitroglycerin, hydrocodone, and diphenhydramine (Table 3). A decreased vitamin D level (17.9 ng/mL), which should be suspected with muscle pain or weakness, fractures, or decreased sun exposure, could also have contributed.

The examination should include cognitive evaluation, postural blood pressure measurement, cardiac rhythm and rate, muscle strength, joint range of motion, and examination of the feet and proprioception (Table 3). A balance and gait screen or evaluation should also be performed (Box).

Mr Y's abnormal clock drawing (eFigure) indicates executive dysfunction that can occur with intact memory, as with Mr Y.[49] Like Mr Y, individuals with executive dysfunction

may have difficulty with instrumental ADL (Table 1) and may manifest slow gait and other gait impairments.[50] This combination of cognitive and gait impairments can be seen in subcortical degenerative disorders such as normal-pressure hydrocephalus (not evident on Mr Y's magnetic resonance imaging scan) or subcortical vascular dementias.[51]

MANAGING THE RISK FACTORS IDENTIFIED

The evidence suggests that improving as many of the factors listed in Table 3 as possible is the most effective way to reduce the risk of falling. Medication reduction, physical therapy, and home safety modifications have the strongest evidence of benefit for fall prevention in clinical practice.

Dr C: I took off a lot of blood pressure medications because he was feeling dizzy and his pressure was low… . We need to make sure that we control the pain, because if you have severe pain … you get deconditioned and you fall. On the other hand, the more medications you take, you run the risk of getting more confused … it increases the risk that … he might fall… .

Medications

Dizziness or lightheadedness on standing or the use of 4 or more medications should prompt the measurement of postural blood pressure and reduction in the number and dosages of medications. Particular attention should be given to the possible elimination or dose reduction of medications known to increase orthostasis or fall risk (Table 3).

The presence of multiple health conditions necessitates a consideration of trade-offs between benefits vs risks of medications, particularly when the treatment of one condition may worsen another.[52] Antihypertensive, anticoagulant, and antidepressant medications commonly pose such trade-offs for patients at risk for falling. Few data currently exist to guide decision-making for these trade-offs. The clinician must consider which condition presents the greatest threat to the outcome priority of greatest importance to the patient.[53,54] By eliminating unnecessary medications and reducing the dose of necessary medications, it is often possible to treat coexisting conditions while minimizing risk of medication-related fall or injury.

Dr C articulated well the trade-off between pain management and fall risk for Mr Y. Because pain is a risk factor for falling,[55] appropriate treatment may reduce fall risk. Pain assessments result in improved detection and treatment. The American Geriatrics Society pain management guideline provides strategies for older adults (Resources, available at http://www.jama.com).

Adding vitamin D, 800 IU and probably without calcium, is indicated in patients such as Mr Y, who are deficient.[45]

PHYSICAL THERAPY AND HOME SAFETY MODIFICATION

Mr Y: My doctor and my daughter … decided [an emergency alert necklace] would be good … and it is. It's a 24-hour-a-day watchdog. It's very simple to use … I have a fixture in the bathtub with handrails and seats… . I haven't had any missteps … since I started it.

Ms Y: When he had the [hip] hardware removed, I requested [physical] therapy again… .

Home safety evaluations and modifications, as described in Table 3, can be self-conducted (Resources) or performed by a nurse, physical therapist, or occupational therapist. Patients with reported or observed balance or walking problems should be referred for PT. If

homebound, a patient is eligible for treatment by a Medicare-certified home care agency if progress is documented. Treatment at home allows assessment and management of mobility in the patient's own environment. If not homebound, then the patient must be referred to outpatient rehabilitation, and the therapist must rely on self- or family-report of home safety issues. Available evidence suggests that, for fall prevention, PT should consist of progressive standing balance and strength exercises; transfer practice; gait interventions, including evaluation for an assistive device (cane or walker); and instructions in techniques for arising after a fall. Referral should be made to therapists skilled in evidence-based progressive balance training for older patients (Resources). Endurance training, such as walking, should be added when safe. A challenge is that ongoing exercise is needed to maintain improvements after therapy ends. In addition to recommending walking, referral to community programs targeting older adults should be considered (Area Agencies of Aging may have this information). There is insufficient evidence to determine if PT is beneficial for patients with dementia.[56] Strategies used by therapists with patients with dementia include simple, repetitive routines; removal of environmental hazards; easy-to-read instructions with pictures; and caregiver involvement.

Occupational therapy for community-dwelling at-risk older adults focuses on safe ADL functioning; upper-extremity function; activity to lerance; and mobility.[57] Occupational therapists provide patient and family education and prescribe adaptive devices(Table 3).For patients with dementia, occupational therapists counsel caregivers about strategies for safe functioning.

SAFETY VS INDEPENDENCE

Ms Y: I'm a physical therapist, so safety is my job. He does everything the least safe, worst way possible! I'm trying to learn to choose my battles … .

Persons at risk for falling face trade-offs between safety and functional independence. To reduce fall risk, they may have to avoid desired activities or rely on help. Conversely, patients may have to accept risk of serious injury if they wish to continue performing activities beyond their balance capability. For individuals who are cognitively intact, the clinician's responsibility is to present the evidence, attempt to minimize risk through proven assessment and management strategies, and ensure an informed decision. If there is any question, the clinician must ascertain whether the individual has the capacity to make informed decisions, either by interviewing the patient and family or by referring the patient to a psychiatrist or geriatrician.

For the individual with reduced decisional capacity, the clinician must work with the family or caretakers, as did Dr C and Mr Y's daughter. As she has done, Mr Y's daughter needs to take the initiative. As was evident with Mr Y and his daughter, the family may prioritize safety while the patient values independence and mobility. Negotiations are often needed to get the family to agree, and the patient to assent, to a balance between safety and independence.

Support for Caregivers

Ms Y: Living with someone with dementia—is tremendously stressful. I had no idea that I would be this impatient sometimes. I have a group of women I know from taking a class on caregiving, and we try to support each other. It's been rough, but it's been a real gift in terms of getting to know my dad.

Dr C: I wanted to know what would help her [daughter] not get burnt out and to try to provide her with more services … we've talked about respite programs… . We've offered home health aides and other kinds of home support.

Cognitively intact older adults who fall may handle their own health and functional needs. Among community-dwelling frail or cognitively impaired older adults, however, falls further increase caregiver burden.[58] As Dr C elicited from Ms Y, primary caregivers of cognitively and functionally impaired elders often experience stress, which can be uncovered through a brief private interview with the caregiver or by use of self-administered instruments.[59] Caregivers with high levels of stress should be referred to social agencies or support groups. Local Area Agencies on Aging (Resources) can provide information on sources of help and financial assistance. Geriatric care managers are another source of assistance, although neither health insurance nor long-term care insurance usually covers this cost.

Challenges to Incorporating Fall Prevention Into Practice

Some challenges to incorporating fall prevention into practice, such as time constraints, competing demands, and inadequate reimbursement, are similar to those facing other cognitive services.[60-62] Other barriers, such as perceived lack of skills in managing complex, multifactorial health conditions, and lack of coordination across disciplines and settings, are particularly acute for geriatric syndromes.

CONCLUSIONS

With the use of screening tools, consideration of trade-offs between competing conditions, and reliance on other members of the health care team, evidence-based fall risk assessment and management is feasible and effective. Because the factors contributing to falls affect important health outcomes such as symptom burden and function, fall prevention strategies bestow multiple health benefits. Dr C, working with Mr Y's daughter, demonstrated the feasibility and effectiveness of incorporating fall prevention strategies into clinical practice.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Box

Mobility Screen and Balance and Gait Evaluation

Get Up and Go Test[7]

The most frequently recommended screening test for mobility, this test takes less than 1 minute. Have the patient get up from a chair, walk 10 feet, turn, return to the chair, and sit down. Any unsafe or ineffective movement suggests balance or gait impairment and increased risk of falling, and the patient should be referred to physical therapy for complete evaluation and treatment.

(Mr Y was very slow and unsteady getting out of the chair; he had flexed posture and a slow, shuffling gait.)

A person who fails this quick mobility screen should have a more complete balance or gait evaluation by a physician or a physical or occupational therapist. An example:

Performance-Oriented Mobility Assessment (POMA)[8,9]

The POMA involves assessing the quality of transfer, balance, and gait maneuvers used during daily activities and takes about 5 to 10 minutes to complete. The POMA is not appropriate for very functional patients or patients with a single disabling disease such as Parkinson disease or stroke. While there are several versions of the POMA, one feasible in a busy ambulatory setting includes observing these transfer and balance maneuvers: get up from chair; perform side-by-side, 1-leg, and tandem (one foot in front of the other) stands (5-10 seconds each); turn in circle; sit down; and assessment of these gait components while the patient walks 10 feet and turns: gait initiation; heel-toe sequencing; step length, height, and symmetry; path deviation; walk stance (how far feet are apart while walking); steadiness on turning; arm swing; neck, trunk, hip, and knee flexion.

In addition to determining if the patient is at risk of falling, the POMA can be used to ascertain if there are balance and gait impairments that require intervention (eg, cane or walker) and to assess for the presence of possible neurological or musculoskeletal disorders. For example, difficulty getting up without arms suggests proximal muscle weakness; difficulty with gait initiation suggests fronto-subcortical disorders such as Parkinson disease or normal-pressure hydrocephalus; worse performance with eyes closed than open suggests peripheral neuropathy or vestibular problem; wide-based gait that worsens with eyes closed and improves with handheld assist suggests peripheral neuropathy; leg crossing the midline suggests central nervous system disorder such as stroke or normal-pressure hydrocephalus; shorter step with one leg suggests a muscle, joint, or nervous system problem on the opposite side.

A version of the POMA, with scoring, can be found at http://www.geriatricsatyourfingertips.org/ebook/gayf_36.asp#c36s7_PERFORMANCE-ORIENTED_MOBILITY_ASSESSMENT_POMA.

Copies of the assessment with instructions and scoring can also be obtained from the author.

Table 1

Independent Risk Factors for Falling Among Community-Living Older Adults[a,b]

Risk Factor	Studies in Which Factor Was Significant[c]		Ranges of Adjusted Values[d]	
	No.	References (Listed in eAppendix)	RR	OR
Previous falls	16	1, 2, 5, 6, 7, 9, 10, 11, 15, 17, 18, 19, 21, 25, 26, 29	1.9-6.6	1.5-6.7
Balance impairment[e]	15	1, 4, 5, 7, 9, 12, 13, 17, 18, 19, 22, 24, 28, 30, 31	1.2-2.4	1.8-3.5
Decreased muscle strength (upper or lower extremity)[e]	9	4, 6, 9, 18, 19, 21, 24, 25, 26	2.2-2.6	1.2-1.9
Visual impairment	8	8, 11, 15, 16, 13, 22, 29, 30	1.5-2.3	1.7-2.3
Medications (>4 or psy-choactive medication use)	8	4, 11, 17, 23, 28, 29, 30, 33	1.1-2.4	1.7-2.7
Gait and impairment or walking difficulty[e]	7	6, 7, 8, 9, 10, 12, 20	1.2-2.2	2.7
Depression	6	2, 11, 17, 25, 32, 33	1.5-2.8	1.4-2.2
Dizziness or orthostasis	5	4, 10, 20, 21, 30	2.0	1.6-2.6
Functional limitations, ADL disabilities[f]	5	2, 9, 13, 21, 23	1.5-6.2	1.3
Age >80 y	4	5, 18, 23, 30	1.1-1.3	1.1
Female	3	1, 27, 30	2.1-3.9	2.3
Low body mass index	3	8, 21, 27	1.5-1.8	3.1
Urinary incontinence	3	3, 29, 30		1.3-1.8
Cognitive impairment	3	18, 27, 28	2.8	1.9-2.1
Arthritis	2	1, 26	1.2-1.9	
Diabetes	2	13, 22	3.8	2.8
Pain	2	14, 19		1.7

Abbreviations: ADL, activities of daily living; OR, odds ratio; RR, relative risk.

[a] A total of 33 studies met search criteria. The complete search strategy is available at http://www.jama.com.

[b] Identified as an independent risk factor in multivariate analyses in at least 2 of the 33 prospective cohort studies. Study sizes ranged from 152 to 9249 participants. Risk factors identified in a single study include white race, Parkinson disease, peripheral neuropathy, and multifocal lens.

[c] It is not possible to determine the number of studies in which each factor was considered, because many studies did not list all the potential factors included in the models.

[d] Odds ratios are presented separately because they may overestimate the risk of the factor with a common outcome such as falling. The RRs and ORs are results of multivariate analyses reported in individual studies. Only results in which the 95% confidence intervals did not include 1 are included.

[e] Some studies assessed balance, gait, strength, and transfer impairments separately and others at various combinations.

[f] Basic ADL comprise bathing, dressing, eating, grooming, transferring, and walking across room; instrumental ADL comprise taking medications, using the telephone, handling finances, housekeeping, cooking, shopping, and using transportation.

Table 2

Randomized Controlled Trials of Multifactorial (≥3) Fall Prevention Strategies in Community-Living Older Adults Without Known Cognitive Impairment[a]

Source[b]	Setting	Eligibility Criteria	Participants			Persons Who Fell			Risk Reduction (95% CI)[c]
						No./Total (%)			
			No.	Mean Age, y	Female, %	Intervention	Control	*P* Value	
Investigators Carried Out or Ensured Completion of at Least 1 Component									
Clemson, 2004	Community	Self-reported fall or fear of falling	310	78.4	74	82/157 (52)	89/153 (58)	NS	RR, 0.69 (0.50-0.96)
Close, 1999	ED	Presented with a fall	397	78.2	Not reported	59/184 (32)	111/213 (52)	NR	OR, 0.39 (0.23-0.66)
Davison, 2005	ED	Cognitively intact	313	77	73	94/144 (65)	102/149 (68)	NS	RR, 0.95 (0.81-1.12) IRR, 0.64 (0.46-0.90)
Day, 2002[d]	Community	No recent exercise program; physician approval	272	76.1	60	65/135 (48)	87/137 (64)	NR	RR, 0.67 (0.51-0.88)
Hogan, 2001	Self-referred or by health professional	Recent fall	163	77.6	Not reported	54/75 (72)	61/77 (79)	NS	RR, 0.74 (0.62-0.88)
Shumway-Cook, 2007	Community	Complete Get Up and Go Test in <30 s	453	75.6	77	124/226 (55)	130/227 (57)	.61	RR, 0.96 (0.82-1.13) RR, 0.75 (0.52-1.09)
Spice, 2009[e]	General medical practices	At least 2 falls in previous year; did not go to ED with index fall	505	82	74	158/210 (75)	133/159 (84)	.02	AOR, 0.52 (0.35-0.79)
Steinberg, 2000	Volunteers from a senior association	None except age >50 years	253 (3 intervention groups; 1 control group)	(25% >75)	79	NR	NR	NR	HR, 0.70 (0.48-1.01)
Tinetti, 1994	General medicine practices	At least 1 fall risk factor	301	78	69	52/147 (35)	68/144 (47)	.04	RR, 0.76 (0.58-0.98) IRR, 0.69 (0.52-0.90)
Vind, 2009	ED	Presentation after fall	392	72	74	110/196 (56)	101/196 (52)	NS	RR, 1.21 (0.81-1.79)
Wagner, 1994	Random selection from HMO general medicine practices	Volunteers who responded to letters	1242	72.5	60	175/635 (28)	223/607 (37)	<.01	
Participants Given Advice and Referred Without Direct Intervention or Assurance of Completion [f]									
Coleman, 1999	Primary care practices	At risk for hospitalization or functional decline	169	77.3	49	43	38	.37	RR, 1.14 (0.74-1.09)
Elley, 2008	Primary care practices	No unstable medical condition or severe physical disability	312	80.8	69	106/155 (68)	98/157 (62)	NS	IRR, 0.96 (0.70-1.34)
Gallagher, 1996	Community	Fall in past 3 mo	100	74.6	80	NR	NR	NR	Average No. of falls, 1.9 vs 3.0 (NS)
Hendriks, 2008	ED	Presentation after fall	333	75	68	55/124 (46)	61/134 (47)	.59	OR, 0.86 (0.50-1.49)
Huang, 2004	Community-living, county in northwest Taiwan	NR	120	71.9	46	0/55 (0)	4/54 (7)	.12	

Source[b]	Setting	Eligibility Criteria	Participants			Persons Who Fell			Risk Reduction (95% CI)[c]
			No.	Mean Age, y	Female, %	No./Total (%) Intervention	No./Total (%) Control	*P* Value	
Jitapunkal, 1998	Randomly selected poor community	NR	142	75.6	66	5	10		RR, 0.5 (0.14-1.97)
Lightbody, 2002	ED	Presentation after fall	348	75	74	39/171 (25)	41/177 (26)	NS	No. of falls, 141/171 vs 171/177 (6 mo)
Mahoney, 2007	Multiple community sites	Lived in assisted living facility	349	80	79	NR	NR	NR	RR, 0.81 (0.57-1.17)
Newbury, 2001	Primary care practices	Randomly drawn until 100 enrolled	100	79	63	12/50 (27)	17/50 (39)	.32	
Pardessus, 2001	Geriatric hospital	Hospitalized after a fall	60	83.2	78	43	50	NS	
Salminen, 2009	Community-living	At least 1 fall	591	73	84	140/292 (48)	131/297 (44)	NS	IRR, 0.92 (0.72-1.19)
Van Haastregt, 2000	General medicine practices	Recent falls or mobility problem	316	77	65	68/120 (57)	58/115 (52)	NR	OR, 1.3 (0.7-2.1) (18 mo)
Vetter, 1992	General medicine practices		674	>70	NA	95/240 (40)	65/210 (30)	Difference, 9 (95% CI, −5 to 21)	
Whitehead, 2003	ED	Presentation after a fall	140	NA	NA	NA	NA	NA	OR, 1.7 (0.7-4.4) (6 mo)

Abbreviations: AOR, adjusted odds ratio; CG, control group; CI, confidence interval; ED, emergency department; HMO, health maintenance organization; HR, hazard ratio; IRR, incident rate ratio; NA, not available; NR, not reported; NS, not significant; OR, odds ratio; RR, relative risk.

[a] Includes only trials that evaluated at least 3 risk factors identified in the first search (Table 1) and that enrolled only community-living participants without known cognitive impairment. Follow-up was 12 months unless stated otherwise.

[b] References are included in the eAppendix.

[c] All results are for the intervention group relative to the control group.

[d] Used a factorial design with 7 intervention groups. Only the full multifactorial intervention and control groups are included here. Total N = 1107 in all groups.

[e] Additional primary care group (risk factor assessment plus referral back to primary care physicians) was not effective (primary care referral relative to control: OR, 1.17; 95% CI, 0.57-2.37).

[f] Community sites and physicians may not have had the training or ability to complete the interventions; there was no assurance that participant or physician followed up on recommendations.

Table 3

Recommended Assessment and Management of Predisposing and Precipitating Factors for Falls Among Community-Living Older Adults Based on Observational and Trial Evidence

	Level of Evidence[a]	Screen/Assessment	Management
Predisposing factors			
Cardiovascular (carotid sinus hypersensitivity, bradyarrhythmias, tachyarrhythmias)	Ib	Cardiac evaluation, including heart rate and blood pressure responses to carotid sinus stimulation if indicated	Medication management as indicated; consider dual chamber cardiac pacing
Postural hypotension	Ia	Check blood pressure and pulse after >5 min supine, then on standing. Abnormal is defined as ≥20 mm Hg (or ≥20%) decrease in systolic blood pressure with or without symptoms immediately or after 1 or 2 min of standing	Reduce or eliminate medications likely to contribute (eg, antihypertensive medications, alpha agonists, tricyclic antidepressants); elevate head of bed; dorsiflexion and hand clench exercises before arising; compression stockings; medication (eg, midrinone, fludrocortisone)
Other chronic conditions (especially arthritis, neurological diseases)	III	Musculoskeletal and neurological examination (joint range of motion, muscle strength, proprioception, tone, rapid alternating movements)	Treat the underlying disease(s) and manage the identified musculoskeletal and neurological impairments
Cognitive impairment or dementia	III	See eFigure for example	
Balance or gait impairment	Ia	See Box	Refer to physical or occupational therapy for progressive strength, balance, and gait training; appropriate assistive device (eg, cane, walker)
Vision problems	Ib	Check for cataracts	Refer for single cataract extraction
	III	Check acuity (eg, Snellen and Jaeger charts, although Snellen test results are poorly correlated with daily visual function); have patient read headline and sentence from a newspaper (central visual loss due to cataracts, macular degeneration, or glaucoma may become apparent)	Refer to occupational therapy or low vision clinic if severe impairment interferes with mobility or functioning
Psychoactive medications	Ia	Medication review; because patients are unlikely to volunteer such information, clinicians also should inquire about common medication-	Eliminate or reduce dose of as many of the following as possible (all types increase fall risk): sedatives, antidepressants; anxiolytics; antipsychotics

	Level of Evidence[a]	Screen/Assessment	Management
		related adverse effects such as confusion, impaired alertness, fatigue, insomnia, dizziness, unsteadiness, or decreased appetite	
Other medications	Ia	Medication review, including both prescription and nonprescription medications, especially if taking ≥4 or a high-risk medication; assess for possible adverse medication-associated effects (see above)	Eliminate or reduce dose of as many other medications as possible, particularly medications that cause (1) orthostasis (eg, antihypertensives, alpha blockers, nitrates); (2) confusion or impaired alertness (eg, opioids, antihistamines, anticonvulsants); (3) parkinsonism (eg, antipsychotics, metoclopramide); or (4) other (eg, digitalis)
Functional disabilities (activities of daily living limitations)	Ia	Assessment tools in references 4 and 5	Physical and occupational therapy (see text); home safety modifications
Precipitating factors			
Home hazards	Ia	Home visit (by occupational therapist, physical therapist, nurse); self-administered checklist	Physical and/or occupational therapy: adaptive devices (eg, reaching device; sock aid and long shoe horn; grab bars in the bathtub; shower chairs; raised toilet seats). Remove tripping hazards; ensure adequate lighting; other safety measures (keep a telephone at floor level or a cell phone in pocket at all times; enroll in personal emergency response system such as “Lifeline”)
Footwear and foot problems	III	Ask about foot pain; check for bunions, toe deformities, ulcers or deformed nails, and peripheral neuropathy	Refer to orthotist, podiatrist, or other relevant expert
	III	Check footwear	Advise patients that walking with well-fitting shoes of low heel height and high surface contact area may reduce falls
Multifocal eyeglasses	II		Avoid multifocal lenses while walking, particularly on stairs
New eyeglass prescription following refraction; Ib	Ib		Caution that there may be an increased risk of falling after new lenses are placed

	Level of Evidence[a]	Screen/Assessment	Management
Alcohol	IV	Use nonjudgmental general screen such as, "Please tell me about your drinking," followed by screening tools such as by the 4-item CAGE questionnaire[47] or 10-item AUDIT test[48] if indicated	Alcohol counseling or treatment

Abbreviation: AUDIT, Alcohol Use Disorders Identification Test.

[a]Level of evidence based on the results of authors' 3 systematic reviews (eAppendix): class Ia, evidence from at least 2 randomized controlled trials; Ib, evidence from 1 randomized controlled trial or meta-analysis of randomized controlled trials; II, evidence from at least 1 nonrandomized controlled trial or quasi-experimental study; III, evidence from prospective cohort study (risk factor for falls); IV, based on expert committee opinion or clinical experience in absence of other evidence. All management recommendations also meet the criteria of ease of implementation and clinical importance.