Falls and their prevention in old age

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Falls in old age present a threat to the everyday activities of elderly people and pose a challenge to health-care professionals. Why are falls common in elderly people and how can we address this major problem?

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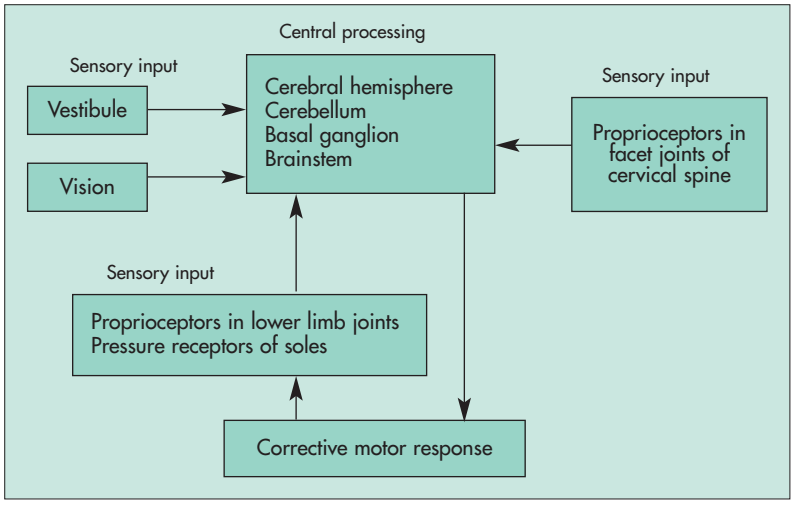
There is extensive published research on various aspects of falls in elderly people. This article gives a brief account of the neuromuscular mechanism of maintaining balance and the risk factors and prevention of falls in old people. As many as 35% of community dwelling elderly people over the age of 65 years sustain a fall each year and the prevalence of falls is higher in females than in males, although this ratio narrows with advancing age (Blake et al, 1988). The risk of falls increases with age, from 47 falls/100 person-years for those aged 70–74 years, raising to 121/100 person-years for those aged 80 years and over (Campbell et al, 1990). In people over 65 years of age attending an accident and emergency department, a fall was the main reason for attendance in 45% (Richardson et al, 1998).

MECHANISM OF MAINTENANCE OF BALANCE

The human body is essentially an unstable structure because of its relatively small base of support compared to its vertical height. To maintain an upright stance the centre of mass has to be kept within the base of support. This is achieved by a complex neuromuscular mechanism (*Figure 1*) that integrates information about the orientation and motion of the body from various sensory sources (cutaneous, proprioceptive, visual, vestibular) and uses this information to produce an appropriate motor response to keep the centre of mass within the base of support.

Constant control of balance is required during most activities. When this balance is challenged, e.g. by a stumble or a slip, a quick compensatory reaction is required whereby appropriate limb movements take place to regain the balance. Any deficit in any of the components of the above mentioned neuromuscular control mechanism might predispose to falls. However, to some extent a deficit in one system is compensated for by the other components of the balance mechanism, e.g. a deficit in proprioception may be compensated for by good vision.

Figure 1. Mechanism of postural control.



AGING AND BALANCE

With increasing age changes occur in all sensory modalities that subserve postural control. Old people who experience falls are more likely to have decreased cutaneous sensation, proprioception, low contrast sensitivity, and diminished visual acuity (Lord et al, 1994). Increased muscle stiffness in elderly people is thought to interfere with balance and may contribute to increased risk of falling (Blanpied and Smidt, 1993). There are changes in vestibulo-ocular reflex with advanced age and there is also a progressive loss of labyrinthine hair cells and vestibular ganglion cells (Paige, 1991). Age-related visual changes include reduced visual acuity, contrast sensitivity, depth perception and darkness adaptation (Verillo and Verillo, 1985). While young adults with fully intact neuromuscular control are able to cope with trivial challenges like trips or slips the same challenges in elderly people with age-related changes may overwhelm their balance control resulting in a fall. Although these age-related changes may contribute to falls, falls are not an inevitable feature of old age.

RISK FACTORS FOR FALLS

The literature on risk factors for falls in elderly people is extensive. Previous history of falls, poor vision, postural hypotension, four or more prescribed medications, sedative and antipsychotic medications, cognitive impairment, decreased range of limb movements, limb weakness, impaired gait and impaired transfer skills are all recognized as risk factors for falls (Tinetti et al, 1994). Multiple pathologies are common in old age and may contribute to falls. Falls in a patient with diabetes may be related to polyneuropathy, postural hypotension caused by autonomic neuropathy, retinopathy or hypoglycaemia.

Cervical spondylosis in old people is common and may cause falls in three ways. The degenerative changes in facet joints of the cervical spine distort the proprioception from these joints and may cause dizziness leading to a fall or falls may be caused by vertebro-basilar insufficiency or by myelopathy. There is increased prevalence of carotid sinus hypersensitivity (Richardson et al, 1998) and postprandial hypotension (Puisieux et al, 2000) in elderly fallers. The causes of falls can be divided into intrinsic and extrinsic causes (*Table 1*). Usually falls in elderly people are caused by a combination of factors rather than by a single factor and each episode may have a different cause in the same person.

COMPLICATIONS OF FALLS

- Restricted activities: after a fall elderly people are frightened of further falls and restrict their social and daily activities (Cumming et al, 2000). They lose confidence and may become housebound
- Injuries: about 5–10% of falls result in injury (Gryfe et al, 1977). Proximal femoral fracture constitutes a major complication
- Hypothermia
- Pressure-related injury
- Dehydration.

CAN FALLS IN ELDERLY PEOPLE BE PREVENTED?

There is good research evidence that falls in elderly people can be prevented by various interventions. A systematic review by the Cochrane group (Gillespie et al, 2004) revealed a significant reduction in falls by multidisciplinary, multifactorial, health or environmental risk factor screening or intervention programmes in the community (for unselected older people, pooled relative risk (RR) = 0.73, 95% confidence interval (CI) = 0.63–0.85 and for old people with history of falls or known risk factors, pooled RR = 0.86, 95% CI = 0.76–0.98). This review also confirmed the reduction in falls by balance retraining and muscle strengthening exercise programmes (RR = 0.80, 95% CI = 0.66–0.98) and by home hazard assessment and modification (RR = 0.66, 95% CI = 0.54–0.81).

MANAGEMENT OF FALLS IN ELDERLY PEOPLE

As falls in elderly people usually have a multifactorial basis, multifaceted intervention is needed to prevent further falls. This consists of medical, nursing, physiotherapy and occupational therapy assessments and interventions. Members of other disciplines, e.g. pharmacists, dieticians, chiropodists and ophthalmologists, and members of footwear departments, also have a role to play. For elderly people living in the community the initial medical assessment is carried out by the GP who can review medications, and check for postural hypotension and visual problems. A simple test called 'Get up and Go' (Mathias et al, 1986), recommended by the American and British Geriatrics Societies, could be used to assess the gait and balance. After the preliminary assessment the GP can decide about the need for further referral to a specialist falls clinic where systematic multidisciplinary assessments and interventions can be carried out. The National Institute for Clinical Excellence (NICE) has recently published guidelines on assessment and prevention of

TABLE 1.
Causes of falls in old people

Intrinsic	Acute illness	
	Drugs	Diuretics, antihypertensives, sedatives, antidepressants, antipsychotics, alcohol
	Neuromuscular	Transient ischaemic attack, stroke, peripheral neuropathy, spondylotic myelopathy, subacute combined degeneration, Parkinson's disease (late), cerebellar ataxia, normal pressure hydrocephalus, benign paroxysmal positional vertigo, myopathies, epilepsy
	Cardiovascular	Postural hypotension, brady/tachy arrhythmias carotid sinus hypersensitivity, vasovagal or situational syncope, postprandial hypotension, valvular disease
	Skeletal	Lower limb osteoarthrosis, cervical spondylosis (vertebrobasilar insufficiency, myelopathy, impaired cervicovestibular reflex)
	Ophthalmological	Reduced visual acuity, cataracts, macular degeneration, visual field defect
	Foot or footwear problems	Painful callous, ulcers, narrow and high-heeled shoes
	Miscellaneous	Hypoglycaemia, electrolyte imbalance
Extrinsic	Indoor	Poor or no lighting, loose carpets or rugs or clutter on the floor, inappropriate heights of furniture
	Outdoors	Uneven or slippery pavements, poorly lit streets, forceful winds

falls in older people living in the community (NICE, 2004) and these could be adapted locally according to the available resources.

Medical assessment

A detailed history of circumstances surrounding the fall is important as it may give clues to the diagnosis, for example falls after meals may indicate postprandial hypotension, or a fall after prolonged standing in a queue may be the result of a vasovagal episode. A systematic medical assessment is carried out to identify risk factors for falls. The important points to be noted in medical assessment are given in *Table 2*.

TABLE 2.
Important points to consider in medical assessment and investigations

History	Previous falls
	Palpitations, loss of consciousness, vertigo or dizziness related to posture, unsteadiness related to neck movements
	Postprandial relation to falls
	Convulsions
	Ability to get up from floor after the fall
	Medications, alcohol intake
	Previous fragility fractures and other risk factors for osteoporosis
Physical examination	Postural hypotension
	Cardiac valvular disease
	Range of movements particularly in lower limbs
	Neck movements
	Deformity of joints
	Feet: callous, ulcers
	Kyphosis (may indicate osteoporosis)
	Abbreviated mental test score
	Visual acuity/visual fields
	Motor tone, power
	Tendon reflexes
	Touch and joint position sense
	Extrapyramidal and cerebellar signs
	Stance with feet together
	Romberg sign
	Gait
	Footwear
	If indicated: postprandial blood pressure recordings, Hall Pike manoeuvre
Investigations	Full blood count, haemoglobin, electrolytes, blood glucose
	Other tests when indicated: X-ray of joints in lower limbs, 24-hour electrocardiogram
	Carotid sinus massage and head-up-tilt test in unexplained falls
	Investigations relating to osteoporosis, e.g. bone profile, thyroid function tests, ESR, spinal X-rays, DXA for bone mineral density
	Brain computed tomography in patients with cognitive impairment, head injury or stroke
	Nerve conduction studies if peripheral neuropathy is suspected

DXA = dual energy X-ray absorptiometry; ESR = erythrocyte sedimentation rate

The investigations depend on history and examination findings. Although a 24-hour electrocardiogram (ECG) is usually done it has some limitations and the benefit of this investigation is low unless patients are selected. ECG abnormalities are common in elderly people and falls may not be necessarily related to the abnormality found on 24-hour ECG. Unless this is appreciated there is a potential for unnecessary prescription of antiarrhythmic drugs. When falls are unexplained after preliminary investigations one should consider carotid sinus massage and head-up-tilt testing to confirm or exclude carotid sinus syndrome or vasovagal syncope. In some cases the cause of falls may not be found even after extensive investigations. The medical assessment should also include identifying risk factors for osteoporosis and a plan for its prophylaxis or treatment.

Many older people are on multiple medications. These need to be reviewed and whenever possible their doses reduced or stopped altogether. Specific treatment depends on the identified cause(s). For example cardiac tachyarrhythmias could be treated with antiarrhythmics while cardioinhibitory carotid sinus hypersensitivity needs a permanent pacemaker insertion. Some measures to correct orthostatic hypotension are given in *Table 3*. Refractory errors could be corrected and appropriate footwear with wide and low heels may help in maintaining balance.

Physiotherapy

A detailed assessment of gait and balance is done by physiotherapists using different assessment tools available, e.g. the Berg Balance Scale which consists of 14 items, each item having a score from 0–4 (Berg et al, 1989). Physiotherapists teach exercises to improve muscle strength and balance although such programmes may not be suitable for certain patients, e.g. those with severe dementia. Exercise programmes like Tai Chi are promising. Physiotherapists can advise on how to get up from the floor after a fall and about appropriate mobility aids.

Occupational therapy

All patients with recurrent falls should ideally have a home hazard assessment by an occupational therapist to identify environmental hazards for falls and rectify them if possible, e.g. replacing dim lights with higher wattage light bulbs, removing loose rugs or carpets, installing grab rails and advising on appropriate furniture.

Other disciplines

Chiropodists can advise on foot problems and on appropriate footwear. Clinical psychologists, dieticians, pharmacists and opticians all have a role to play in fall prevention.

Fear of falling poses a major problem in rehabilitation and physiotherapists, occupational therapists and clinical psychologists play an important role in managing this problem. Patients and their carers should be provided with information on how to avoid and cope with falls. Wilmes et al (2004) developed a web and kiosk-based health information pack for the public. This is a simple touch-screen computer offering health information to the public on falls and their prevention, and reflects the recommendations of the NICE guidelines on education and information regarding fall prevention (NICE, 2004).

FALLS IN INSTITUTIONAL SETTINGS

The incidence of falls in older people in an institutional setting is high. Clark et al (1993) found the incidence of falls to be as high as 55% in a nursing home setting. In addition to the risk factors mentioned earlier, previous history of falls, confusion and the need for frequent toileting are associated with increased falls (Gluck et al, 1996). The risk of falls seems to be high during the early days after admission into an institution and a screening tool may be used to identify those at a high risk of falls (Oliver et al, 1997). Some common-sense measures to prevent falls in institutionalized patients are listed in *Table 4*.

FRACTURE PREVENTION

A major consequence of falls is hip fracture. About 95% of all hip fractures in older people result from a fall (Grisso et al, 1991) and over 90% of all hip fractures in over 75-year-old people occur in those who have osteoporosis. Proximal femoral fractures are not only associated with increased morbidity and mortality (Laxton et al, 1997) but also have important socioeconomic implications. As the combination of osteoporosis and falls may result in a fracture it is important to identify risk factors for osteoporosis, assess bone mineral density in elderly fallers and take measures to reduce the risk of fractures in old people (*Figure 2*). Hip protectors have been found to reduce the risk of fractures in institutionalized patients (Parker et al, 2004), but long-term patient compliance with hip protectors has been found to be poor. Vitamin D and calcium supplements may have some protective effect, reducing fractures in institutionalized patients (Gillespie et al, 2001).

CONCLUSIONS

Falls in old people are common and have a multifactorial basis. Falls in elderly people can be reduced through a systematic approach with risk identification and risk modification by multifaceted intervention. The combination of falls and osteoporosis is potentially hazardous and may result in hip fracture, which is associated with morbidity and mortality. Satellite centres in the community with physiotherapists and occupa-

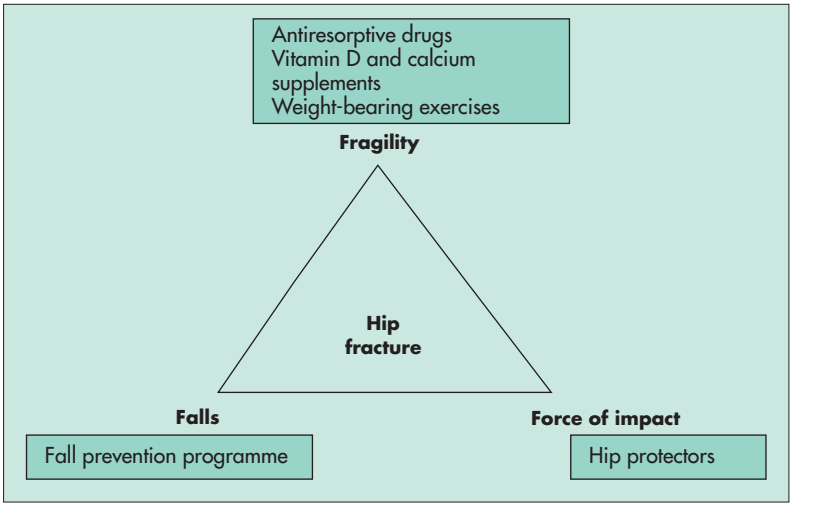
TABLE 3.
Treatment of orthostatic hypotension

Reduce or stop the culprit medications	
Raise the head end of the bed	
Increase fluid and salt intake (exclude cardiac failure, hypertension)	
Supportive stockings (after arterial Doppler)	
Sit for 1–2 minutes before standing and stand for 1–2 minutes before walking	
Exercise calf muscles before standing	
Pharmacological intervention (when above measures fail/severe cases)	Fludrocortisone initially
	Midodrine
	Desmopressin

TABLE 4.
Fall prevention measures in institutionalized patients

Closely supervise confused patients
Supervise and assist patients with frequent toilet needs
Consider leaving the night light on for patients with poor vision and confusion
Keep calling cord, food and drinks within easy reach of patients
Review medications, particularly sedatives, psychotropics, diuretics, antihypertensives
Correct postural hypotension (*Table 3*)
Consider hip protectors and vitamin D supplements

Figure 2. Fracture prevention triangle. Adapted from National Institutes of Health (1999).



tional therapists to reinforce balance retraining, muscle strengthening exercises and provide educational programmes to patients and carers may complement hospital falls clinics. To be effective the falls prevention programme needs resources such as trained medical and allied professionals, time, equipment for special investigations like tilt testing, and finances to meet these needs. HM

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KEY POINTS

- Falls are common in elderly people.
- Falls can be prevented by a systematic approach with multidisciplinary assessment intervention.
- Identification of risk factors and prophylaxis or treatment of osteoporosis in elderly fallers is important to prevent hip fractures and should be part of a fall prevention programme.