

Falls in Older Adults: Assessment and Intervention in Primary Care

Case Study and Commentary:
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Falls in elderly persons create a tremendous individual and social burden. Of the more than 147 million injury-related emergency department visits logged each year, falls account for approximately 24%, representing the leading cause of external injury.¹ Children and elderly persons comprise the largest group responsible for this percentage. Compared with children, however, older adults are 10 times more likely to be hospitalized and 8 times more likely to die as the result of their fall.² Notably, the number of falls increases with age in both men and women, across all ethnic groups.³⁻⁵ The injury rate for falls is also highest among elderly persons, particularly among those older than 85 years,⁶ although falls do not only involve the very old. Some 20% to 30% of persons older than 65 years will sustain a serious fall in the coming year, which translates to an estimated 7 million falls annually.^{7,8} The estimated cost of caring for elderly persons who fall is exceedingly high—as much as \$12.4 billion per year.⁹

Among elderly persons, falls typically occur in various places, including hospitals, nursing homes, and private homes. For hospitals, falls generally represent the single largest category of reported incidents¹⁰; indeed, hospital-based falls are rapidly becoming a major worldwide epidemiologic problem.¹¹ Home-based and nursing home falls also cause great concern. Between 15% and 44.9% of falls in elderly persons take place in the home, and as many as 60% of nursing home residents experience a fall at some point during their institutionalization.¹² Consequently, implementing preventive measures to prevent falls in elderly persons should be a major goal of primary care practitioners interested in enabling their elderly patients to continue to live and function independently.

Prevention of falls in elderly persons takes on added significance in light of the potential sequelae of these falls. Of greatest concern is the significant mortality asso-

ciated with falls in an aged population. Falls cause 70% of accidental deaths in persons age 75 years and older.¹³ Roughly 9500 deaths of elderly persons in the United States each year are directly associated with falls.¹⁴ Although elderly persons represent only 12% of the US population, they account for 75% all deaths from falls.¹⁵ Approximately 25% of elderly persons who sustain a hip fracture as a result of a fall die within 6 months of their injury; more than 50% of those who survive are discharged to nursing homes, and nearly 50% of these patients will still be in the nursing home a year later.¹⁶

There are other significant morbidities associated with falls in an aged population. The length of hospitalization for elderly persons who fall and survive the event is roughly twice as long as that of elderly patients who are admitted to hospitals for other reasons.¹⁷ In addition, those who fall are at greater risk for experiencing functional declines in activities of daily living and participation in physical and social activities that can often lead to institutionalization.^{18,19} Of nursing home residents who fall each year, half will have multiple episodes, often resulting in significant injuries; head trauma, soft-tissue injuries, fractures (including hip fractures), and dislocations are most common.²⁰ It is estimated that for each of the next few years, at least 340,000 hip fractures will occur in elderly persons as a result of falls, increasing to double this amount by the middle of the 21st century.²¹

The physical impairment associated with falls may also be accompanied by emotional difficulties. Fear of future falls may limit the activities of elderly persons who

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have experienced a fall, and this fear may contribute to decreased mobility and reduced independence.²² Indeed, between 50% and 90% of elderly patients who have fallen report that they restrict their activities because of fear of a subsequent fall.²² Unfortunately, such a response can induce further functional decline, thus increasing the risk for falls.²³

As noted in the following case study, addressing the issue of falls in elderly persons must be a multifactorial response to a multifactorial problem. Extrinsic environmental factors must be taken into account, as should underlying diseases and prescribed treatments that may impair function. Extrinsic factors appear to be a major contributing factor in roughly 22% of falls; the remaining 78% are largely a function of disease state and treatment status.²⁴ There is some debate as to whether educational and exercise programs actually serve to reduce falls and improve function.^{25,26} Thus, primary care physicians must be cognizant of the recent literature when assessing these programs and their effectiveness.

In summary, falls in elderly persons exact a tremendous overall cost on patients and society. Given the many possible causes of falls in elderly persons and the highly negative consequences of these falls, primary care physicians must be extremely vigilant about any contributing environmental factors, disease symptoms, and treatment effects. Falls in elderly persons represent a major social issue. Nevertheless, with appropriate efforts, primary care physicians can assist elderly patients in both prevention of falls and appropriate rehabilitation after they occur, thus maintaining these patients' independence and contributions to society.

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Initial Presentation of Case Patient

A 78-year-old woman goes to a primary care physician for evaluation after enrolling in a new Medicare risk plan.

History

The patient's medical history is notable for hypertension treated with hydrochlorothiazide, depression treated with paroxetine, and episodic benign positional vertigo treated with meclizine as needed. Her surgical history includes a total abdominal hysterectomy for fibroids and repair of a Colles' fracture that required open reduction and internal fixation.

When the physician asks the patient to enumerate her health concerns, her first statement is "I'm so afraid that I am going to fall. I just have no balance!"

She states that she has fallen once in the past year as she was walking in her garden. She had great difficulty getting up but after 5 minutes was able to pull herself up with a garden hoe. Her only previous fall occurred 3 years ago when she fell down some steps at church, resulting in the wrist fracture. She says there was no vertigo, palpitations, or presyncope during either episode. She does not use assistive devices. She says that she has significantly curtailed activities that she enjoys such as gardening and shopping because of her fear of falling. She has arranged her furniture so that she has something to grab onto at all times. Her maximal physical activity is walking 500 feet to the mailbox.

Physical Examination

Physical examination reveals a thin, white woman who appears to be her stated age. She has bilateral cataracts. Cardiovascular, pulmonary, and abdominal examinations reveal no abnormalities. She is not orthostatic. There is decreased proximal muscle bulk in the extremities and signs of osteoarthritis in her hands and knees with diminished range of motion. She has mild kyphosis of the thoracic spine. Neurologic examination reveals fair vision and hearing and normal deep tendon reflexes and cerebellar function. She has normal muscle tone without cogwheeling or fasciculations. She has mild sensory loss to vibration in her feet bilaterally and slightly diminished strength in her hip flexors and extensors bilaterally. She requires several "bounces" to get up from the chair and must use her arms. Her gait is hesitant with absent arm swing, decreased stride length, wide base, and shuffling feet. She takes 3 steps to complete a turn. She is unable to tandem walk but can stand on her heels and toes. Romberg's test is negative, but she has increased postural sway when gently pushed.

- **What factors are associated with recurrent falls in elderly patients?**

Risk Factors

Numerous cohort and case-control studies have reported the association of various health conditions, lifestyle factors, home hazards, socioeconomic states, psychiatric illnesses, and drugs with falls.^{27–52} Factors with strong and consistent evidence of association with falls are listed in **Table 1**. Of course, it is impossible to prove causality in these nonrandomized study designs. Moreover, elderly subjects often have multiple medical conditions and frailties that confound the association despite the most valiant attempts at statistical correction. With these important caveats in mind, however, the

reader will note that many of these putative risk factors have a great deal of “face validity.” For example, it makes sense that visual impairment would cause more slips and trips given environmental hazards. One must only observe the antalgic gait of a patient with osteoarthritis to understand the association between osteoarthritis and falls. Determining true risk factors is not an idle exercise. Because patients who fall are a heterogenous group who require a multidisciplinary approach to prevention, identification of these risk factors forms the basis of the design of prevention strategies.

There are several important categories of risk factors. Adverse drug effects are of special concern, because this area is most directly under the physician’s control. Leipzig and colleagues published 2 high-quality meta-analyses of drugs and falls in older persons.^{34,35} Pooling 40 studies of psychotropic drugs, they found a consistent small increase in the odds of falls among users of most classes of psychotropic drugs; the use of any psychotropic drug increased the odds by 73%.³⁴ The odds of falling were increased by 48% to 66% with individual classes of psychotropic drugs, including neuroleptic agents, sedative-hypnotic agents, tricyclic antidepressants, and benzodiazepines. Dose-response relationships were not explored in this analysis, although others have reported such effects.^{36,45} A large case-control study using the Canadian Health System database and a smaller retrospective cohort study of nursing home residents also implicated selective serotonin reuptake inhibitors in falls and hip fractures.^{36,48} Leipzig and colleagues’ second meta-analysis, which included 29 studies of cardiac or analgesic drugs, showed weak associations only for digoxin, type IA antiarrhythmic drugs, and diuretics.³⁵ Interestingly, narcotic analgesic agents and other centrally acting antihypertensive drugs that are generally considered risky in older patients were not associated with falls in this analysis, although only a small number of studies assessed these agents. The authors note that their results are based on pooled observational data only; few randomized controlled trials report falls as an adverse event. Furthermore, there is the concern about confounding by indication; that is, the underlying cardiac or psychiatric illness may be the true cause of the fall. Nonetheless, physicians should be wary when prescribing drugs of these classes to older patients. Several cohort studies have also found increasing risk of falls with increasing number of prescription medications.⁴⁹

Environmental and situational risk factors for falls are an important area to explore because they are relatively easy to alter. Tinetti and colleagues examined the contribution of situational and predisposing risk factors to serious fall injuries in a prospective cohort of elderly

Table 1. Intrinsic Risk Factors Associated with Falls

Risk Factor	Relative Risk/ Odds Ratio	Comments
Age ²⁷	1.2/10 y	
History of falls ^{31*}	2.0	
Female sex ^{49,50†}	1.8–2.1	When adjusted for age, the rate of falls did not increase but injurious falls did increase.
Medical illness		
Stroke ^{27*}	1.7	
Parkinson's disease ^{27†}	1.9	
Osteoarthritis ^{53*}	1.4	Self-report only
Multiple chronic diseases ^{50*†}	1.8–2.0	
Peripheral neuropathy ^{40,41*}	17.0–23.0	
Cognitive impairment ^{49,50,52†}	2.2–5.0	
Lower-extremity strength ^{30,38,52†}	2.9–3.8	
Visual impairment ^{27,30,32,33,38*†}	1.4–6.0	Self-report and assessed
Hearing impairment ^{27*}	1.5	Possibly mediated through vitamin D
Increased parathyroid hormone level ^{47*}	5.6 per unit of the natural log increase	
Abnormal gait/impaired mobility ^{30,50,54*†}	1.2–3.6	Dependent on timing of assessment and patient population
Orthostasis ^{41*}	NS–13.0	
Urinary incontinence ^{27*†}	1.6	
Depression ^{27,44,55*†}	1.3–1.6	
Functional status limitations ^{27,31*}	1.5–1.9	
Foot problems ^{52*}	1.8	

NS = not significant.

*All falls.

†Injurious falls.

patients in New Haven, CT.⁴⁹ They found that almost 70% of the injurious falls took place in the home and during the daytime. Falling on the stairs, falling during an activity that displaced the person's center of gravity, and falling from greater than body height were all significantly associated with serious fall injury. A large prospective population-based cohort study in Finland also found that falls and fractures were increased 30% to 70% during the winter months, with nearly all of the additional falls explained by slips on ice and snow.²⁸ On the other hand, a direct in-home assessment of hazards in 270 patients presenting for treatment of fall-related injuries compared with 691 sex- and age-matched controls found no clear differences in environmental hazards such as throw rugs, nonskid tubs, electrical wires, lighting, and other commonly implicated potential risk factors.⁴³ The rates of noninjurious falls were not reported, however, and it is possible that absolute fall rates were similar in the 2 groups, with unmatched intrinsic factors responsible for the incremental injury in the case subjects.

The role of physical activity in falls and injuries is similarly complex. A recent review of the epidemiologic evidence suggests a U-shaped distribution in which the most active and least active older persons have the highest risk for falls.^{44,53} This finding is further evidence of the complex etiology of falls. Vigorous persons engaging in strenuous activity place themselves at greater extrinsic risk and may fall given any new intrinsic insult. On the other hand, frail persons with multiple intrinsic risk factors may fall even with minimal physical activity. This hypothesis is supported by a study that reported differential risk factor profiles for indoor and outdoor falls in older people in the United Kingdom.⁵⁴ Indoor fallers were more likely to have poorer health status, be housebound, have diminished handgrip strength, have slower walking speed, and take more prescription drugs. Outdoor fallers' risk was increased by only the total number of hours spent walking for relaxation and number of medications. The authors speculate that because these groups represent clinically distinct populations, different risk factors should be targeted for fall prevention.

It is worth noting what putative risk factors have not been found to be associated with falls. Diuretic therapy has been associated with falls in a few studies, but larger cohort studies, including the Study of Osteoporotic Fractures (SOF), did not find an association.²⁹ Similarly, radiographic osteoarthritis of the hip in SOF women was not correlated with falls, but self-reported osteoarthritis was correlated.⁵⁶ It may be that the pain and stiffness of osteoarthritis rather than the joint changes themselves increase fall risk. Alcohol use, often overlooked in the

elderly, would seem to be a logical risk factor for falls. Yet, at least 1 case-control study failed to find an association between self-reported alcohol use and injurious falls.³⁹ This finding may reflect unreliable self-reporting of alcohol consumption, an increase in total falls but not injurious falls, or a true lack of association. Orthostatic hypotension has been found to be both highly associated or not at all associated with falls, likely reflecting the different patient populations evaluated.³⁷

Finally, the risk factors for falls are also risk factors for other geriatric syndromes. Using exploratory modeling techniques on prospective cohort data from New Haven, Tinetti and colleagues found 4 independent predisposing risk factors for falls, incontinence, and the development of functional dependence.⁵¹ These are slow timed chair stands, decreased arm strength, sensory impairment, and high anxiety or depression scores. The risk for each syndrome increased dramatically in patients with increasing numbers of these risk factors. This work highlights the multifactorial nature of falls. It also raises the intriguing possibility that interventions modifying these common risk factors might affect several functional domains in older individuals.

- **What is the prognosis in patients who have recurrent falls?**

Predicted Outcome Following Falls

There have been few long-term cohort studies of patients with falls from which to obtain prognostic information. The most long-term published prospective study that gathered information on falls followed a cohort of 1815 volunteers older than 75 years living in England over 3 years.⁵⁷ Twelve percent of subjects reported a fall within the previous 3 months during the first year, with 4% reporting multiple falls. Recurrent fallers (ie, those who fell more than once) were more disabled at baseline and were more likely to be women. After adjustment for age, sex, and disability, the relative risk (RR) of death was significantly increased in recurrent fallers compared with nonfallers (RR = 1.9). The rate of admission to institutions was also increased at 9.7% for recurrent fallers versus 1.4% for nonfallers. Recurrent falling was associated with self-reported confusion and sadness. Functional decline, however, was not different between the groups. Significant numbers of subjects moved between the falling states over time. The results must be interpreted cautiously, however, because more than 30% of patients were lost to follow-up over the 3 years and we are not told whether there was differential follow-up in the fallers and nonfallers.

Three other prospective studies have expanded these findings. The Project Safety Cohort included 1103 Connecticut residents with an average age of 80 years; 34% of these participants fell over 16 months.¹⁹ Of the uninjured fallers, 47% could not get up after at least 1 fall. Older age, depression, and gait or balance impairment were significant risk factors for inability to get up after a fall. Those unable to get up experienced a greater decline in activities of daily living than did nonfallers, and all fallers had a greater risk of nursing home placement. The risk of death was not significantly greater for either fall group. Data from the Longitudinal Study of Aging found a similar increased rate of decline in activities of daily living among fallers.¹⁸

Vellas and colleagues explored the psychosocial impact of falls in the Albuquerque Falls Study.⁵⁸ This was a prospective cohort of 487 healthy volunteers older than 60 years who were followed for 2 years. The prevalence of falls was 32%. Twenty-one percent of single-time fallers and 45% of recurrent fallers expressed a fear of falling again. Fallers who were fearful experienced a greater decline in mobility score than did nonfearful fallers. Female sex, poor cognitive status, and lesser economic resources were associated with fear of falling.

Finally, Grisso and colleagues interviewed 299 African American patients older than 65 years who went to urban emergency departments for care after a fall.⁵⁹ Thirty-one percent were hospitalized for injuries due to the fall, and the median hospital length of stay was 8 days. Eight weeks after the fall, 43% reported continued limitations in activity and 46% had a fear of falling again. Of these, 41% reported continued limitations 7 months after the fall. Few subjects had received home health, physical, or occupational therapy assessments.

Altogether, several clinically relevant prognostic conclusions can be reached from these studies. Falls occur in older, more disabled individuals; it is not clear whether the increased mortality reported in the Gloucestershire cohort is due to unmeasured comorbidities or is a consequence of the fall itself. It seems certain, however, that falls are a marker for underlying illness and frailty. This conclusion is supported by the findings of Rubenstein and colleagues, who showed that a focused history and physical assessment by nurse practitioners following a fall frequently resulted in the identification of underlying modifiable medical conditions.⁶⁰ Subjects randomized to this assessment had substantially decreased hospitalization rates over 2 years compared with control fallers, while fall rates remained unchanged, suggesting that increased attention to underlying illness and medications is warranted after a fall. Recurrent fallers and uninjured fallers who are

unable to get up without assistance appear to be at particular risk for functional decline and nursing home placement. Fear of falling is an important sequela of recurrent falls and may limit mobility. Self-reported disability, pain, and activity limitations persist in a substantial number of subjects who seek emergency department care after a fall for at least 7 months.⁶⁰

- **What office-based tools are useful in the assessment of fall risk?**

Instruments for Predicting Risk

Laboratory testing measures multiple aspects of gait and balance precisely, reliably separates fallers from nonfallers, and predicts future falls, but laboratory assessment is costly, cumbersome, and unavailable to most clinicians.^{61,62} Therefore, a variety of simple, inexpensive home- or office-based screening tests have been developed to identify those at highest risk for falls. The best studied and most useful of these are the Berg scale, the functional reach test, the Tinetti gait and balance instrument, the timed up and go (TUG) test, the physical performance test (PPT), the 1-leg balance test, and the modified gait abnormality rating scale (GARS-M). These tools range in size from 1 to 28 items, their administration times vary, and they have adequate inter-rater and intrarater reliability. The validity, particularly the predictive validity, has not been established for all of these instruments, however (Table 2).

Several of these tests are particularly amenable to administration by physicians. The TUG test measures the time required for a subject to rise from an armchair, walk 3 meters, turn, walk back to the chair, and sit down. It can be administered in 1 to 2 minutes and can easily be incorporated into a routine examination. The TUG test has excellent reliability and is strongly correlated with other validated measures of gait and functional status, including the Berg scale, gait speed, and the Barthel index.⁶⁴ Using a cutoff score of 16 seconds, the TUG test was able to distinguish between recurrent fallers and nonfallers with a sensitivity of 87% and specificity of 87%.⁶⁶ In a 5-year prospective study of falls in Japan, the TUG test had a sensitivity of 54%, specificity of 74%, and positive predictive value of 44%.⁶⁷

The functional reach test measures the maximal distance one can reach forward beyond arm's length while standing upright and bending forward with the shoulder flexed 90 degrees. This test takes only 1 to 2 minutes to administer. In a prospective validation study, the adjusted odds ratio of having 2 falls (recurrent) in 6 months was 2.0 in elderly men who were able to reach more than 6 inches but less than 10 inches compared

Table 2. Selected Tools for Risk Assessment of Falls

Tool	Description	Predictive Validity	Strengths and Weaknesses
One-leg balance test ⁶³	Subject balances on 1 leg for 5 seconds without support	Sensitivity, 36% Specificity, 76% PPV, 31%	Simple to administer; balance but not gait assessed; only injurious falls predicted
Functional reach test ^{64,65}	Measures arm extension with 90 degrees of shoulder flexion while patient stands upright and at maximal forward reach	Odds ratio for future falls: 0 in. = 8.07 1–6 in. = 4.02 > 6 but < 10 in. = 2.0 ≥ 10 in. = 1.0	Simple to administer; sensitive to change over time; measures only forward balance
Timed up and go test ^{66,67}	Measures time to get up from chair, walk 3 meters, turn, return to chair, and sit down; ≥ 16 seconds is positive	Sensitivity, 54%–87% Specificity, 74%–87% PPV, 44%	Simple to administer; insensitive to change; tests routine activity
Tinetti gait and balance test ⁵²	16 balance and 12 gait items incorporating activities of daily living	Risk ratio, 6–7* Odds ratio in patients with gait and balance abnormalities, 1.9	More complex to complete and score; measures multiple domains
Physical performance test ⁶⁴	9-item static and dynamic balance using maneuvers encountered in daily life	Not established	Relatively long administration time; requires some supplies; tests multiple domains; predictive of mobility problems requiring hospitalization
Berg balance scale ^{68–70}	14-item balance test graded on 5-point ordinal scale for maximum 56 points (< 45 is abnormal)	Sensitivity, 55%–82% Specificity, 87%–95%	Longest time to complete; does not assess gait

PPV = positive predictive value.

*Represents the relative risk for subsequent falls for patients with lowest quartile score on the test versus those with a normal score.

with those able to reach more than 10 inches.⁶⁵ In men with scores less than or equal to 6 inches, the odds of recurrent falls were 4.02, and those unable to reach at all had odds of 8.07. Other investigators, however, reported that both the TUG test and functional reach tests were unfeasible for 30% to 36% of elderly people, primarily because of cognitive impairment.⁷¹

The 1-leg balance test, also easy to administer, assesses whether the subject can balance unassisted on 1 leg for 5 seconds. In a prospective evaluation of 316 subjects, the 1-leg balance test achieved operating characteristics similar to the TUG and functional reach tests in predicting injurious falls, but not all falls, with a sensitivity of 36%, specificity of 76%, and a positive predictive value of 31%.⁶³ Finally, a small study of elderly nursing home patients demonstrated that the simple observation of “stops walking when talking” predicted falls with a sensitivity of 48%, specificity of 95%, positive predictive value of 83%, and negative predictive value of 76%.⁷²

None of these tools individually has spectacular operating characteristics. Nonetheless, in a prospective

study of frail veterans, the sensitivity and specificity of the GARS-M and the PPT were substantially increased to 90.6% and 87.1% when the 2 tests were used together and a patient demonstrated impairment on either test.⁷³ A combination of the Berg scale with a history of imbalance separated groups of fallers and nonfallers with a sensitivity of 91% and specificity of 82%.⁷⁴ Using the simpler tests in various combinations may also increase their predictive value.

Using clinical risk factors alone to predict risk for falls has been explored with more disappointing results. A recent study that is representative of these attempts used a random sample of 1042 community-dwelling older persons in the United Kingdom. Using 16 variables selected from an original 253, the authors were able to show a sensitivity of 31% and specificity of 92%.⁵⁴ A combination of physical performance items and clinical risk factors was developed by Tinetti and colleagues.⁷⁵ The 9 items associated with subsequent falls in an institutional setting included a mobility score, distant vision, hearing, morale score, mental status

score, back extension, orthostasis, medications, and activities of daily living score. No subject with 0 to 3 risk factors had recurrent falls, and 100% of subjects with 7 to 9 risk factors did. Unfortunately, the majority of subjects were categorized as “intermediate risk,” a range that was not informative. In addition, administration of the scale is time-consuming, and the scale has not been validated in a separate cohort.

The relatively high specificities and low sensitivities of all of these tools make them useful for ruling in high risk for falls with confidence, but many potential fallers will be missed if any 1 tool is applied in isolation.

- **What interventions reduce fall incidence or severity in high-risk elderly subjects?**

Intervention Strategies

A variety of interventions have been designed and tested with the goal of reducing the number of falls or reducing injury from falls. These interventions are based on the clinical characteristics of older adults who fall; they can be divided into 3 categories: exercise training as a single intervention, other single interventions, and interventions that target multiple risk factors.

Exercise as a single intervention has a great deal of appeal because both lower-extremity strength and balance have been shown to markedly improve with relatively simple exercise programs in even the oldest-old. A number of randomized controlled trials have tested the hypothesis that exercise training can reduce falls. The components, intensity, compliance, and patient populations studied in these programs vary widely; not surprisingly, the results are mixed. The 8 sites of the FICSIT (Frailty and Injuries: Cooperative Studies of Intervention Techniques) studies each used a different exercise regimen in their fall-reduction programs. The most successful of these was a 15-week tai chi dynamic balance intervention that reduced falls by 37% compared with a wellness discussion group.⁷⁶ A preplanned meta-analysis of all the exercise interventions in the FICSIT trials was also performed; the interventions analyzed were tai chi, low-level endurance training, flexibility exercises, balance exercises, resistance training, and conditioning. Assignment to groups containing exercise in FICSIT was associated with a significant 10% decrease in fall incidence. Balance exercise training was particularly effective, with a 17% decrease in falls.⁷⁷ There were, however, other nonexercise interventions in the FICSIT trials, the effect of which is difficult to separate from that of the exercise component. Furthermore, several adequately powered studies of

exercise programs have found no difference in fall rates,^{78–80} or even an increase in falls in the exercise group.^{26,81} Two systematic reviews of randomized controlled trials of exercise have been completed. One of these, a Cochrane Collaboration meta-analysis, concluded that there was no evidence that exercise programs alone reduce fall rates.⁸² Both reviews concluded, however, that exercise in conjunction with other risk-factor reduction strategies was effective.^{82,83}

Several other single, nonexercise interventions have been tested. A randomized trial of home visits by occupational therapists to identify environmental hazards and facilitate home modifications was shown to be effective in reducing fall rates.⁸⁴ The effect was most pronounced in patients with a history of falls in the year preceding the study; falls in this group were reduced by 36%. A small randomized, controlled trial of 14-week gradual psychotropic medication withdrawal showed this strategy to be effective in reducing falls.⁷⁸ The medications were primarily benzodiazepines and antidepressants, and the withdrawal was unsuccessful in 45% of the treatment group. Nonetheless, in intention-to-treat analysis there was a 66% reduction of falls in the withdrawal group. Finally, a randomized trial of a psychosocial intervention to reduce fear of falling and associated activity restriction was tested against a control group who received social visits only.⁸⁵ The intervention consisted of biweekly sessions for 4 weeks and a variety of techniques aimed at changing patients' attitudes about falls and fall behavior, including activity restriction, environmental hazards, and high-risk activities. Intervention subjects showed improved activity levels and mobility control immediately after the program, with improved social functioning persisting for 1 year.

The most successful programs for reducing falls, however, are those that target multiple risk factors. The programs components vary between studies but have included exercise regimens, medication review and adjustment, postural exercise for subjects with orthostatic hypotension, transfer training, home hazard review, environmental adjustment, hearing and vision screening with appropriate corrective devices, and referral to alcohol treatment programs.^{86–90} A Cochrane Collaboration meta-analysis of 13 trials with multifactorial interventions found a significant 33% reduction in fall rates.⁸² A variety of patient populations and settings have been studied, including random community samples, health-maintenance organization patients, senior citizen group members, and women older than 80 years in Australia. Most studies have not been able to identify a single component that explains most of the risk reduction,

although in a 4-armed trial, little benefit was gained by adding home safety assessment and medical review to an exercise class.⁸⁸ In an analysis of the Yale FICSIT study, Tinetti and colleagues⁹¹ were able to demonstrate significant improvements in multiple risk factors for falls in the intervention group, a progressively lower fall rate in tertiles that had increasing risk reduction, and similar fall rates in intervention and control subjects when risk-factor reduction was controlled for. These findings suggest that the decreased fall rate is at least partially explained by the strategy of adjusting multiple risk factors.⁹¹ Although these complex programs are more cumbersome to implement than single interventions, their success again emphasizes that falls are the result of a heterogeneous group of underlying conditions that require a multifaceted approach to prevention.

- **What is the economic impact of falls and fall reduction programs?**

Cost of Falls and Fall Prevention

Because falls are inextricably interwoven with frailty and underlying illness, it is difficult to reliably estimate the true cost of falls. Certainly injurious falls are costly; epidemiologic data from the 1980s indicates that 8% of persons older than 70 years are treated in an emergency department for a fall injury annually, and 40% of these are ultimately admitted to the hospital with an average length of stay of nearly 12 days.⁴² In Project Safety Cohort subjects who experienced 1 or more injurious falls, home health utilization increased 7-fold, hospitalization costs increased 3-fold, and emergency department costs increased 4-fold compared with nonfallers. Injurious falls were associated with incremental Medicare claims of \$19,440 annually.²¹

Noninjurious falls, however, are more difficult to quantify. Most studies have found increased health care utilization in uninjured fallers even after adjusting for comorbidities. Data from the Longitudinal Study of Aging, a nationally representative sample of 4113 elderly persons, found that even single falls were associated with greater rates of hospitalization, physician contact, and nursing home placement.¹⁸ Total health care utilization costs in Project Safety subjects who had a single noninjurious fall were \$2500 greater than in nonfallers, based on Health Care Financing Administration reimbursement data.²¹ Recurrent, uninjured fallers used an additional \$12,000 in health care resources than did nonfallers after adjustment for potential confounders. None of these studies attempted to measure the opportunity costs of seeking medical attention and limiting activities, durable medical equipment use, or the informal care

costs incurred by fall victims. Thus, it seems reasonable to conclude that even noninjurious falls place an economic burden on both individuals and society.

Fall prevention strategies have a price as well. The best systematic cost analysis of a multifactorial fall prevention strategy examined the costs of the program reported by Tinetti et al.²¹ The intervention cost \$905 per subject, with most of the expense resulting from nursing and physical therapy time. With falls reduced by one third and one half in low-risk and high-risk groups, respectively, the overall cost per fall prevented was \$2150. The intervention was more attractive in the high-risk (\$1528 per fall prevented) than in the low-risk group (\$4146 per fall prevented). When only falls resulting in medical care were considered, the intervention cost \$10,709 per fall prevented. The authors used a combination of charge and cost information in calculating health care utilization in the intervention and usual care groups, making true cost-effectiveness analysis difficult. Mean total charges were lower in the intervention than the control group, however, and median charges were slightly greater in the intervention group, suggesting that a few outliers accounted for a great deal of the usual care group expense. Most of the difference in mean charge was accounted for by hospital care for injurious falls; the intervention group's hospital charges were \$100,000 less and they had 68 fewer hospital days. An economic analysis of a home hazard reduction program in Australia found a similar cost of \$5000 per fall prevented; overall cost savings were realized if the intervention was used in subjects with a history of falls.⁹² These studies suggest that modestly priced interventions are likely to be cost-effective or even cost-saving if they reduce even a few injurious falls. Cost-utility analyses have not been performed, and the impact of such programs on quality of life is largely unexplored.

Management Plan

The patient has a number of risk factors for falls, including depression, vertigo, a history of injurious fall, cataracts, medications associated with fall, decreased proximal muscle strength, osteoarthritis, peripheral neuropathy, and abnormal gait with compensatory changes suggestive of poor balance. In addition, the patient's fear of falling is affecting both her functional status and her quality of life. In light of these risk factors and the patient's performance on the functional reach test (7 inches, indicating a doubling in the odds of future fall), the physician prescribes a multidisciplinary approach to decrease her risk for falling. The physician recommends acetaminophen 1000 mg 3 to 4 times daily to treat the patient's arthritis pain, and discusses

the risks and benefits of discontinuing meclizine and paroxetine. The physician also refers the patient to an ophthalmologist to assess and maximize her visual acuity and to physical and occupational therapists to identify home hazards, suggest adaptive equipment, and teach balance and strengthening exercises. The physician advises the patient to begin a regular exercise program and recommends that she contact her local senior center or YMCA, which may offer tai chi or other exercise groups specifically for older adults. The physician also suggests walking on a school track or local mall with friends or family members. In addition, the physician suggests that she obtain and wear a call device so that she can receive prompt assistance if she falls.

SUMMARY

Falls, particularly recurrent falls, frequently indicate underlying illness or functional impairment in elderly persons. Although it is difficult to distinguish fall risk factors from confounding markers of frailty, the wide range of risk factors that have been associated with falls suggest that falling is a heterogeneous disorder that should be considered a geriatric syndrome. Recurrent falls frequently result in or are a marker of declining functional status, restricted mobility, nursing home admission, increased resource utilization, and possibly death. Simple screening maneuvers can identify persons at risk to fall with good specificity but poor sensitivity. Programs that target reduction of multiple risk factor have been shown to be effective in preventing falls in well-designed clinical trials. With the exception of tai chi, insufficient evidence supports the use of exercise alone. Nonetheless, exercise seems to be an important component of multidisciplinary reduction strategies. Because injurious falls are extremely expensive, inexpensive programs that reduce even a few such events are likely to be highly cost-effective or cost-saving. When evaluating and treating patients with falls or fall risk factors, physicians should screen for acute medical illness and identify potentially reversible risk factors (such as psychotropic medication use), orthostatic hypotension, and hearing and visual impairments. Other health care team members, such as physical therapists, occupational therapists, pharmacists, and nurse specialists, should be consulted to implement patient-specific interventions. This approach may not only reduce fall risk but also may lead to improved overall functional status for frail elderly persons. **HP**

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