Falls as a Geriatric Syndrome: Mechanisms and Risk Identification

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"It takes a child one year to acquire independent movement and ten years to acquire independent mobility. An old person can lose both in a day Bernard Isaacs". [1]

Introduction

This quote from the late Bernard Isaacs, now four decades after being written, still portrays the crude consequence an older adult may experience after a single fall [1]. Falls, as a geriatric syndrome, certainly affect independent movement and mobility in older adults. Despite the enormous efforts of researchers and clinicians to comprehend the complexity of falls, there is still a significant gap in our complete understanding of this challenging syndrome. The aim of this chapter is to reduce this gap, address new areas of knowledge, including the role of certain aspect of cognition in falls mechanisms, and provide a rationale for the integration of a falls and fractures risk assessment into research on the emerging problem of osteoporosis in older populations.

Falls and fall-induced injuries in older people is a worldwide problem with substantial clinical and public health implications. They are both associated with advancing age and an increased risk of disability, dependency, premature nursing home admission, and mortality [2]. First described almost 40 years ago in context of the geriatric syndrome "instability," falls have become increasingly important in recent years [3]. A fall is defined as "an unintentional change in position resulting in coming to rest at a lower level or on the ground" [4]. Syncopal events, loss of consciousness due to seizures or acute stroke are not included in the fall definition, although they can also present as an episode of instability and a change of position to a lower level [5, 6]. While falls can have multiple and diverse aetiologies, they generally share similar risk factors as they frequently result from the accumulated effect of impairments in multiple systems. Therefore, an intelligent approach to addressing this complex problem must first take into consideration the most likely causes, contributing factors, and associated comorbidities. Since falls and fractures in older adults have an entangled relationship, a characterization of the risk factors for fractures must be also considered in this joint approach.

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Historical Perspectives and New Insights

Falls, as a geriatric syndrome, has been described for centuries as a natural accident that occurs commonly with older adults. For instance, the ancient Egyptians represented older persons in hieroglyphs as a man bent over using a cane, possibly indicating an understanding of an older individual's tendency to experience falls. This begs the question: if falls have been a known problem in the elderly for so long, why has interest in the topic increased today? One possibility may relate to the number of scientific discoveries and social improvements that have been made in recent decades. Advances in medicine, nutrition, and better social and working conditions have allowed the proportion of elderly people in the population to increase dramatically, a pattern seen in most of the western world. This increased longevity, however, has also been accompanied by increased levels of disability and incidence of falls and fractures, consequences that are now being studied and published in the medical literature. In the beginning, the primary focus of falls research was on the mechanical consequences of the fall namely physical injury and fractures, both of which were assumed to be an expected result of the normal ageing process. However, to consider falls as an inevitable or even normal phenomenon associated with aging, has significantly delayed the creation of a systematic approach to this syndrome. As a result, the initial approach was based exclusively on treating the consequences of falls, which generated a therapeutic nihilism to the syndrome itself.

With the creation of Geriatrics as a distinct medical specialty, this view has changed and falls have started to be considered as a syndrome with concomitant risk factors and aetiologies. Falls and fractures are principal components of the geriatric giants of "Instability" and "Immobility" [1] and both are principal components in the vicious circle involving fall and fractures in older adults. As shown in Fig. 10.1, once immobilization due to falls or muscle weakness starts, it exacerbates the neuromuscular impairment leading to deconditioning problems, and increasing muscle weakness and potentially sarcopenia, increasing the risk of future falls and fractures. Cohort and retrospective observational studies conducted during the early 1980's described the epidemiology, consequences, and underlying factors responsible for the falls syndrome [3, 4, 6–10]. Clinical trials conducted in the late 1980's demonstrated that interventions based on multifactorial and multidisciplinary approaches can prevent falls and their associated consequences [3, 11–15]. Despite the myriad of successful clinical trials in preventing falls, however, important gaps still exist in the current clinical knowledge of the area. This gap is even more evident when we look at the applicability of falls prevention and fractures treatment to everyday clinical scenarios.

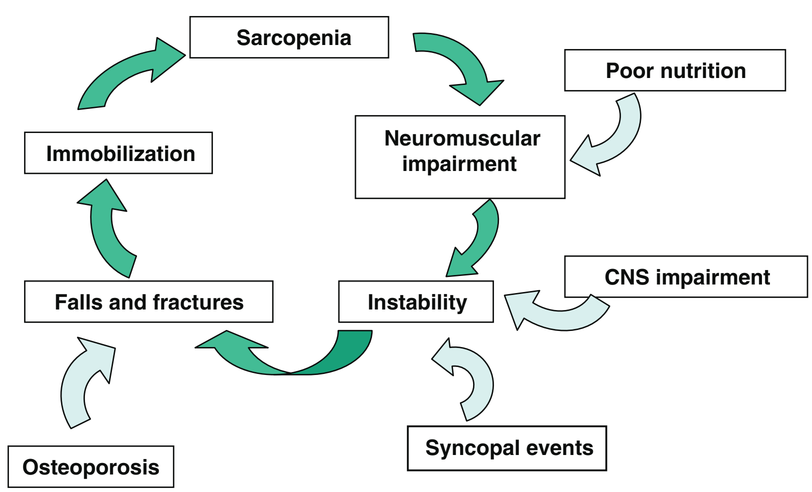

Fig. 10.1 Vicious cycle in falls and fractures and principal contributors. *Green arrows* is the circle. *Blue arrows* are the contributors. Note: CNS, central nervous system

Falls do not happen all the time in the same individual and there are key "trigger events" that act as contributors of the falls syndrome, which will be explored in the "risk factors" section of this chapter. Similarly, the role of cognitive processes, particularly attention and executive function deficits, are becoming increasingly thought as an important determinant of falls, even in those elderly considered cognitively normal [16]. These intriguing findings will be explored in this chapter under the "Cognitive aspects for fall risk" section.

Epidemiology of Falls

The incidence and severity of fall consequences rises steadily entering the sixth decade and tends to be higher among persons over 80 years old. However, the high incidence of falls in this group is not the actual problem as other populations, such as children and professional athletes, have an even higher frequency of falls. Rather, the problem for the elderly is the increased morbidity associated due to falls. Due to the number of comorbidities associated with the ageing process, in particular osteoporosis and the loss of the adaptive and defensive mechanisms related to falling, older people are much more susceptible to sustaining a serious injury even after a minor fall. Accidents are generally ranked as the fourth or fifth leading cause of death in the developed world, with falls being the leading cause of accidental death in older adults accounting for two thirds of these deaths [17].

The prevalence and incidence of falls vary according to the population and setting being analyzed. The reported incidence of falls in community dwelling older adults is about 30 % per year for ages 65 and older, and between 40 and 50 % for ages 80 and older [14]. Among individuals who have a history of falls in the previous year, the annual incidence is closer to 60 %. In older hospitalized patients the prevalence of falls rises to 40 %, while older adults living in long-term care facilities have a prevalence of falls ranging from 45 to 50 % [17–19]. As was stated earlier, falls constitute the largest single cause of injury related mortality in elderly individuals; moreover, falls are an independent determinant of functional decline, leading to 40 % of all nursing home admissions and substantial societal costs. This prevalence in institutional settings is due to a variety of factors including the intrinsic characteristics of the residents in nursing homes, with the majority being frail and/or cognitively impaired, and the more accurate reporting of falls that generally occurs in these settings [18].

Complications of Falling

Falls can have a number of serious medical, physiological, and social consequences that are sometimes underreported or underestimated in the literature (see Table 10.1).

Morbidity and Mortality

Complications and consequences resulting from falls are the leading cause of death from injury in men and women aged 65 and older. One rule of thumb used to describe the frequency of various outcomes of sustaining an unexpected fall by older adults: 20 % of the individuals develop a "fear of falling"; 15 % sustain sufficient injury that leads to frequent visits to emergency care due to the pain, bruises, or dizziness; 10 % sus-

Table 10.1 Frequent consequences of the fall syndrome in older people

Cause	Consequence
Medical	Haematoma
	Fracture
	Chronic pain
	Death
Psychological	Fear of falling
	Anxiety
	Loss of confidence
	Depression
Social	Dependency
	Isolation
	Placement in long term care
Functional	Immobility
	Deconditioning
	Disability and dependence

tain a severe injury but not a fracture (e.g. head injury, brain haematomas, or chest trauma), and 5 % sustain a fracture with 1 % of these being a hip fracture [18, 20]. These percentages can be more than doubled for women aged 75 and older [21].

It has long been understood that the way a person falls can determine the type of the injury they will sustain. For example, wrist fractures often result from forward falls onto a hand, hip fractures typically happen from falls on the side, while falling backwards tends to have the lowest rate of fracture. Older adults between the ages of 65 and 75 tend to have more wrist fractures, while those over the age of 75 suffer more hip fractures. Several hypotheses have been postulated in an attempt to explain this apparent shift from wrist to hip fractures. One of the most accepted theories explains the shift as a result of slower defensive reflexes in individuals over 75 years of age [22].

Psychological and Social Consequences

No less important, and in some cases even more frequent, are the social and psychological consequences of falls and how they may impact functional domains. Fear of falling has been described as a serious concern with prevalence rates ranging from 25 to 55 % amongst community-dwelling older adults [18, 23–25]. Fear of falling can strongly influence an elderly individual's quality of life as it can lead to isolation, depression, and poor satisfaction with life. Moreover, fear of falling itself has been shown to be a predictor of actually falling. The consensus is that individuals develop a fear of falling and depression secondary to recurrent falls. Fear of experiencing another fall (known as "post fall anxiety") may trigger something of a downward spiral for the individual in terms of their social and psychological life. The fear of experiencing another fall can lead the individual to restrict their social activities, possibly due to a decrease in confidence about their abilities. This in turn can gradually lead to isolation, feelings of loneliness, hopelessness, and potentially depression. What makes this pattern particularly unfortunate is that the social isolation stage may be the easiest point at which to affect change; however, it is frequently not reported or identified, which leads to much needless suffering for the individual.

Risk Factors for Falls

While it may be possible to determine the precipitating factor for a given fall, the actual underlying causes tend to be varied and complex. Multiple risk factors have been identified as contributors to the fall syndrome and accordingly, the list is highly heterogeneous including such things as age-associated changes, sensory impairments, muscular weakness, co-morbidities, cardiovascular mediated problems, polypharmacy, and environmental hazards, among others [8, 26, 27]. The most accepted classification of falls is based on whether risk factors are related to an extrinsic hazard or due to an intrinsic disorder [17, 28]. Extrinsic falls are usually related to environmental hazards that cause the individual to slip, trip, or sustain an externally induced displacement, whereas intrinsic falls are generally related to mobility or balance disorders, muscle weakness, orthopaedic problems, sensory impairment, or a neurally-mediated cardiovascular disorder such as postural hypotension or post-prandial hypotension [28]. However, for almost 80 % of fallers, this classification is of limited clinical applicability as their falls were caused by a combination of intrinsic and extrinsic factors [29].

Previous studies showed that the risk of falling increases consistently as the number of risk factors increase. While modifying only one of these risk factors may reduce incidence of falls, the risk reduction is likely to be greater when multiple risk factors are modified [15]. From a clinical point of view, it is more efficient to select interventions that simultaneously address several risk factors, this chapter proposes an aggregation of risk factors into four categories related to potential interventions. These categories are the following: neuromuscular problems, medical problems, cardiovascular problems, and environmental problems. Table 10.2 lists these domains as well as their proposed risk factors, assessment measures and tests, and some potential interventions appropriate for each giving disorder. One important precipitator of falls is medications, which are included under medical problems. While there are inherent difficulties in studying the role of medications as a risk factor for falls, there already exists strong evidence that both the type and class of medications, in particular psychotropics, sedatives, and vasodilators, and the sheer number of medications taken can be important causes of falls in older adults [23, 31–33].

Mechanism and Pathophysiology of Falls

Basis of Posture Control

The human upright position is naturally unstable due to a narrow base of support with a high center of body mass. To maintain this delicate equilibrium while walking or standing the human body has a harmonious modulation of trunk/ankle flexibility. This equilibrium modulation is challenged by motor impairments (either weakness, slowness or poor coordination) that increases the risk of falling under physiological perturbations (e.g. body sway during standing or walking) or after an extrinsic destabilizing factors (e.g. during tripping). The rapid succession of strategies aimed at preserving body stability after a perturbation included first the "ankle strategy", a motor plan characterized by the release of trunk muscles and stiffening of the ankle joint [34–37]. When the perturbation is more severe and the ankle strategy is not efficient enough, the second motor plan is the "stepping strategy", during which the ankle joint is released and the subject performs one or more steps to enlarge the base of support. If these motor acts fail to preserve stability, the upper limbs play a major role in performing rescue strategies (e.g. holding on some support) or protective reactions (limiting the traumatic consequence of falling when it cannot be avoided). This model explains the pathophysiological link between trunk inflexibility (worsened by rigidity or fear of falling) and instability (i.e. ankle strategy), the mechanistic link between gait disorders and falling (i.e. "stepping strategy"), the need for an adequate flow of information through visual, vestibular and somatosensorial afferents, the need for attentive and executive resources to adapt to the environment and to the type of perturbation by rapidly switching from one strategy to the other. The motor determinants of a frequent faller are characterized by a disorder of either the base of support or the center of body mass [34]. A good study model of a "base of support" disorder is Parkinson's Disease. Patients with Parkinson's manifest disorders of both the base of support and the center of body mass and therefore fall much more frequently than elderly subjects. Additional ageing processes not strictly confined to the dopaminergic systems play a major role in the pathogenesis of the axial impairment. Interestingly, in recent years, mild Parkinsonian signs have been recognized in elderly subjects without PD. These patients present features recognized as risk factors for falling, such as an almost exclusive involvement of gait and postural stability as well as executive cognitive function.

Postural stability can be viewed as a strategy per se. As such, the central nervous system adapting to the environmental constrains should rapidly select the appropriate stabilizing strategy for each circumstance which evolves from postural perturbation, including a protective reaction when fall cannot be avoided. Seniors with a higher rate of injuries show an impaired protective arm response during falling. The relevance of the protective arm response is also highlighted by the observation that elderly fallers with the combined fractures of distal radius and hip have a better prognosis than the peers with isolated hip fracture.

Table 10.2 (continued)

Domain assessed	Risk factor/disease	Level of evidence[a]	Screen/assessment	Management
Cardiovascular	Orthostatic hypotension	Ia	Cardiac evaluation including heart rate, morning orthostatic blood pressure, and carotid sinus massage supine and tilted upright, prolonged head-up tilt, if indicated	1. Advice on avoiding precipitants and modification of drugs
	Postprandial hypotension	Ib		2. Postural hypotension: compression hosiery, fludrocortisone, or midodrine
	Vasovagal syndrome	Ia		3. Cardioinhibitory carotid sinus hypersensitivity: permanent pacemaker
	Carotid sinus hypersensitivity	Ib		4. Symptomatic vasodepressor carotid sinus hypersensitivity or vasovagal syncope: fludrocortisone or midodrine

[a]Level of evidence based on reference [30] as following: 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; IV, based on expert committee opinion or clinical experience in absence of other evidence

Cognitive Aspects of Falls Risk

Although walking has long been considered a primarily automatic motor task, emerging evidence suggests that this view is overly simplistic [39]. Walking in the real world requires paying attention to various environmental features and recovering from postural perturbations to avoid stumbles or falls. Therefore, it is not surprising that deficits in attention and executive function processes are independently associated with risk of postural instability, impairment in activities of daily living, and future falls [40].

The research on "dual-task walking", i.e. the abilities to perform a secondary task simultaneous to walking, has been driven by the observation that the failure to maintain a conversation while walking ("stop walking when talking") is a strong predictor of future falls [41]. Dual-task walking abilities worsen due to the impairment of automaticity and attentional related cognitive resources. Even during standing, postural sway increases when a cognitive task is performed concurrently with a postural task, suggesting that constant dynamic control of postural adjustments during standing also requires certain level of cognitive attentional resources. Similarly, locomotion requires certain level of attention resources.

Even among healthy older adults with "normal" cognition, low performance in executive function was prospectively associated with falls [42]. A systematic review and meta-analysis found that executive dysfunction was associated with 1.44 times increased risk for any fall and falls associated with serious injury [16].

In patients with neurological overt disease, such as stroke, Parkinson's Disease or dementia syndromes, their gait deteriorates even more during dual tasking [43–45]. The involvement of cognitive control in normal gait could explain why falls are so common in patients with cognitive impairment and dementia and why they are susceptible to fall while multitasking. Daily life activities involve many attention demanding events which explain the high occurrence of falling while performing a secondary attentional demanding task.

Finally, additional evidence for the role evidence for the role of attention deficits in postural control come from the side effects of drugs impairing cognition. On the other hand, cognitive enhancers, including donepezil, which are usually used for the treatment of dementia, has been found to significantly reduce falls rather than near-falls in patients with PD with cognitive impairment, thus indicating that the drug did not improve stability, but rather cognitive resources. Similarly, cognitive enhancers have improved gait and mobility in people with AD [46, 47].

Risk Identification for Falls

Falls Classification and the Value of Gait Performance

Falls can be classified in a number of diverse ways including by their number (single fall vs. multiple falls); whether or not an injury was sustained (injurious falls vs. non-injurious falls); and what risk factors may have been involved (intrinsic vs. extrinsic factors). The traditional classification, based on the presence of intrinsic and extrinsic factors, has been validated and widely accepted [28]; however, to attribute a fall solely to an to an extrinsic factor is difficult as the majority of environmentally related falls result from an interaction with the intrinsic factors of that individual. Although the intrinsic-extrinsic categorization was originally intended to separate and identify multiple contributors to the fall, older people who experience an extrinsic fall often have an underlying intrinsic condition that decreases their ability to compensate for the hazardous situation. In other words, there may be an intrinsic incapacity to avoid the external factors. As explained earlier, falls are often related to a complex interaction among these factors that can challenge postural control and the ability of the individual to maintain an upright position.

Problems in balance and gait performance are common in older people and have a profound impact on health and quality of life [23, 48–50]. A number of disorders associated to the aging process affect mobility and gait in older persons: loss of muscle mass and strength, also known as sarcopenia, decrease in visual acuity, impairment in proprioception and nerve conduction with loss of the defence reflexes, to list a few. In addition to these age-related changes, many chronic diseases and conditions, including arthritis, neurological problems, and cardiac and respiratory conditions, have marked effects on gait and balance [51, 52]. More frequent factors that can affect gait performance in older persons include muscle weakness, chronic pain, reduced joint mobility and impaired central nervous system processing [48].

Gait performance is a complex task that depends on the normal functioning of multiple systems working in a highly coordinated and integrated manner [48, 53]. As impairments in different domains can alter this delicate system, it has been hypothesized that different chronic conditions such as visual or hearing problems, muscular weakness, osteoarthritis, or peripheral neuropathy could be evidenced through gait performance [53]. In addition, certain psychotropic medications such as benzodiazepines and neuroleptics, which have central nervous system action, may also affect gait performance. Therefore, gait performance can be seen as a common pathway affected by different factors that can cause the fall syndrome. This fact may explain why gait problems "per se" are among the highest predictive risk factor for falls in older adults [6, 48, 53, 54].

In clinical practice, rather than looking for a single, rare disease that causes gait problems in older people, such as myelopathy or normal pressure hydrocephalus, more prevalent causes should be sought in order to establish the potential cause of the gait impairment. The identification of these major contributors will allow the formulating of an operational diagnosis for the individual's gait problem and, in turn provide further information on which to base a therapeutic plan.

Clinical observation is sufficient to detect gait problems in the majority of the older adults, so formal testing in a gait laboratory is not necessary.

Table 10.4 Common cause of gait disorder in older people according the hierarchic level

Level	Deficit/condition	Gait characteristic
Low	Peripheral sensory ataxia: posterior column, peripheral nerves, vestibular and visual ataxia	Unsteady, uncoordinated (especially without visual input)
	Peripheral motor deficit due to hip problems	Avoids weight bearing on affected side
	Arthritis (antalgic gait, joint deformity)	Painful knee flexed
		Painful spine produces short slow steps and decreased lumbar lordosis, kyphosis and ankylosing spondylosis produce stooped posture
	Peripheral motor deficit due to myopathic and neuropathic conditions (weakness)	Proximal motor neuropathy produces waddling and foot slap
		Distal motor neuropathy produces distal weakness
Middle	Spasticity from hemipeligia, hemiparisis	Leg swings outward and in a semi-circle from hip (circumduction)
	Spasticity from paraplegia, paresis	Circumduction of both legs; steps are short, shuffling, and scraping
	Parkinsonianism	Small shuffling steps, hesitation, acceleration (festination), falling forward (propulsion)
	Cerebral ataxia	Wide-based gait with increased trunk sway, irregular stepping
High	Cautious gait	Fear of falling with appropriate postural responses, normal to widened gait base, shortened stride, slower turning en bloc. Performance improve with assistance or evaluator walking on the side
	Ignition Failure	Frontal gait disorder: difficulty initiating gait; short, shuffling gait, like Parkinsonian, but with a wider base, upright posture, and arm swing presence

Source: Adapted with permission from Nutt et al. [55] and Alexander [48]

older adults with recurrent falls, should be aware of cardiovascular causes in those individuals [61].

Dual-Task Gait Assessments

As explained above, dual-task gait has been proposed and used as an instrument to detect the role of cognitive deficits in gross motor performance, gait stability and navigation, and in falls risk. Specifically, dual-task gait performance isolates the role of attention and executive function deficits in the regulation of brain gait control [43, 44, 62]. Emerging evidence is suggesting that "dual-task gait" can help to identify risk of falls [62]. During the dual-task gait test, the individual performs an attention-demanding task while walking to assess any modifications, compared to the reference, single task condition, in either the cognitive or the walking subtasks [63]. The underlying hypothesis is that two simultaneously performed tasks interfere and compete for brain cortical resources [40]. Therefore, dual-task gait can act as a stress test to the brain to detect impeding mobility problems and risk of fall. Gait modifications during dual-tasking (also known as dual-task costs), such as slowing of gait, are interpreted as the increased cost of involvement of cortical attention processes while walking. The role of dual-task costs as a marker of future falls has been evaluated with mixed results in the literature due to the heterogeneity of studies, small sample sizes, limited prospective fall ascertainment, and the lack of standardization in dual-task procedures [64]. Although clinically meaningful cut off values of dual-task costs for predicting falls are still controversial and other unanswered questions remain, a growing body of evidence supports the potential clinical utility of this paradigm for falls prediction: it is neither costly nor invasive, can easily be

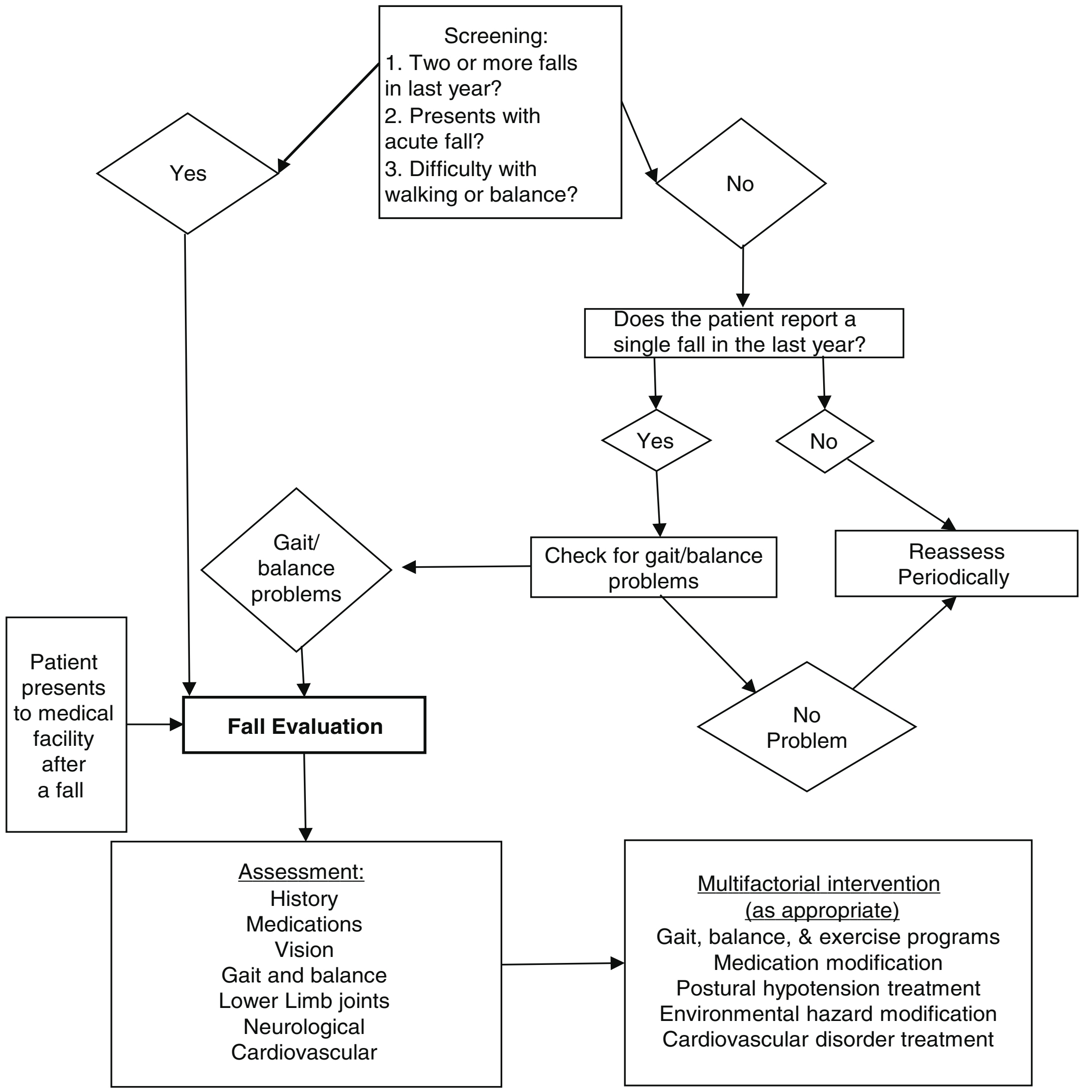

Fig. 10.2 American Geriatrics Society, British Geriatrics Society, and American Academy of Orthopaedic Surgeons approach to falls (Source: Adapted from Summary of the Updated American Geriatrics Society/British Geriatrics Society clinical practice guideline for prevention of falls in older persons. Panel on Prevention of Falls in Older Persons, American Geriatrics Society and British Geriatrics Society [17]. Used with permission of Wiley)

implemented, and provides a valid and sensitive means of assessing motor-cognitive interactions and fall risk. Based on recent studies, a dual-task cost higher than 20 % may denote individuals at higher risk of falls when they sustain a gait velocity of 95 cm/s or faster, highlighting the sensitivity and predictive ability in older adults who have a relatively normal gait velocity [65].

Falls and Fracture Risk Assessment: Who to Assess? How to Assess?

Falls are highly prevalent across the older population; consequently, screening strategies have been developed and a systematic approach has been recommended as summarized in Fig. 10.2 [17].

validated that assess gait performance in older adults, however, as is common with most tests, each has its own set of advantages and disadvantages. The majority of the tests in use today have evolved from a test first described by Mathias and Isaacs, namely the "Get Up and Go Test" [68]. Briefly, the "Get Up and Go" consists of rising from a chair, walking 3 meters, turning around, walking back to the start point, and sitting down again. A timed version, "Timed Up and Go," has been validated and widely adopted. [69]. Since TUG was initially created to evaluate frail older adults, high functioning people generally perform well on the task which introduces a ceiling effect [70]. Therefore, for these individuals a cut-off time of 12 s has been proposed to detect those vulnerable to suffer future falls [71]. More complex tests such as the "Performed Oriented Mobility Assessment" (POMA) test and the "Berg Balance Scale" have been described and validated for assessing risk of falling in different scenarios [72–74]. Gait evaluation in the POMA assesses the following nine components: initiation of gait, step height and length, step symmetry and continuity, path deviation, trunk stability, walking stance, and turning while walking [74]. Each component is scored as 1 (normal) or 0 (abnormal) providing a final score, which ranged from 0 to 12, with a higher score indicating a better gait performance.

A powerful test that can be used in different settings is the gait velocity test. This test has been demonstrated to be sensitive for detecting mobility impairment and a strong predictor of falls, even in high functioning older people. Gait velocity is measured as the time taken to walk a known and predetermined distance (e.g. the middle 8 m of 10 m) and it is usually timed by a chronometer [53] with the participants being instructed to "walk at a comfortable and secure pace". The only limitation of the gait velocity test appears when it is tested in older people using assistive devices. In this situation, changes in functionality may show less effect on gait velocity [70].

The proper gait and balance test needs to be selected in regard to the population being assessed. For instance, in long-term care facilities or when evaluating frail older adults with poor functionality, the "Get Up and Go" test may provide good discrimination for detecting those at risk. For higher functioning older adults, such as older persons without disability, a more continuous measurement without ceiling effects, such as the gait velocity test may be more appropriate. Once a gait problem has been detected with a quantitative test, it can be categorized with clinical observation using the hierarchical classification (Table 10.4) or using an established quantitative protocol such as that of the POMA test.

Gait velocity tests may serve as an initial step in the approach and different cut-off points for detecting individuals at high risk of falls can be established according to the population evaluated. For example, it has been suggested that a gait velocity cut off of 1 m/s in community elderly without disability, 0.8 m/s in older persons with disabilities, and 0.6 m/s in older persons living in nursing homes are strong predictors of falls [48, 53, 54]. The role of dual-task gait test to predict falls seems to be important in those with gait velocity over 1 m/s or when the subtle cognitive impairment is suspected to affect motor control.

Finally, assessments of the risk of injuries due to falls should be performed. Specifically, the identification of those at risk of falls in the first step should prompt the assessment of risk of fracture. The more important factors for fracture risk are the history of previous osteoporosis fracture; the use of psychotropic medication, the presences of cognitive impairment, and presence of sarcopenia and impaired mobility [75]. This stepped approach is summarised in Fig. 10.3. Once assessment is completed and risk categorisation determined, appropriate and focussed strategies and interventions can be instituted.

Conclusions

Falls and fractures represent an important and sometimes neglected feature in older adults. A systematic approach based on clinical assessment and performed based measurements or using simple gait assessment can detect those at higher risk. During the evaluation of the risk of injuries, special attention should be paid to frail older adults.

Older adults with previous falls need to have a comprehensive evaluation addressing all the potential factors previously described. Gait and balance is the domain that will yield more information for falls risk in those without history of falls. There is no evidence that the remaining domains (orthostatic hypotension, visual impairment, medication review, activities of daily living, and cognitive impairment) should be screened in older adults without history of falls if the only purpose is to determine risk of falling [66]. These domains were less frequently, or not at all, independently associated with falls in comprehensive longitudinal studies. If previous history of falls is present, a comprehensive evaluation is needed as described in Table 10.2. Certain cognitive aspects including attention and executive function need to be part of the fall risk evaluation.

Based on the deficits and impairments detected on evaluation, a logical treatment should emerge that involves a combination of medical, rehabilitative, environmental and psychosocial interventions.

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