

## CLINICAL RISK ASSESSMENT, INTERVENTIONS AND SERVICES

# Falls in older people: epidemiology, risk factors and strategies for prevention

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### Abstract

Falls are a common and often devastating problem among older people, causing a tremendous amount of morbidity, mortality and use of health care services including premature nursing home admissions. Most of these falls are associated with one or more identifiable risk factors (e.g. weakness, unsteady gait, confusion and certain medications), and research has shown that attention to these risk factors can significantly reduce rates of falling. Considerable evidence now documents that the most effective (and cost-effective) fall reduction programmes have involved systematic fall risk assessment and targeted interventions, exercise programmes and environmental-inspection and hazard-reduction programmes. These findings have been substantiated by careful meta-analysis of large numbers of controlled clinical trials and by consensus panels of experts who have developed evidence-based practice guidelines for fall prevention and management. Medical assessment of fall risks and provision of appropriate interventions are challenging because of the complex nature of falls. Optimal approaches involve interdisciplinary collaboration in assessment and interventions, particularly exercise, attention to co-existing medical conditions and environmental inspection and hazard abatement.

**Keywords:** *geriatrics, fall prevention*

### Background and epidemiology

Falls and unstable balance rank high among serious clinical problems faced by older adults. They are a cause of substantial rates of mortality and morbidity as well as major contributors to immobility and premature nursing home placement. Unintentional injuries are the fifth leading cause of death in older adults (after cardiovascular disease, cancer, stroke and pulmonary disorders), and falls constitute two-thirds of these deaths. In the United States, about three-fourths of deaths due to falls occur in the 13% of the population age  $\geq 65$ , indicative of primarily a geriatric syndrome. About 40% of this age group living at home will fall at least once each year, and about 1 in 40 of them will be hospitalised. Of those admitted to hospital after a fall, only about half will be alive a year later. Repeated falls and instability are very common precipitators of nursing home admission.

Many population-based studies have described the epidemiology of falls for older people in different settings, and rates vary considerably. Lowest rates (0.3–1.6 per person annually, weighted mean 0.65) occur among community-living, generally healthy elderly people (age  $\geq 65$ ). Although most of these falls result in no serious injury, about 5% do induce a fracture

or require hospitalisation. Moreover, the rates of falls and their associated complications rise steadily with age and are about twice these figures for persons aged  $>75$  years. Persons living in long-term care institutions have much higher rates (0.6–3.6 per bed annually, mean 1.7). Falls among those in institutions also tend to result in more serious complications, with 10–25% of such falls resulting in fracture or laceration.

The way in which a person falls often determines the type of injury sustained—wrist fractures usually result from forward or backward falls onto an outstretched hand and hip fractures typically from falls to the side, whereas backward falls directly onto the buttocks have much lower rates of associated fractures [1]. Wrist fractures are more common than hip fractures between ages 65 and 75, whereas hip fractures predominate in ages after that, probably reflecting slowed reflexes and loss of ability to protect the hip by ‘breaking the fall’ with one’s wrist after age 75.

The problem of falls in the elderly population is clearly more than simply a high incidence, because young children and athletes certainly have higher incidences of falls than all but the frailest elderly groups. Rather, it is a combination of a high incidence together with a high susceptibility to injury, because of a high prevalence of clinical diseases (e.g. osteoporosis) and age-related physiological changes (e.g.

slowed protective reflexes) that make even a relatively mild fall particularly dangerous. In addition, recovery from fall injury is often delayed in older persons, which in turn increases risk of subsequent falls through deconditioning. Another complication is the post-fall anxiety syndrome, in which an individual down-regulates activity in a perhaps overcautious fear of falling; this in turn further contributes to deconditioning, weakness and abnormal gait and in the long run may actually increase risk of falls.

The National Health Interview Survey indicates that falls are the largest single cause of restricted activity days among older adults, accounting for 18% of restricted days. Moreover, fall-related injuries recently accounted for 6% of all medical expenditures for persons aged >65. The U.S. Public Health Service has estimated that two-thirds of deaths due to falls are potentially preventable, based on a retrospective analysis of causes and circumstances of serious falls. Identifying and eliminating environmental risks in homes or institutions could prevent many falls due primarily to environmental causes, and adequate medical evaluation and treatment for underlying medical risk factors, such as unstable gait and disabling medical conditions, could prevent many medically related falls.

### Causes and risk factors for falls

There are many distinct causes for falls in old people, as listed in Table 1, which summarises data from 12 of the largest retrospective studies of falls among older persons living in a variety of settings. 'Accidental' or environment-related is the most frequently cited, accounting for 30–50% in most series. However, many falls attributed to accidents really stem from the interaction between identifiable environmental hazards and increased individual susceptibility to hazards from accumulated effects of age and disease. Older people have stiffer, less co-ordinated and more dangerous gaits than do younger people. Posture control, body-orienting reflexes, muscle strength and tone, and height of stepping

**Table 1.** Causes of falls in elderly adults: summary of 12 studies<sup>a</sup> that carefully evaluated elderly persons after a fall and specified a 'most likely' cause

Cause	Mean percentage <sup>b</sup> (%)	Range <sup>c</sup> (%)
'Accident'/environment-related	31	1–53
Gait/balance disorders or weakness	17	4–39
Dizziness/vertigo	13	0–30
Drop attack	9	0–52
Confusion	5	0–14
Postural hypotension	3	0–24
Visual disorder	2	0–5
Syncope	0.3	0–3
Other specified causes <sup>d</sup>	15	2–39
Unknown	5	0–21

<sup>a</sup>Adapted from [15].

<sup>b</sup>Mean percentage calculated from the 3,628 falls in the 12 studies.

<sup>c</sup>Ranges indicate the percentage reported in each of the 12 studies.

<sup>d</sup>This category includes arthritis, acute illness, drugs, alcohol, pain, epilepsy and falling from bed.

all decline with ageing and impair ability to avoid a fall after an unexpected trip or slip. In old age, the 'strategy' for maintaining balance after a slip shifts from the rapid correcting 'hip strategy' (fall avoidance through weight shifts at the hip) to the 'step strategy' (fall avoidance via a rapid step) to total loss of ability to correct in time to prevent a fall. Age-associated impairments of vision, hearing and memory also tend to increase the number of trips and stumbles.

The broad category of gait problems and weakness is the next commonest specific precipitating cause for falls (10–25% in most series). The ability to walk normally depends on several bio-mechanical components, including free mobility of joints, particularly in the legs; appropriate timing of muscle action; appropriate intensity of muscle action; and normal sensory input, including vision, proprioception and vestibular system. Gait and balance problems have many aetiologies, and many therapeutic approaches can be effective. Readily identifiable gait problems adversely affect function in 20–40% of people aged >65 (and 40–50% of those aged >85), and about half of these problems are severe. In a large longitudinal study of persons aged ≥75, 10% needed assistance to walk across the room, 20% were unable to climb a flight of stairs without help and 40% were unable to walk half a mile. Gait problems can stem from simple age-related changes in gait and balance as well as from specific dysfunctions of the nervous, muscular, skeletal, circulatory and respiratory systems or from simple deconditioning following a period of inactivity.

The next major reported cause of falls is dizziness, which is an extremely common symptom among older persons. However, it is a non-specific symptom and may reflect problems as diverse as cardiovascular disorders, hyperventilation, orthostasis, drug side-effect, anxiety or depression. The related problem of orthostatic hypotension, defined as a drop of over 20 mmHg of systolic blood pressure between lying and standing, has a 10–30% prevalence among 'normal' elderly people living at home. It can stem from several factors, including autonomic dysfunction (frequently related to age, diabetes or brain damage), hypovolaemia, low cardiac output, Parkinsonism, metabolic and endocrine disorders, and medications (particularly sedatives, antihypertensives and antidepressants). The orthostatic drop may be more pronounced in the morning, because the baroreceptor response is diminished after prolonged recumbency. However, it is a less common cause of falls than its prevalence would indicate, probably reflecting the fact that most persons with the syndrome become accustomed to it and are able to find a seat or adjust before falling.

Drop attacks are defined as sudden falls without loss of consciousness or dizziness and have in the past been implicated in between 1 and 10% of falls. Patients typically experience abrupt leg weakness, sometimes precipitated by sudden head movement. The weakness is usually transient but can persist for hours. This syndrome has been attributed to transient vertebrobasilar insufficiency, although it probably stems from diverse mechanisms, including leg weakness and knee instability. Drop attacks are today reported much less often—probably reflecting better diagnostic precision. In the past, the drop attack category was

often used as a ‘waste basket’ category for otherwise unexplained falls. In reality, true drop attacks are quite uncommon.

Syncope, or sudden loss of consciousness, usually results from decreased cerebral blood flow or metabolic factors. It has been the attributable cause of between 2 and 10% of falls in several series but has been excluded from many other series either by definition (because syncope is not a typical type of fall) or because many elderly patients with syncope are acutely hospitalised and are treated differently.

Other specific causes of falls include disorders of the central nervous system, cognitive deficits, poor vision, drug side-effects, alcohol intake, anaemia, hypothyroidism, unstable joints, foot problems, severe osteoporosis with spontaneous fracture and acute illness. Because most elderly individuals have multiple identifiable risk factors predisposing to falls, the exact cause can often be difficult to determine.

Because a single specific cause for falling often cannot be identified, and because falls are usually multifactorial in origin, many investigators have performed both prospective and retrospective epidemiological studies to identify specific risk factors that place individuals at increased likelihood of falling. In many ways, identifying risk factors for falls is much more useful than trying to classify specific precipitating causes retrospectively. Not only are prospective data likely to be more accurate than data derived from chart review after the event, but by identifying risk factors early, the most effective preventive strategies can be devised and instituted. Table 2 lists the major fall risk factors, and their relative importance, pooled from a large number of such studies [2–6]. The most important of these risk factors are muscle weakness and problems with gait and balance.

Muscle weakness is an extremely common finding among the aged population when looked for, mostly stemming from disease and inactivity rather than ageing *per se*. Case-control studies demonstrate substantially increased risk of falls and fractures among individuals with gait and muscle dysfunctions. A simple screening test of gait and balance function, such as the ‘timed up and go’ or Tinetti’s gait and balance test [7], is often useful in identifying risk and documenting need for treatment. Medications, specifically

psychoactive medications, have also been identified in a number of studies as risk factors for falls, although their relative risk has generally been in the 1.5–1.7 range, just below that of the other factors in the list.

Most of the factors on the list are amenable to improvement, implying ways that many falls can potentially be prevented; moreover, the effectiveness of these preventive strategies has been documented in a number of studies. (Among the most widespread of the risk factor reduction strategies involve regular exercises to improve strength, gait and balance, and results have been promising.)

## Evaluating the fall patient

When assessing a patient who has fallen, obtaining a full report of the circumstances and symptoms surrounding the fall is crucial [2]. Reports from witnesses are important, as the patient may have poor recollection of the event. Fall circumstances that can point to a specific aetiology or narrow-down the differential diagnosis include sudden rise from a lying or sitting position (orthostatic hypotension), trip or slip (gait, balance or vision disturbance or an environmental hazard), drop attack (vertebrobasilar insufficiency), looking up or sideways (arterial or carotid sinus compression) and loss of consciousness (syncope or seizure). Symptoms experienced near the time of falling may also point to a potential cause—dizziness or giddiness (orthostatic hypotension, vestibular problem, hypoglycaemia, arrhythmia and drug-side effect), palpitations (arrhythmia), incontinence or tongue biting (seizure), asymmetric weakness (cerebrovascular disease) or chest pain (myocardial infarction or coronary insufficiency). Medications and concomitant medical problems may be important contributors.

On the post-fall physical examination, it is especially pertinent to look for particular findings that may have directly contributed to the fall, as well to note other fall risk factors. Important to look for are orthostatic changes in pulse and blood pressure, presence of arrhythmias, carotid bruits, nystagmus, focal neurological signs, weakness and other musculoskeletal abnormalities, visual loss, gait disturbances and cognitive dysfunction. It is often useful to attempt (under carefully monitored conditions) to reproduce the circumstances that might have precipitated the fall, e.g. positional changes, head turning or carotid pressure. Gait and stability should be assessed by close observation of how the patient rises from a chair, stands with eyes open and closed, walks, turns and sits down. One should take particular note of gait velocity and rhythm, stride length, double support time (the time spent with both feet on the floor), height of stepping, use of assistive devices and degree of sway. Use of a formal gait assessment screening protocol, such as the Tinetti balance and gait instrument [7], can be very helpful. More detailed gait evaluation can be useful among persons who fail the screen.

Laboratory tests are seldom very useful, although a full blood count, serum electrolytes and ECG often disclose contributory abnormalities. More costly tests (e.g. Holter monitoring and gait laboratory evaluation) should be reserved for persons with suggestive signs or symptoms.

**Table 2.** Important individual risk factors for falls: summary of 16 controlled studies<sup>a</sup>

Risk factor	Significant/ Total <sup>b</sup>	Mean RR–OR <sup>c</sup>	Range
Weakness	11/11	4.9 (8) <sup>d</sup>	1.9–10.3
Balance deficit	9/9	3.2 (5)	1.6–5.4
Gait deficit	8/9	3.0 (5)	1.7–4.8
Visual deficit	5/9	2.8 (9)	1.1–7.4
Mobility limitation	9/9	2.5 (8)	1.0–5.3
Cognitive impairment	4/8	2.4 (5)	2.0–4.7
Impaired functional status	5/6	2.0 (4)	1.0–3.1
Postural hypotension	2/7	1.9 (5)	1.0–3.4

<sup>a</sup>Adapted from [15].

<sup>b</sup>Number of studies with significant association/total number of studies looking at each factor.

<sup>c</sup>Relative risks (prospective studies) and odds ratios (retrospective studies).

<sup>d</sup>Number in parenthesis indicated the number of studies that reported relative risks or odds ratios.

## Therapeutic and preventive approaches

Once the cause(s) and/or risk factor(s) of falling are determined, appropriate specific therapy can be instituted [2]. The following are among the more obvious examples: (i) cardiac dysrhythmias clearly related to a fall should be treated with antiarrhythmics or a pacemaker, or both; (ii) hypovolaemia due to haemorrhage or dehydration calls for treatment directed towards restoring haemodynamic stability; (iii) Parkinsonism usually responds to specific therapy, at least transiently; however, in advanced cases, safe ambulation can require extensive assistance. Discontinuing medication that causes postural hypotension or undue sedation is important whenever possible. For patients with gait and balance disturbances, specific assistive devices (e.g. walkers, canes and shoe modifications) are often helpful. Also helpful can be a programme of gait training under supervision of a physical therapist, individualised to deal with the specific underlying cause(s) (e.g. weakness, imbalance and arthritis).

Several techniques may benefit patients with persistent orthostatic hypotension due to autonomic dysfunction. These include sleeping in a bed with the head raised to minimise sudden drop in blood pressure on rising, wearing elastic stockings to minimise venous pooling in the legs, rising slowly or sitting on the side of the bed for several minutes before standing and avoiding heavy meals and vigorous activity in hot weather. If conservative mechanical measures are ineffective, blood volume can be increased by liberalising dietary salt. If this is ineffective, mineralocorticoid therapy (fludrocortisone increasing gradually from 0.1 mg/day) or an  $\alpha$ -1 agonist, such as midodrine (beginning at 2.5 mg tid), can help to maintain blood pressure, as long as associated medical conditions do not preclude these agents, and due care is taken to avoid side-effects such as supine hypertension and fluid accumulation.

More difficult is managing and preventing recurrent falls among patients for whom a specific cause cannot be identified or who have multiple or irreversible causes. A careful search for, and correction of, other risk factors that predispose to falling (such as visual and hearing deficits) is essential. For disabilities that do not properly resolve with treatment of the underlying medical disorder (e.g. hemiparesis, ataxia, persistent weakness or joint deformities), a trial of short-term rehabilitation may improve safety and diminish long-term disability. When irreversible problems exist, residual limitations should be explained and coping methods be developed.

Physicians should caution patients to eliminate home hazards such as loose or frayed rugs, trailing electrical cords and unstable furniture. Patients and their families should be advised of the importance of specific environmental improvements—adequate lighting, bathroom grab rails and raised toilet seat, secure stairway banisters, raising or lowering bed and an easily accessible alarm system are possibilities. A visiting nurse or any experienced person can perform a home evaluation to suggest modifications. Checklists to aid in this process are available [2,8].

Fall-prevention has been an area of active research over the past 10–15 years. A number of programmes (e.g. assess-

ment, risk factor reduction, exercise, environmental modification and education) have been tested, and recent meta-analyses have documented the effectiveness of several approaches [9]. Effective approaches include multidimensional risk factor assessment tied to targeted interventions, exercise programmes (which include balance, strength and endurance training), and environmental assessment and modification. Programmes combining all of these approaches seem to have had the strongest effects. Recent clinical practice guidelines from the AGS/BGS/AAOS panel and other organisations have strongly advocated preventive approaches using these three components [2]. Post-fall assessments, as outlined above, have been shown to reveal many otherwise undetected treatable conditions and risk factors, as well as to significantly prevent falls and reduce hospitalisations [2, 10, 11]. Exercise programmes can clearly improve strength, endurance and body mechanics, and several controlled trials have shown significant reduction in falls [2, 12–15].

Several European trials of hip protector pads mainly in nursing home settings have reported dramatic reductions in hip fractures [16]. Compliance has been an issue but appears to be surmountable, especially with more comfortable newer models. Some preliminary new data indicate possible mild benefits from vitamin D on balance and fall reduction.

In summary, newest study data confirm the clear effectiveness of a number of interventions in preventing falls, including fall risk assessments tied to interventions, exercise, environmental inspection and modification, and combined interventions. The future looks bright in this area, as in so many areas of geriatrics. Systematic attention to fall prevention is a vital part of comprehensive care of the older adult.

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## Key points

- Falls occur in 30–60% of older adults each year, and 10–20% of these result in injury, hospitalisation and/or death.
  - Most falls are associated with identifiable risk factors (e.g. weakness, unsteady gait, confusion and psychoactive medications).
  - Research shows that detection and amelioration of risk factors can significantly reduce the rate of future falls.
  - Other evidence-based fall reduction methods include systematic exercise programmes and environmental inspection and improvement programmes.
  - Recent international groups have developed useful clinical guidelines for reducing the risk of falls.
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