Prevention and management of falls: falling into place?

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This article reviews the broad international status of falls prevention research and evidence-based guidance, and highlights the apparent discrepancy between information and implementation, with an emphasis on the need for delivery systems. The case is made for the dissemination of a broader concept of the phenomenon of age-associated falls, for its outworking in the resolution of outstanding research topics and, in particular, for the achievement of a robust, networked, economical service delivery model to drive standards forward. The current window of opportunity for progress in falls prevention may prove crucial to the future of cost–effective healthcare in the context of demographic change.

The importance of the falls phenomenon in later life is now increasingly well recognized. As the significance of demographic change gradually dawns on the administrative and health professional consciousness, the public health and health economic consequences of falls in later life – in particular those causing consequent fragility fractures – have become self-evident, simple to quantify and relatively easy to bring to the attention of provider agencies, governments, industry and research funding bodies (although the 'noninjurious' consequences of falls have proved a little more difficult to demonstrate).

As a result, the body of knowledge on which we can draw is now considerable. There is a substantial number of published systematic reviews, the most recent (and possibly the most helpful) from the US Preventive Services Task Force [1]. There is some debate within the field regarding the balance of effort and investment between population-based preventative measures on the one hand and timely identification and management of risk in those presenting to healthcare systems on the other. However, the available evidence, that falls can be prevented has led to the development and publication of detailed national and international evidence-based consensus guidelines that focus on those presenting to healthcare systems, but allow for elements of all categories of intervention [2,3,101,102].

The potential health economic gains from the effective prevention and management of falls are enormous, given the estimated annual (and rising) cost to healthcare systems (e.g., US $19.2 billion dollars in the USA in 2000) [2]. In spite of this, it is clear that progress in implementation within healthcare systems worldwide has been painfully slow [4].

It is not the purpose of this article to provide a critical review of the guidelines. Rather, using consensus guidelines as a starting point, I will briefly explore some of the background issues and potential solutions underlying the discrepancy between guidance and implementation, with an emphasis on broad strategic concept and delivery systems.

Evidence-based guidance

The published consensus guidance based on cumulative evidence from research has focused on a three-stage process that is applicable to community-dwelling older adults presenting to the healthcare system (outcomes for older people in long-term care and hospital settings remain less clear): primary ascertainment of risk; more detailed assessment of those found or demonstrated to be at risk; and single or multifactorial interventions to prevent falls [2,3].

A narrative summary of the guidance is as follows.

Primary (stage 1) assessment of risk

Primary assessment of risk hinges on a screening approach that is a loose combination of population-based and opportunistic screening. It is generally acknowledged that, to stand any chance of widespread implementation, a screening tool for risk needs to be simple, easy and quick to administer. Therefore, it is considered reasonable to request primary care healthcare professionals to ask all of their older patients annually (presumably in person or by letter) if they have fallen (and, if so, to enquire about the frequency and circumstances), and if they experience difficulties with walking or balance. A positive fall history should prompt an in-person assessment of balance and gait. Any observed or

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Keywords

• broader significance • evidence-based guidance • falls prevention • implementation • research needs • service models

reported balance or walking problem or a history of recurrent falling (two or more times in a year) should prompt a stage 2 assessment. The cost of information gathering in stage 1 might be seen as slight or negligible, although that of the ensuing in-person balance assessments could be greater in terms of the healthcare professionals time.

Detailed (stage 2) assessment

A detailed assessment consists of a focused clinical history, clinical examination, and detailed functional and environmental evaluation is delineated in the guidance as an expert procedure appropriately involving more than one professional discipline "with appropriate skills and training". The inference is that this would normally necessitate referral, unless in the case of primary care clinicians and/or teams have designated specialist training in medical gerontology.

While the recommended assessment is comprehensive, its focused content reflects a distillation of recognized risk factors (both intrinsic and extrinsic) clearly identified as such from the large body of literature and systematic reviews. It includes, for example, the diagnostic processes involved in the assessment of postural hypotension and in determining the need or otherwise for cardiac pacing for carotid sinus hypersensitivity.

It also increasingly incorporates more sophisticated measures of a range of physiological functions to enable more focused and accurate targeting of an intervention. These may include lower limb strength, standing balance, visual function, proprioception and central processing (reaction times) of demonstrable sensitivity to prospective falls risk [5]. The technology to undertake these is ostensibly user friendly for on-site administration in the clinic.

Single and/or multifactorial interventions

Single and/or multifactorial intervention sare recommended, based on the outcome of the stage 2 assessment.

Multifactorial intervention (including modification of any an environmental hazard and an education component) is assumed as the default strategy, on the basis that it is exceptional for only one isolated risk factor to be identified in any one individual at risk.

In the case of a single intervention to prevent falls, individualized exercise within the framework of a number of defined programs (including group programs) has been the most extensively applied and evaluated, showing principal benefit to community dwelling older people over 80 years of age [6,7]. It is also recommended as a more or less universal component of any intervention program, including a multifactorial one. There is a strong focus on strength and balance training [2].

Dual chamber cardiac pacing for cardioinhibitory carotid sinus hypersensitivity, cataract removal, avoidance of varifocal lenses, medication reduction (in particular psychoactive medication), correction of foot and footwear problems, and correction of vitamin D deficiency are all recommended targeted interventions to reduce fall rates.

Guidance implementation & service delivery

The *National Service Framework (NSF) for Older People in England*, published by the Department of Health in 2001 incorporated a defined chapter or standard (standard 6) on the prevention of falls and fractures [8,103]. Hpwever, it did not specify any type of service design or model, focusing instead on a somewhat complex algorithmic pathway representing the legitimate expectation of the individual. In addition, both the AGS/BGS [2] and the UK National Institute of Health and Clinical Excellence (NICE) [3] guidelines are essentially nonprescriptive concerning the organizational, health policy and health economic approaches to implementation; although both provide an algorithmic activity model charting the pathway from stage 1 screening to the 'specialist falls service' or 'fall evaluation'.

Tracking the progress of service delivery in response to published guidance has at times proved elusive. In the UK, local commissioners were expected by the NSF to develop some form of falls service, but there were no clear audit hooks on which they could be strung up by the Healthcare Commission for failing to deliver. Therefore, it is perhaps unsurprising that an organizational audit report from the Clinical Effectiveness and Evaluation Unit (CEEU) of the Royal College of Physicians in 2006 found that: "Although 74% of primary care trusts and acute trusts within England self-reported having an integrated, multidisciplinary falls service in line with the NSF, the details suggested otherwise [9,104]:

- Most had no case finding and referral systems in either accident and emergency departments or fracture services;

- Most had not set up systems for the routine identification of need for osteoporosis treatment after fragility fractures;
- The number of patients reaching specialist services for the assessment and treatment of falls risk factors was very low;
- The rates of key investigations were a fraction of those necessary to identify patients who could benefit from treatment for black-outs (syncope)".

There were concerns that implementation of the NICE guideline [3], if widely adopted, would completely inundate those specialist falls services that had been established. However, in 2007, a further clinical audit from the CEEU for the Healthcare Commission, focusing on those who had fallen and sustained a fragility fracture, found that "most patients returning home from A&E after a fragility fracture were not offered a falls risk assessment and only 22% were referred for exercise training to reduce future falls". Only approximately were on appropriate treatment for osteoporosis at 3 months. This was despite the fact that "for the minority of patients who attended a falls clinic the falls and fracture risk assessments and treatments offered were better" [10,105]. At a local level, falls clinics were found to be attracting minimal referral numbers from primary care services.

Winning the hearts and minds of hard-pressed primary care physicians – perhaps already beleaguered by too many centrally driven targets in the UK – has, it seems, proved difficult. An initiative in 2007 to secure the inclusion of fragility fracture prevention in a list of national priorities for primary care performance – the Quality Outcomes Framework (QOF) [106] – proved unsuccessful, even when the emphasis was placed on the detection and management of osteoporosis rather than on falls risk. Although within primary care a number of 'champions' have sought to blaze a trail, even to the extent of promoting general practice settings as the natural location for specialist falls clinics, generalizing their enthusiasm across the primary care fraternity has, so far, proved elusive.

Such developments raise the question of whether the total approach being adopted across both the research and operational elements of falls prevention is yet sufficiently cohesive to ensure that the necessary change presented by this demographically driven challenge actually takes place in the real world of healthcare provision, and this continues to promote lively debate. It has been suggested that on health economic grounds only single intervention strategies stand a real chance of implementation at national level [11].

Three main issues are suggested in considering these difficulties: the broad concept of age-associated falls; residual problems with the evidence base; and organizational implications of cost–effective delivery.

Age-associated falls phenomena: the broader concept

The four main areas of research given previously – screening for risk, assessment of risk, single and multifactorial interventions – all with the occurrence of further falls as the core outcome measure, might seem to constitute a comprehensive agenda. However, the significance of falls occurrence and falls risk in later life is much broader. While it is true that they constitute a signal of preventable falls and preventable injury, and that these in themselves are of major importance, consideration and understanding of a number of parallel and often interacting issues is fundamental to their effective management; one reason why the field holds fascination as well as challenge.

Aging processes

An enhanced propensity for falling amongst the older population in general must first be understood (in the absence of evidence to the contrary) as a phenomenon associated with aging *per se*. In general, human aging is associated with a decline in physiological functional reserve capacity. At the same time, the variation amongst individuals (heterogeneity) also increases, rendering the degree of any specific functional reserve loss complex and difficult to predict. This is true for the loss of reserve function involved in maintaining the upright posture. It may be mediated via any of the range of different mechanisms involved, but it may nevertheless be identifiable in the context of 'good health' – the absence after careful scrutiny of any identifiable pathological causes. However this does not imply that such reserve capacity cannot, to an extent, be retrieved or enhanced through a process of retraining.

Suboptimal physical fitness

A major and obvious pointer to this is the potential to prevent falls by improving strength and balance using defined targeted exercise regimens [6]. The propensity for falling in this context may at least in part be a manifestation of suboptimal

physical fitness, often as a result of physical inactivity. The full benefits of exercise programs extend beyond solely those of falls prevention to encompass the quality, range and fulfillment of daily activity amongst otherwise healthy older people, and even in the long run to bring about an increase in healthy active life expectancy.

Stable specific impairment

Falling also commonly signifies a defined physiological impairment resulting from a specific, direct, local pathological cause that may or may not be reversible. An example of this would be loss of proprioception in a lower limb caused by to lumbar/sacral radiculopathy as a result of a previous prolapsed intervertebral disc, for example. Another would be proximal lower limb weakness caused by a successful knee replacement [12]. Visual impairment caused by a cataract is a further example [13].

As well as helping to identify components of suboptimal function in the assessment of physical fitness, physiological profiling has been demonstrated to be a valid method of highlighting and quantifying specific impairment, providing a strong rationale for the focused physical and occupational techniques required for improvement, and enabling progress to be accurately monitored alongside the ascertainment of any subsequent related falls history [5].

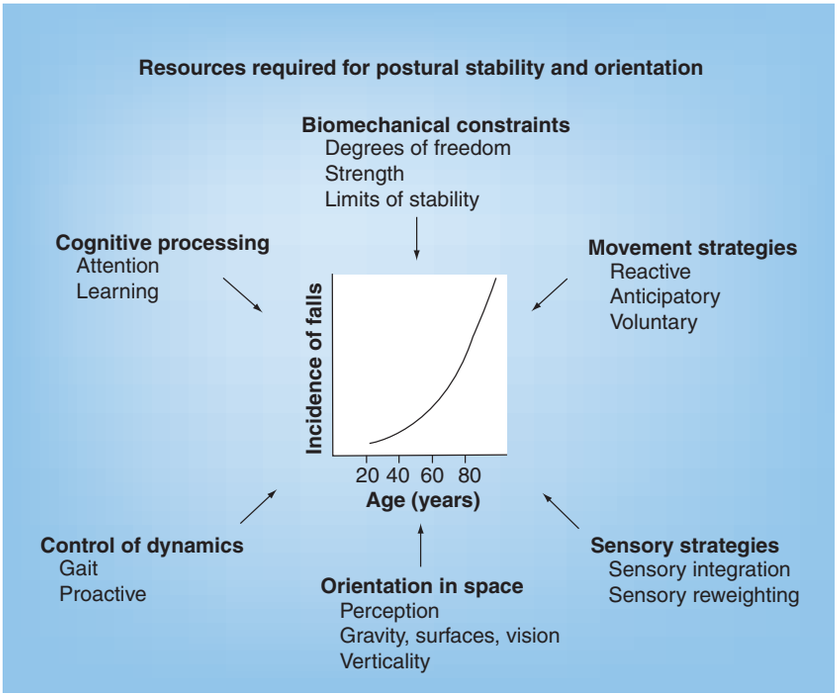

Figure 1. Important resources required for postural stability.
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Unstable systemic illness

Broadly speaking, the interacting mechanisms involved in maintaining the upright posture encompass afferent sensory pathways (especially vision and proprioception) central neural processing, and efferent neuromuscular and muscular responses (Figure 1) [14]. Aging progressively accentuates the susceptibility of these finely balanced mechanisms (perhaps particularly central processing) to perturbation by an enormous range of systemic pathological processes, which can be chronic, subacute and acute.

Therefore, for example, neuropathy caused by diabetes or occult malignancy may affect proprioception, the autonomic control of blood pressure, or both. Subacute hyponatremia caused by inappropriate antidiuretic hormone secretion (which may itself have numerous causes) may cause hypotension and/or impair central processing. Acute sepsis may compromise all pathways involved in postural control, and is a common underlying diagnosis when an older person has been acutely hospitalized either with a hip fracture or 'having been found on the floor'.

Such scenarios are notorious for presenting difficult diagnostic challenges, and where there is low awareness of the falls syndrome in older people as a prevalent front-end presentation of often serious systemic illness, diagnosis is commonly delayed or missed altogether. The short-, medium- and long-term consequences of such delay or omission are all too commonly major, far-reaching and costly, both for the individual and the healthcare system.

This particular aspect of the falls phenomenon provides the strongest possible rationale for the inclusion of a rigorous, iterative diagnostic process within any multifactorial assessment, as distinct from the mere listing or aggregation of a group of documented risk factors.

As already mentioned, it has been argued (with some supportive evidence) that single interventions, most notably exercise programs, constitute the most economic and cost–effective form of falls prevention activity [15] (arguably, in the case of exercise, with additional spin-off benefits in other health domains, such as cardiovascular risk and/or even mortality [16]) and, hence, the legitimate preferred or sole focus of future service investment. One meta-regression analysis [17] and a subsequent meta-analysis [18] have indicated that an equal number of falls were prevented by targeted single interventions as by multifactorial approaches. Notwithstanding assertions to the contrary [11], this pragmatic 'either-or' dichotomous advocacy does look

rather like a retreat from the real challenges of badly managed comorbidity thrown up by the falls epidemic [4]. By definition, single interventions have been simpler to model economically and it is highly likely that the corresponding data on multifactorial approaches underestimate their potential (see later). Current guidance is that, alongside its status, where appropriate, as an effective single intervention, tailored exercise should also be an integral component of multifactorial interventions [2].

Preventable injury

Approximately 10% of falls lead to serious injury, such as fracture (~5%), major soft tissue injury or brain injury, and at least 90% of all fragility fractures in the older population are the result of a fall from standing height or less [19,20].

Assessment of the contribution of bone mineral density and its specific correlates to fracture risk is now at an advanced level of sophistication, epitomized in the WHO FRAX 10-year fracture risk algorithm [21,107] and its derivatives in the USA [22] and the UK (the National Osteoporosis Guideline Group algorithm [NOGG]) [23,108].

A continuing deficiency of these algorithms is the exclusion of falls risk as a variable. The principal assumptions underlying this exclusion are that the precise proportional contribution of falls risk to fracture risk is unclear, falls prevention is not amenable to pharmacological intervention (not strictly correct) and the literature quantifying the efficacy of falls prevention interventions in fracture prevention remains deficient [109]. This, in combination with a lifetime horizon (life-expectancy) methodology for 10-year risk calculation, is not only counterintuitive, but risks doing a potential disservice to today's high-risk cohort of older people by skewing the equivalent fracture risks calculated from the algorithms in the direction of younger age groups, and rationalizing a rising threshold with age (in NOGG) for pharmacological intervention. It also implicitly down-plays any genuine potential for nonpharmacological interventions to prevent fractures in future research and clinical practice.

In one recent 3-year clinical trial, *post hoc* analysis indicated no effect of falls risk on the efficacy of the bisphosphonate clodronate [24], but it is not clear what, if any, falls prevention measures were encountered by participants. However, the authors concluded that it would now be appropriate to incorporate falls risk into international fracture risk algorithms.

In the UK, NICE is yet to provide an agreed national clinical guideline on the prevention of osteoporotic fragility fractures. Thankfully, at a local level, most competent providers adopt a parallel approach targeting both falls risk and bone mineral density, especially in 'secondary prevention' – the avoidance of further injury in those who have already sustained a fracture.

Preventable disability, dependency & mortality

Intuitively, falling might be anticipated to bring about reduced mobility, not least as a result of fear and loss of confidence. There is growing evidence that this happens in the medium and long term, with mobility reduction observed at 1–2 years after presentation with falls (particularly indoor falls affecting women). However, comorbidity is observed to be a significant factor in this, rather than solely the consequence of falls themselves [25].

It is noteworthy that only a small proportion of the 30% 12-month mortality after hip fracture can be traced back to consequences of the fall/fracture trauma itself [26]; the vast majority is attributable to a nontrauma comorbidity identified either at the time of the fracture or diagnozed subsequently, and likely to have been causally related to the fall/fracture event in the first place.

In a 9-year longitudinal prospective cohort study, frequent falling, older age and a self-reported worsening of health were independently and significantly associated with mortality. The relative risk of death when experiencing at least two falls was 1.6 (95% CI: 1.1–2.4) when compared with no falls [27].

In randomized prospective clinical trials of falls prevention, the focus has quite appropriately been on falls recurrence as the primary end point, but several studies have legitimately measured a range of 'secondary' endpoints, including (for example) mortality, ADL functional status and/or hospitalization rates for a given period after the intervention. The early comprehensive ED-based multifactorial intervention study, conducted in my own department [28], demonstrated a significantly reduced decline in ADL status over 12 months compared with controls. Overall, however, the methodological and contextual variability across the range of studies in the literature has precluded robust conclusions on such secondary end points, particularly in systematic reviews.

In summary, a cohesive and comprehensive health strategy is required to address each aspect of the age-associated falls phenomenon itemized

here and to do so in a way that is demonstrably cost–effective, both in the short, medium and longer term.

Residual needs within the evidence base

Two areas of particular priority for ongoing research are suggested. To achieve progress in either, it will be necessary for experimental purposes to utilize a much tighter agreed standardization of the content and conduct of a best option comprehensive multifactorial intervention than has been the case to date. [29–31] In order to drive 'generalizable' improvement, it is first necessary to benchmark what is achievable.

The proportional contribution of falls risk reduction to fracture prevention

It is unfortunate that the proportional contribution to fracture prevention of nonpharmacological measures to prevent falls (and hence their cost–effectiveness) remains inadequately documented. As already stated, large-scale trials of drugs to treat osteoporosis have by default or by design failed to gather data on falls risk status in the study populations or to correct for any falls prevention measures occurring alongside drug treatment, on the pretext that this is unnecessary for the assessment of pharmacological efficacy. It could also be argued that the increased sample sizes likely to be required if this were built into the study design and the putative 'dilution' of the perceived fraction of efficacy solely attributable to the drug might constitute a disincentive to companies funding the trials. Therefore, the relative paucity of evidence on the fracture prevention efficacy of nonpharmacological intervention is best recognized at present as a proportional deficiency in research investment rather than as any inherent weakness of the primary hypothesis. The undesirable effect of this reality on fracture risk prediction algorithms has already been highlighted.

The low percentage of all falls that result in a fragility fracture restricts this research topic to large-scale studies. For the reasons stated previously it may or may not be realistic to expect the pharmaceutical industry to rise to this particular challenge. However, it should be incumbent upon senior researchers engaging in pharmaceutically funded major trials of new and existing treatments for osteoporosis to insist on falls risk identification and management as core variables in the design of such studies. Clinicians with a primary interest in bone health have historically been a little reluctant to do this, but this is thankfully now changing. It should be made a requirement by pharmaceutical licensing bodies and by organisations, such as the WHO, concerned with risk prediction algorithms.

In settings where there has been sufficient development of falls prevention activity to implement a best option multifactorial program, an ideal approach (if funding could be identified) would be the conduct of multicenter trials with 'usual care' as control and fracture prevention as a key outcome. However, this might be unrealistically costly, present major challenges of study design and, increasingly in the context of international guidance, be considered ethically unacceptable. Alternatively, prospective cohort data collection to an agreed protocol within routine follow-up across centers may be a more realistic strategy to acquire this information. This is an outstanding research requirement urgently in need of resolution.

The epidemiology of falls-related comorbidity & the cost–effectiveness of measures to manage & prevent it

As already indicated, the understandable focus of randomized controlled trials has been the evaluation of falls prevention efficacy. Whilst the enormous variety of contributory comorbidity (often multiple) is acknowledged, a concerted effort seems necessary to document this more clearly. A high prevalence of previously undiagnozed medical problems in those presenting to the accident and emergency department is well recognized. [28,32] While, for example, the relationship of fall events to cardioinhibitory carotid sinus sensitivity has been helpfully characterized [33], the prevalence of many other unstable health disorders presenting commonly as falls or falls remains inadequately charted, although studies are now beginning to emerge [34].

Promising initiatives to address the interaction of multiple factors using classification and regression tree analysis [35], albeit confined thus far to falls risk alone, are now beginning to emerge, and these along with similar methodology may well help to cast light on the broader picture of comorbidity. Useful initiatives are emerging to address the woeful deficiency in the basic documentation of falls as an entity (as distinct from injury) [36], for example in emergency medicine (EM) departments [37].

There is a similar lack of information on the subsequent management and ultimate outcome of these disorders. As a result, the potential yield (direct or indirect) of 'falls services' as measured by the benefits of prompt and/or early diagnosis and intervention remains unidentified. Subject

to the configuration of services, it is suggested that this is likely to be considerable in both public health and health economic terms. Modelling the latter constitutes a challenging but very important component of the required epidemiological research. As with the research on fracture prevention, the collection and analysis of routine data by falls services with comparable operational profiles and using an agreed defined protocol across centers would seem the best place to start.

Importantly, a major (in fact the largest) component of the healthcare cost of falls is the cost of hospital bed days, driven predominantly by the scale of comorbidity and complexity encountered [25]. There is evidence that duration of stay in hospital can be substantially reduced by multifactorial falls intervention in the emergency department [38], but more is needed. This constitutes a potentially strong economic rationale for the role of falls prevention activity in the early recognition and diagnosis of comorbidity *per se*, and it is in the fulfillment of this role as well as in the reduction of the incidence of falls that the cost–effectiveness of such activity should be evaluated.

In summary, this research effort is necessary to achieve a greater understanding of the falls phenomenon itself, the scale of healthcare load incurred in connection with falls and the contribution of falls-related clinical activity to the wider public health. It is essential to support further the economic case for funding.

Organizational approaches for cost–effective delivery

The root basis of the falls phenomenon is human aging with its associated comorbidity, and the scale of its importance is driven by demographic change. If the challenges of population aging in developed societies are to be properly addressed, then the provision of best-estimate solutions to the phenomenon of falling is an imperative, not an option. The alternative is a relentless escalation of the costs (both human and economic) of long-term dependency in old age. The falls phenomenon is a paradigm of the spectrum of healthcare need in later life; from primary prevention, through the management of nonacute, subacute and acute comorbidities, to the prevention and management of long-term functional disability and premature mortality. This general concept has been elaborated elsewhere [39].

However, the poor track record of implementation to date indicates the need for additional strategic and organizational impetus and accountable leadership on the ground. In turn, this requires clear delineation both of the activity involved, of the extent to which it can be reliably embedded at minimal cost within existing services, and of the content and scale of any additional coordinating, leadership and specialist functions of a specific falls service. The variable findings to date from studies of multifactorial intervention programs reflect disparities in many of these aspects of service delivery [1].

Population-based approaches to falls

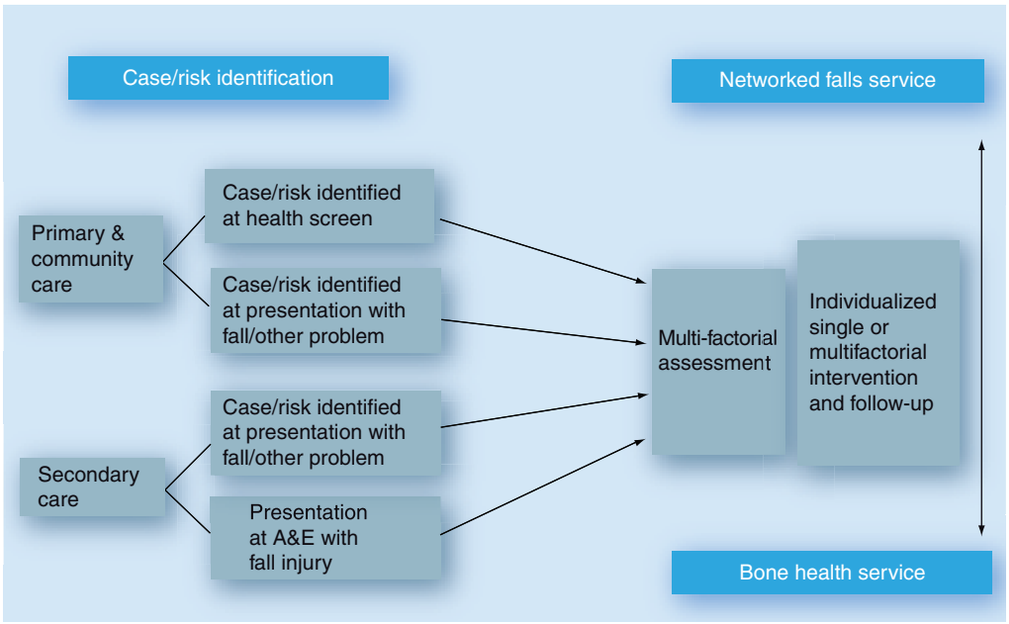

Figure 2. Generic falls assessment intervention and activity.
Adapted with permission from [2].

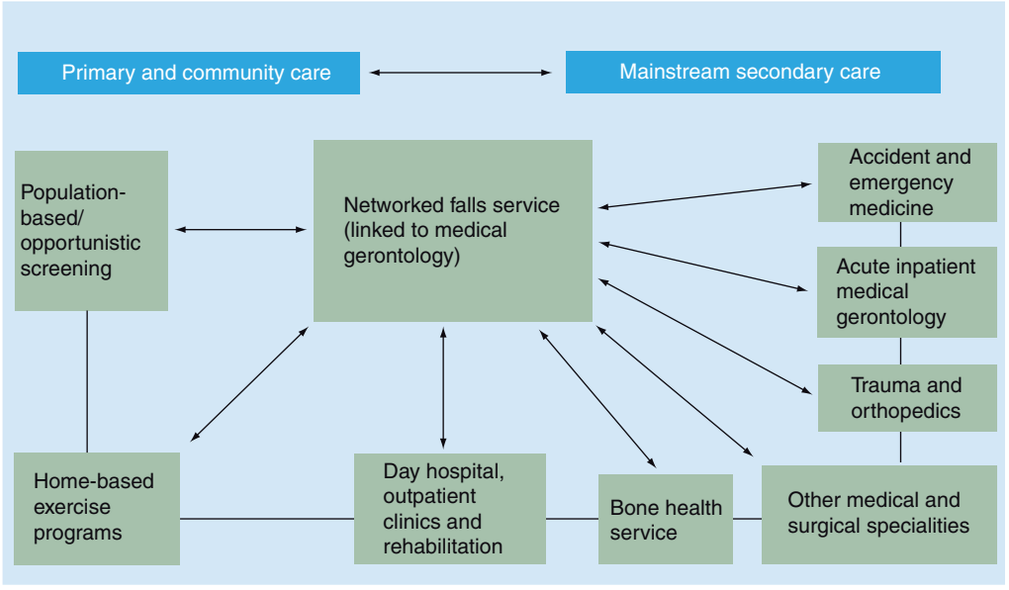

Figure 3. Generic network for the delivery of falls prevention services.

prevention are supported by evidence with particular reference to addressing the needs of fitter community-dwelling older people and those with 'suboptimal' physical fitness.

For those presenting to the healthcare system, the specialist knowledge base resides within medical gerontology. Both its scientific basis, presentation and appropriate management are manifestly broad, multifactorial, multicontextual and synthetic, as distinct from narrowly focused and subspecialized. Accordingly, this knowledge base and expertise are central to the organization of care as well as to professional and performance accountability for the outcome of services. Furthermore, both current guidance and the most recent systematic review [1] strongly suggest that a comprehensive (complete and actively managed) approach to multifactorial intervention is the preferred strategy.

With this in mind, a generic activity pathway is suggested in Figure 2 and a corresponding networked service model in Figure 3. Figure 2 is also compatible with the international AGS/BGS Guidelines, (though the latter's algorithm incorporates elements of decision-making).

With the exception of the primary screen, all stage 1 elements of case/risk identification are 'opportunistic' and reflect minor shifts in clinical practice with negligible cost. Even if these alone were to occur routinely, this would constitute a major step forward in falls management and prevention. Implementation of the primary screen requires central consensus and direction so far not achieved in the UK via the QOF. The approach of the latest elected administration, intrinsically opposed to 'process targets', remains to be seen.

Provided its content and conduct could be assured, implementation of most stage 2 assessments need not be costly either. Figure 3 illustrates a generic working service network. The emphasis is emphatically on parsimonious networking as distinct from costly structural reorganization, although elements of the latter may be required in some settings. Departments of medical gerontology are established within mainstream acute hospitals in the UK, contribute substantially to acute general medical care and have strong links (including full mutual referral access) with emergency medicine and trauma, and orthopedic departments, as well as other medical subspecialities and primary care. The existing models of 'orthogeriatric' collaboration in the management of hip fracture are likely to be strengthened by current consensus statementshealth care [110], national guidance [111] and a Health Department "Best Practice Tariff" initiative [112] linked to a National Hip Fracture Database [113].

Most stage 2 assessments can probably be absorbed at minimal, or at most modest, cost within such an existing network, enabling specialist falls and syncope clinics with realistic economy to provide leadership, address specific needs, coordinate benchmarking, routine data collection and audit, and undertake and coordinate research. In this way, the scene is set to deliver a demonstrably effective, cost–effective and auditable response to the challenge of falls and falls comorbidity.

Given the poor historical take-up, it is difficult

to see how effective multifactorial interventions can become a major reality in settings where such a network is not tenable or in place. In those studies and systematic reviews reporting negative outcomes with multifactorial programs, absence of explicit linkage to such a network, inadequate targeting of those at risk, or weakness of one or more links in the network is commonly identifiable. For example, in one negative EM-based study, postassessment intervention and/or referral was discretionary via primary care only [40]. By contrast there is, a gratifying growth of interest within the EM discipline in the potential contribution of their departments to such a networked approach [41]. The need for a robust, directly networked multidisciplinary basis for falls interventions [42] is reinforced by evidence of the ineffectiveness of single professions (e.g., a fracture liaison nurse coordinator with referral access) operating in comparative isolation [43].

It may be that a major growth in stage 1 activity could drive demand, but unless the existence of a truly efficient and economical networked stage 2 process to attract referral is well established, this is less likely to happen. A growing strategy in many centers is to designate a sessional commitment to falls service leadership for a consultant member of the medical gerontology team. Without such an approach it is also the case that no-one in particular can be held accountable. In these circumstances, it would appear that central policy direction in response to public health needs is required, not least to change the face of acute hospitals in line with demographic change. Some policy initiatives in England have been helpfully summarized [44]. In the UK, a further National Clinical Audit of falls services is currently in preparation [114]. In the USA, there may be impetus from the recently legislated Affordable Healthcare for America Act [45,115].

It is incumbent on all of us concerned with the business of falls prevention to face up to the challenge of translating available evidence and guidance into best option service models, to press for their organized delivery nationally and internationally, and at the same time, to

Executive summary

Progress to date

- The knowledge base of falls prevention, including numerous systematic reviews, is now very extensive.
- Clear national and international evidence-based guidance covers:
  The primary (stage 1) opportunistic and population-based ascertainment of falls risk
  The detailed (stage 2) assessment of risk status and risk factors within individuals
  Recommended single and/or multifactorial interventions to prevent further falls.
- By contrast, progress in the systematic implementation of falls prevention services has been painfully slow, controversial and inconsistent nationally and internationally.

Current needs

- A clearer perception and presentation of the broader significance of age-associated falls is required
- This includes aging processes, suboptimal physical fitness, stable specific impairment, unstable systemic illness, preventable injury, and preventable disability, dependence and mortality
- Key residual research questions include:
  The proportional contribution of falls prevention to fracture prevention,
  The epidemiology of falls-related comorbidity and the cost–effectiveness of its management
- There should be a concerted drive to set in place closely networked service structures covering all key contexts in which falls prevention activity is relevant.
- A parsimonious model is given linking falls services to medical gerontology and networking with other key services.

Future perspective

- Falls researchers need to come together and collaborate strategically in evaluating agreed best estimate comprehensive prevention models.
- A substantial increase in opportunistic screening alone would achieve considerable progress.
- A strong medical gerontology presence within mainstream acute hospital care is fundamental to cost–effective multifactorial intervention.
- Central policy direction seems essential to support both population-based primary prevention and operational change within secondary care.
- There are currently promising major national initiatives and directives in the UK and the USA.
- Future success or failure in falls prevention will be a sensitive parameter of success or failure in delivering cost–effective healthcare in the context of demographic change.

continue collaborating energetically in refining the ongoing research agenda. There are some exceptional opportunities. To miss them would be no less than to set back the whole agenda for cost–effective healthcare in response to today's demographic challenge.

Financial & competing interests disclosure

The authors have no relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript. This includes employment, consultancies, honoraria, stock ownership or options, expert testimony, grants or patents received or pending, or royalties.

No writing assistance was utilized in the production of this manuscript.

Bibliography

Papers of special note have been highlighted as:
- ▪ of interest
- ▪▪ of considerable interest

1. Michael YL, Whitlock EP, Lin JS, Fu R, O'Connor EA, Gold R. US preventive services task force. Primary care-relevant interventions to prevent falling in older adults: a systematic evidence review for the U.S. Preventive Services Task Force. *Ann. Intern. Med.* 153, 815–825 (2010).
2. Guideline for the prevention of falls in older persons. American Geriatrics Society, British Geriatrics Society, and American Academy of Orthopaedic Surgeons Panel on Falls Prevention. *J. Am. Geriatr. Soc.* 49, 664–672 (2001).
3. *Falls: the Assessment and Prevention of Falls in Older People*. National Institute for Health and Clinical Excellence, London, UK (2004).
4. Tinetti ME. Multifactorial fall-prevention strategies: time to retreat or advance . *J. Am. Geriatr. Soc.* 56, 1563–1565 (2008).
5. Lord SR, Menz HB, Tiedemann A. A physiological profile approach to falls risk assessment and prevention. *Phys. Ther.* 83, 237–252 (2003).
6. Sherrington C, Whitney JC, Lord SR *et al.* Effective exercise for the prevention of falls: a systematic review and meta-analysis. *J. Am. Geriatr. Soc.* 56, 2234–2243 (2008).
7. Robertson MC, Campbell AJ, Gardner MM *et al*. Preventing injuries in older people by preventing falls: a meta-analysis of individual-level data. *J. Am. Geriatr. Soc.* 50, 905–911 (2002).
8. *National Service Framework for Older People*. Department of Health, London, UK (2001).
9. *National Audit of the Organisation of Services for Falls and Bone Health for Older People*. Royal College of Physicians, London, UK (2006).
10. *National Clinical Audit of Falls and Bone Health in Older People.* Royal College of Physicians, London, UK (2007).
11. Campbell AJ, Robertson MC. Not a retreat, but advancing on numerous fronts (Letter). *J. Am. Geriatr. Soc.* 57, 565–566 (2009).
12. Kearns RJ, O'Connor DP, Brinker MR. Management of falls after total knee arthroplasty. *Orthopedics* 31, 225 (2008).
13. Harwood RH, Foss AJ, Osborn F, Gregson RM, Zaman A, Masud T. Falls and health status in elderly women following first eye cataract surgery: a randomised controlled trial. *Br. J. Ophthalmol.* 89, 53–59 (2005).
14. Horak FB. Mechanistic and physiological aspects: postural orientation and equilibrium: what do we need to know about neural control of balance to prevent falls? *Age Aging* 35(Suppl. 2), ii7–ii11 (2006).
15. Davis JC, Robertson MC, Ashe MC, Liu-Ambrose T, Khan KM, Marra CA. Does a home-based strength and balance programme in people aged > or =80 years provide the best value for money to prevent falls? A systematic review of economic evaluations of falls prevention interventions. *Br. J. Sports Med.* 44, 80–89 (2010).
16. Thomas S, Mackintosh S, Halbert J. Does the 'Otago exercise programme' reduce mortality and falls in older adults?: a systematic review and meta-analysis. *Age Aging* 39, 681–687 (2010).
17. Campbell AJ, Robertson MC. Rethinking individual and community fall prevention strategies: a meta-regression comparing single and multifactorial interventions. *Age Aging* 36, 656–662 (2007).
18. Petridou ET, Manti EG, Ntinapogias AG, Negri E, Szczerbinska K. What works better for community-dwelling older people at risk to fall?: a meta-analysis of multifactorial versus physical exercise-alone interventions. *J. Aging Health* 21, 713–729 (2009).
19. Tinetti ME, Doucette J, Claus E, Marottoli R. Risk factors for serious injury during falls by older persons in the community. *J. Am. Geriatr. Soc*. 43, 1214–1221 (1995).
20. Centers for Disease Control and Prevention (CDC). Self-reported falls and fall related injuries among persons aged 65 years - United States, 2006. *MMWR Morb. Mortal Wkly Rep*. 57, 225–229 (2008).
21. Kanis JA; On behalf of the World Health Organization Scientific Group. *Assessment of Osteoporosis at the Primary Healthcare Level*. Technical Report. WHO Collaborating Centre, University of Sheffield, UK (2008).
22. Compston J, Cooper A, Cooper C *et al.*; National Osteoporosis Guideline Group (NOGG). Guidelines for the diagnosis and management of osteoporosis in postmenopausal women and men from the age of 50 years in the UK. *Maturitas* 62, 105–108 (2009).
23. Kanis JA, Johansson H, Oden A, Dawson-Hughes B, Melton LJ 3rd, McCloskey EV. The effects of a FRAX revision for the USA. *Osteoporos. Int*. 21, 35–40 (2010)
24. Kayan K, Johansson H, Oden A *et al*. Can fall risk be incorporated into fracture risk assessment algorithms: a pilot study of responsiveness to clodronate. *Osteoporos. Int*. 20, 2055–2061 (2009).
25. Mänty M, Heinonen A, Viljanen A *et al*. Outdoor and indoor falls as predictors of mobility limitation in older women. *Age Aging* 38, 757–761 (2009).
26. Parker M, Johansen A. Hip fracture. *BMJ* 333, 27–30 (2006).
27. Sylliaas H, Idland G, Sandvik L, Forsen L, Bergland A. Does mortality of the aged increase with the number of falls? Results from a nine-year follow-up study. *Eur. J. Epidemiol.* 24, 351–355 (2009).
28. Close J, Ellis M, Hooper R, Glucksman E, Jackson S, Swift C. Prevention of falls in the elderly trial (PROFET): a randomised controlled trial. *Lancet* 353, 93–97 (1999).
29. Gillespie LD, Robertson MC, Gillespie WJ *et al*. Interventions for preventing falls in older people living in the community. *Cochrane Database Syst. Rev.* 15, CD007146 (2009).
30. Carpenter CR. Evidence-based emergency medicine/systematic review abstract. Preventing falls in community-dwelling older adults. *Ann. Emerg. Med*. 55, 296–298

(2010).

31. Mahoney JE. Why multifactorial fall-prevention interventions may not work: comment on "Multifactorial intervention to reduce falls in older people at high risk of recurrent falls". *Arch. Intern. Med*. 170, 1117–1119 (2010).
32. Nemec M, Koller MT, Nickel CH *et al*. Patients presenting to the emergency department with non-specific complaints: the Basel Non-specific Complaints (BANC) study. *Acad. Emerg. Med*. 17, 284–292 (2010).
33. Davis AJ, Steen N, Kenny RA. Carotid sinus hypersensitivity is common in older patients presenting to an accident and emergency department with unexplained falls. *Age Aging* 30, 289–293 (2001).
34. Deandrea S, Lucenteforte E, Bravi F, Foschi R, La Vecchia C, Negri E. Risk factors for falls in community-dwelling older people: a systematic review and meta-analysis. *Epidemiology* 21, 658–668 (2010).
35. Delbaere K, Close JC, Heim J *et al*. A multifactorial approach to understanding fall risk in older people. *J. Am. Geriatr. Soc.* 58, 1679–1685 (2010).
36. Lamb SE, Jorstad-Stein EC, Hauer K *et al*. Prevention of falls network Europe and outcomes consensus group. Development of a common outcome data set for fall injury prevention trials: the prevention of falls network Europe consensus. *J. Am. Geriatr. Soc.* 53, 1618–1622 (2005).
37. Johansen A, Dickens J, Jones M, Richmond P, Evans R. Emergency department presentation following falls: development of a routine falls surveillance system. *Emerg. Med. J.* 28(1), 25–28 (2011).
38. Davison J, Bond J, Dawson P, Steen N, Kenny RA. Patients with recurrent falls attending accident and emergency benefit from multifactorial intervention. A randomised controlled trial. *Age Aging* 34, 162–168 (2005).
39. Nowak A, Hubbard RE. Falls and frailty: lessons from complex systems. *J. R. Soc. Med*. 102, 98–102 (2009).
40. Hendriks MR, Bleijlevens MH, van Haastregt JC *et al.* Lack of effectiveness of a multidisciplinary fall-prevention program in elderly people at risk: a randomized, controlled trial. *J. Am. Geriatr. Soc*. 56, 1390–1397 (2008).
41. Bloch F, Jegou D, Dhainaut JF *et al.* Do ED staffs have a role to play in the prevention of repeat falls in elderly patients? *Am. J. Emerg. Med.* 27, 303–307 (2009).
42. Campbell AJ, Robertson MC. Implementation of multifactorial interventions for fall and fracture prevention. *Age Aging* 35(Suppl. 2), ii60–ii64 (2006).
43. Elley CR, Robertson MC, Garrett S *et al*. Effectiveness of a falls-and-fracture nurse coordinator to reduce falls: a randomized, controlled trial of at-risk older adults. *J. Am. Geriatr. Soc.* 56, 1383–1389 (2008).
44. Oliver D. Development of services for older patients with falls and fractures in England: successes, failures, lessons and controversies. *Arch. Gerontol. Geriatr*. 49(Suppl. 2), S7–S12 (2009).
45. Tinetti ME. Making prevention recommendations relevant for an aging population. *Ann. Intern. Med*. 21, 153, 843–844 (2010).

Websites

101. American Geriatrics Society. Prevention of falls in older persons: AGS/BGS clinical practice guidelines www.medcats.com/FALLS/frameset.htm.
102. National Institute for Health and Clinical Excellence. Falls: the assessment and prevention of falls in older people http://guidance.nice.org.uk/G21/NICEGuidance/pdf/English
103. Department of Health. National service framework for older people www.dh.gov.uk/ en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4003066
104. Royal College of Physicians; Clinical Effectiveness and Evaluation Unit. National audit of the organisation of services for falls and bone health for older people www.rcplondon.ac.uk/clinical-standards/ceeu/Documents/NationalAuditReportFinal30Jan2006.pdf
105. Royal College of Physicians; Clinical Effectiveness and Evaluation Unit. National clinical audit of falls and bone health in older people www.rcplondon.ac.uk/clinical-standards/ceeu/Documents/fbhop-nationalreport.pdf
106. National Institute of Health and Clinical excellence (NICE) www.nice.org.uk/aboutnice/qof/qof.jsp#Programme
107. FRAX WHO. Fracture risk assessment tool www.sheffield.ac.uk/FRAX/
108. National Osteoporosis Guideline Group www.shef.ac.uk/NOGG/
109. FRAX WHO. Fracture risk assessment tool: frequently asked questions www.sheffield.ac.uk/FRAX/faq.jsp
110. British Orthopaedic Association. The care of patients with fragility fractures (Blue Book) www.boa.ac.uk/en/publications/fragility_fractures/
111. National Institute for Health and Clinical Excellence. Clinical Guideline: the management of hip fracture in adults. In progress http://guidance.nice.org.uk/CG/Wave18/51
112. Department of Health. Best practice tariffs. London 2010 www.dh.gov.uk/en/Managingyourorganisation/NHSFinancialReforms/DH_105080
113. British Orthopaedic Association and British Geriatrics Society. The national hip fracture database www.nhfd.co.uk/
114. The Library of Congress. THOMAS. Bill summary and status 111th Congress (2009–2010) http://thomas.loc.gov/cgi-bin/bdquery/z?d111:H.R.3962:
115. Royal College of Physicians. Clinical effectiveness and evaluation unit. National clinical audit of falls and bone health in older people www.rcplondon.ac.uk/clinical-standards/ceeu/Current-work/Falls/Pages/Introduction.aspx