Preventing Falls and Fall-Related Injuries in Hospitals

David Oliver, MD, FRCP[a,*], Frances Healey, RN, BSc[b],
Terry P. Haines, B. Physiotherapy Hons, Grad. Cert. Health Economics, PhD[c]

KEYWORDS

• In-hospital falls • Fall-related injuries • Fracture prevention

HOW IMPORTANT AND COMMON IS THE PROBLEM?

The majority of hospital beds in the developed nations are occupied by older people, many of whom have been admitted because of mobility problems, falls, or injury from falls.[1] With population aging and projected increases in the number of people surviving with functional impairment, cognitive impairment, or multiple long-term conditions, these trends are likely to continue,[2] making fall prevention a very pressing risk management challenge for hospitals and a real threat to patient safety.[3–5]

Single observational studies in acute hospitals have reported rates ranging from 1.3[6] to 8.9[7] falls per 1000 occupied bed days (OBDs), with multihospital studies reporting rates of between 3 and 5 falls per 1000 OBDs,[8,9] although falls are rarely evenly distributed across units, with much higher rates reported from areas such as elderly care, neurology, and rehabilitation units.[9–11] In mental health hospitals this uneven distribution may be particularly marked, with overall rates in the range of 2 to 4 falls per 1000 OBDs[4,9] but rates in some psychogeriatric units ranging from 17 to 67 falls per 1000 OBDs.[11,12] Although rates are the best the way of facilitating comparison between hospitals of differing sizes, they can disguise the sheer scale of the problem; these average rates would represent well over 1000 falls each year in a large acute hospital[4] and perhaps as many as 1 million falls in hospital patients each year in the United States (based on approximately 250,000 falls reported annually in England and Wales,[13] the fourfold greater population size of the United States, and the similarity of reported whole hospital fall rates within the range of 3 to 5 falls per 1000 OBDs between the United States and United Kingdom in the citations used above). In addition, these rates describe *reported* falls; underreporting also has to be factored in.[14,15]

[a] School of Community and Health Sciences, City University, London, England, UK
[b] National Patient Safety Agency, 4-8 Maple Street, London W1T 5HD, UK
[c] Allied Health Clinical Research Unit, Southern Health and Southern Physiotherapy, Clinical School, School of Primary Health Care, Monash University, 270 Ferntree Gully Road, Notting Hill VIC 3168, Australia
* Corresponding author.
E-mail address: David.Oliver.1@city.ac.uk

Clin Geriatr Med 26 (2010) 645–692
doi:10.1016/j.cger.2010.06.005 geriatric.theclinics.com

WHAT ARE THE CONSEQUENCES OF FALLS IN HOSPITAL?

In acute and rehabilitation hospitals, falls resulting in some injury range from 30% to 51%.[4,7,16] Proportions of falls resulting in any fracture range from 1% to 3%,[7,17,18] with reports of hip fracture ranging from 1.1% to 2.0%.[4,7,19] Falls in hospital are also associated with increased length of stay, higher rates of discharge to institutional care, and greater amounts of health resource use.[20–22] Proximal femoral fractures caused by falls that occur in the hospital setting have been found to result in poorer health outcomes than those that occur in the community.[22]

However, even soft tissue injuries or minor fractures can cause significant functional impairment, pain and distress in people who are frail and who have poor functional reserve. These supposedly “minor” injuries, or even falls resulting in no physical harm, can mark the beginning of a negative cycle whereby fear of falling leads an older person to limit their activity, with consequent further losses of strength and independence.[23,24] Falls also lead to anxiety and distress amongst caregivers and relatives who perhaps believe that “something should have been done” in an apparent place of safety to prevent the falls and that “someone must be to blame” and therefore are frequently cited both in complaints and in litigation.[25] Unsurprisingly, all of this leads to anxiety and concern in professional staff caring for patients.[26] This concern is partly caused by fear of complaint or litigation or inquests, and also because staff may feel guilty that they could have done more to prevent the fall and are aware that they are constantly balancing the autonomy and rehabilitation of individual patients versus the duty of care to all of those they look after.[26]

For all these reasons, the prevention of falls in hospitals are of major concern to individual patients, their relatives, and staff, and should be a major risk management concern for management and a key priority for the leaders of health care organizations and external regulators or inspectors. In addition, falls are usually a sign of underlying frailty, medical problems, or change in functional or medical status, and should therefore be used as a “red flag” to prompt reassessment of treatable factors that may be significant causes of morbidity and mortality aside from their impact on the risk of further falls.

WHERE AND WHEN DO PEOPLE FALL IN HOSPITAL?

There have been several observational studies describing the location, timing, and circumstances of falls in hospitals and the characteristics of those who fall. (eg, Refs.[7,9,17,18]). These studies are generally based on retrospective analysis of routinely collected incident reports that can be confounded by underreporting, by partial recording of information, and by reporting bias,[15] but despite this may provide some useful points of learning. If we look at falls in acute and rehabilitation hospitals,[3,4,27] around 80% to 90% of falls are unwitnessed and 50% to 70% occur from the bed, bedside chair, or while transferring between the two. This may be because patients spend a majority of their time in this area. By contrast, in mental health units[4] falls while walking predominate. Of equal concern are the 10% to 20% of falls occurring in toilets or bathrooms,[3,4,27] which is disproportionately high given the small proportion of each day that patients might be expected to spend in them.

Several studies have attempted to look at the relationship between time of day of falls. Peaks in late morning have been identified in larger studies,[9,17,28] although there does not appear to be a consistent pattern across all studies. The examination of local falls data for patterns such as these to drive intervention strategies has previously been reported.[29] However, use of incident report data alone for this purpose may lead to inaccurate results because of overall underreporting and because time of day has been found to influence the likelihood that hospital staff will report falls on incident reports.[30] Moreover, it is hard to disentangle patient-specific factors (such as activity and diurnal rhythms) from unit-specific ones (eg, drug rounds, handovers, staffing ratios) within such comparisons.

WHICH HOSPITAL PATIENTS FALL AND WHY?

Patient-Specific Factors

Just as in the community setting, falls usually result from synergistic interactions between several person-specific intrinsic risk factors, the physical environment, and the riskiness of a person's own behavior.[31] In the hospital setting there is an additional key ingredient: the actions of hospital staff and their interactions with the patient. Hospital staff may offer assistance to patients, allowing them to complete a range of personal tasks. Without this assistance the task would not have been completed or may have precipitated a fall.

In addition to the presence of hospital staff and differences in the physical environment, further differences in risk factors between older people in the community and in-hospital settings might be expected, not least because hospital patients will be under treatment or investigation of acute or chronic physical or mental ill health, or in need of rehabilitation, so the prevalence of risk factors may be very different to that for people in their own homes. Several recent systematic reviews on fall risk factors in hospital inpatients set out this evidence in more detail than is feasible here,[32–34] but the following risk factors are most consistently identified: recent fall; muscle weakness; behavioral disturbance, agitation, or confusion; urinary incontinence or frequency; prescription of "culprit" drugs; postural hypotension or syncope.[32] In the few studies where reported falls are analyzed against a denominator of bed days, studies consistently suggest risk increases with advanced age, with the highest rates seen in the "oldest old," older than 85 years.[9,17] An excess risk of falls in male patients is also consistently seen in large-scale studies that adjust for bed occupancy.[9,17] When we look at specialist settings for mental health, the presence of dementia leads to a greater risk associated with wandering, restlessness, and dementia-related gait disturbance and syncope/presyncope.[35] However, dementia affects around 1 in 3 patients older than 65 admitted to general hospitals and delirium has a similar prevalence,[36] making the management of patients with impaired cognition and restlessness a challenge in all inpatient settings. Those at greatest risk of delirium (and falls) are those with underlying frailty or cognitive impairment to begin with, and many precipitants of delirium (such as sedating or anticholinergic drugs) also increase the risk of falls.

Environmental Risk Factors for Falls (or "Contributors" to Falls)

It can be difficult to disentangle "intrinsic" from "extrinsic" causes of falls in hospital settings. A so-called environmental cause—for instance, around poor lighting, trip hazards, suboptimal chair height, or unsafe staffing levels—generally compounds patient-specific risks such as visual impairment, postural instability, muscle weakness, or restlessness. However, in designing fall prevention strategies we do need to consider the impact of the environment in which the patient is cared for, especially as this is usually an unfamiliar environment to the patient. Key areas where environmental hazards are cited in reports of hospital falls and where expert opinion suggests environmental improvements have potential to reduce the risk of falls are outlined later in this discussion.

Attitude, Skills, and Availability of Staff

It is important to recognize that many falls happen as a consequence of patients mobilizing as they recover from illness when not closely supervised by hospital staff. A short route to fall prevention would be to prevent anyone from mobilizing unsupervised, or worse, to restrain them or keep them in bed. It follows that there are “acceptable” falls that are an inevitable consequence of promoting rehabilitation and respecting autonomy.[37] For patients with capacity, the balance between rehabilitation and safety is theirs to decide on, but for patients without capacity, who are dependent on the decision-making of staff or surrogates, unit policies that seek a sensible balance between the risks of harm from falls and the risks of harm from impaired independence are likely to be crucial.

Staff availability and attitude to fall prevention are also likely to be important. There is next to no empiric evidence around the relationships between staff numbers or skill mix and fall incidents,[8] as simple observational studies in this area may provide counterintuitive results due to complex interactions between staffing, patient case mix and activity patterns, work practices, and falls reporting. For example, both nursing numbers and fall rates tend to be lower at night,[4] but this is likely to be a product of lower patient activity on the ward at this time. However, understaffed units where delays in responding to patients’ needs are commonplace will almost inevitably experience an increase in falls.

CAN FALLS IN HOSPITAL RELIABLY BE PREDICTED?

As already mentioned, falls in hospital are more likely in older patients and in those with underlying risk factors. And because most patients do not fall during their hospital stay there has been understandable interest, especially from nurses and risk managers, in tools purporting to predict patients who are at “high” or “low” risk of falls. Superficially, this is an attractive idea, in theory allowing staff to focus their preventive efforts and limited fall prevention resources on those at higher risk. However, such tools cannot be used uncritically and we need to understand their limitations. First, we need to understand that there is a difference between tools that prompt staff to look for common fall risk factors (with a view to addressing or modifying them) and those that aim to predict an adverse event such as a fall, usually through a numerical score. For clarity in this article the authors use the terms “modifiable risk factor checklists” for tools that prompt staff to identify and act on common reversible fall risk factors, and “fall prediction tools” for those tools designed to identify which patients are at risk of falls or not at risk of falls (or to risk-stratify patients into groups, for example, high, medium, or low risk).

For fall *prediction* tools, we need to consider whether they are fit for purpose, that is, that they actually discriminate sufficiently well between potential fallers and nonfallers*, in that specific population.* For these tools the issues of sensitivity, specificity, and positive and negative predictive values (**Box 1**) are not just theoretical detail, but have very real clinical implications. For example, low sensitivity means the tool gives false reassurance and opportunities to prevent falls are missed, and low positive predictive value means fall prevention efforts may be spread too thinly.

The literature on risk prediction tools is complex, and only a brief summary can be given here; full details are to be found in several recent systematic reviews[32,33,38–40] and critiques.[41] To summarize their findings, few risk prediction tools have been subjected to any kind of validation in one, let alone more than one setting. Many appear to have been simply “home made” with arbitrary weightings and no validation data,[27,41,42] and even those that have been validated do not perform consistently well in discriminating between fallers and non fallers across a variety of settings.

The 2 most widely validated tools identified on systematic review[32,33,40] are the Morse Falls Score (MFS)[27] and the STRATIFY Score.[43] These tools have been

Box 1
The validity of falls risk prediction tools

If a sample of patients is assessed using a falls risk prediction tool, and then observed to see if they subsequently fall, a matrix like this can be generated:

	Actually Fell	Did Not Fall
Predicted to fall	A	B
Predicted NOT to fall	C	D

Using this matrix, the following predictive qualities can be calculated:

- Sensitivity (true positive) = A/A+C (proportion of patients who fell who had been predicted to fall)
- Specificity (true negative) = D/B+D (proportion of patients who did not fall who had been predicted not to fall)
- Positive Predictive Value (PPV) = A/A+B (proportion of patients predicted to fall who fell)
- Negative Predictive Value (NPV) = D/C+D (proportion of patients predicted not to fall who did not fall)

The Youden Index and Receiver Operating Characteristic (ROC) curves can be used to give statistical and graphical representations of the combined attributes (Total Predictive Value) of a tool, where 1.0 represents perfect predictive value and zero no greater predictive value than might be expected by chance.

subjected to several external validations in different settings and patient groups,[42,44,45] all of which showed pooled specificity and sensitivity was relatively low, and PPV lower still. Haines and colleagues,[40] in a systematic review and meta-analysis of all fall risk prediction tools for hospital inpatients, employed the Youden Index to describe the predictive validity of several fall risk prediction tools for hospital patients. For both MFS and STRATIFY, pooled Youden Index scores were approximately 0.2 and no better than the accuracy afforded by the clinical judgment of front-line nurses. As the investigators concluded, "Heterogeneity between studies indicates that the Morse Falls Scale and STRATIFY may still be useful in particular settings, but that widespread adoption of either is unlikely to generate benefits significantly greater than that of nursing staff clinical judgment."

An additional consideration, over and above whether or not fall prediction tools accurately predict future falls, is what practical clinical benefit we might gain from doing so. Previous research has indicated that the cost-effectiveness of a fall prevention program that does not address a specific risk factor can be improved if such an intervention is made available.[46] However, many interventions focus on specific risk factors, such as "culprit" medications or incontinence, which always merit intervention in their own right. Hence, focus may be better placed on the interventions that are (potentially) available and determining the most appropriate means for ensuring that these interventions are provided to patients who will benefit from them.

WHAT ARE THE PROBLEMS PERFORMING AND INTERPRETING RESEARCH ON FALLS IN HOSPITAL?

Although the randomized controlled trial (RCT) coupled with meta-analysis of RCTs is widely seen as the gold standard, it is often hard to recruit acutely ill or cognitively impaired patients to conventional RCTs, or to recruit promptly enough to include the whole patient episode. Fall prevention is usually a complex intervention[47] that aims to change practice at the level of teams or units, making cluster randomization more practical, but allowances for clustering effects can require very large studies for sufficient power. As the GRADE guideline group have made clear,[48] evidence from large, credible parallel or before-and-after studies where the effect size cannot easily be attributable to confounders, and where efforts have been made to control for them, may be at least as valid as smaller, shorter RCT interventions. Given these arguments and the small number of RCTs available, the authors believe it is appropriate to consider at this time evidence arising from before-and-after and parallel (nonrandomized) control group studies to help guide practice in this field. Unfortunately, not all of these studies are both large and credible; too many are small-scale before-and-after studies with many potential confounders, which report large effect sizes based on no more than selective retrospective data trawls. These studies are potentially confounded by underlying secular trends in fall rates, influenced by changes in staffing, case mix or activity, or in the recording practice around falls incidents, rather than by the purported fall prevention intervention. Such studies are also subject to a likely publication bias, as busy clinician investigators may be less willing to spend time writing up the results of an unsuccessful trial for an academic journal (for an example see http://www.strategiesfornursemanagers.com/ce_detail/243,766.cfm) and there is no requirement to register trials such as these (unlike randomized trials). Therefore, in an attempt to balance the overinclusion or underinclusion of before-and-after trials in this article, the authors include those that report outcomes of fallers, falls rate, or injury over a period of at least 9 months postintervention (because shorter "after" periods risk confounding the impact of the intervention with seasonal variations or a "Hawthorne" effect) that have been published since 1999, where the intervention and control conditions were adequately described, and where the "hospital" was not a residential unit (mean length of stay 1 year or more).

A crucial issue in fall prevention research in all settings is outcomes ascertainment, which has been the subject of consensus guidance from PROFANE on the reporting of outcomes in fall prevention trials.[49] Many of the studies report data based on the use of routine clinical incident reporting systems. This is problematic. As already discussed, we know that there is considerable underreporting of fall incidents and in turn this underreporting may be modified by the very process of research, causing changes in apparent fall rates.[14,30,50] Ideally there should be some kind of independent corroboration of these data. It is also true that many published studies are not powered to detect significant differences in major injury (a comparatively rare event) and also rarely have any consideration of the inadvertent harms of focusing on fall prevention, nor do they have economic evaluation built into their design. It is important for practitioners to be aware of all these caveats when critically appraising evidence apparently useful to their practice, so as to avoid copying interventions that on closer scrutiny have little credible evidence behind them.

SO WHAT *IS* THE EMPIRIC EVIDENCE FOR FALL AND INJURY PREVENTION IN HOSPITALS?

Despite these challenges in designing and conducting research on fall prevention in the hospital setting, we should "not let the desire for best possible evidence stand in the way of using the best available evidence."[51] The authors now critically examine the empiric evidence for fall prevention in hospitals, beginning with trials of multifactorial interventions, then of single interventions, before examining the conclusions of recent systematic reviews.

MULTIFACTORIAL INTERVENTIONS

Several studies of multifactorial interventions have been published. When multifactorial "bundles" of interventions are employed, they are never the same in any 2 trials, and it is difficult to determine the attributable benefit from each component in the "bundle" or the type of population where they may be most effective. Therefore, set out here are the key features for each in terms of settings, patient populations, design, and results (**Table 1**), the components included within the multifactorial intervention (**Table 2**), and how these were applied (**Table 3**).

As **Table 1** demonstrates, of the 17 included multifactorial studies, 6 described significant reductions in falls and/or injury plausibly linked to the timing of the introduction of a fall prevention intervention. However, as shown in **Table 2**, the components included within the multifactorial interventions also differed widely. Although this heterogeneity between studies is a barrier to meta-analysis, it can provide some helpful information on what characteristics are more likely to be seen in a successful trial. **Table 2** suggests that the components most commonly seen in successful trials include a post fall review, patient education, staff education, footwear advice, and toileting. The importance of post fall review is unsurprising given the significance of a previous falls as a risk factor in hospital settings, and given the potential for multidisciplinary review to identify and act on a range of modifiable risk factors. Patient and staff education are plausibly important "building blocks" that create the knowledge and attitudes in which other components are delivered, given the complex nature of multifactorial interventions. Footwear provision and attention to the causes of incontinence are again plausible components, given that most mobilization in acutely ill patients will be concentrated on journeys between their bedside and the toilet, and the significance of urinary incontinence or urgency as a risk factor for falls.

Indeed, given that medication review is described in one successful intervention and implied in 2 others, and elements relating to the prevention or detection of delirium were included in 2 successful trials, the components of the successful interventions are a close match to the most significant fall risk factors in hospital inpatients described above. Attention to all the risk factors addressed in the successful trials is part of good comprehensive geriatric assessment, which has a variety of benefits beyond merely fall prevention[52] and is therefore good for the wellbeing of patients and the hospital. It is also important to note that a multifactorial approach including review by a health professional is the approach most favored by patients themselves.[46]

In addition to which interventions are applied, who they are applied to, and who they are applied by may also be important. **Table 3** suggests that it is difficult to demonstrate success in a younger hospital population with a shorter mean length of stay; all the successful trials were applied to a patient group with a mean age of 80 years or more and a mean length of stay of 19 days or more. However, as is discussed in the section on systematic reviews, this may not mean there is no hope of success in populations with a younger average age and shorter average length of stay, because very few adequately powered trials have been performed on such populations, and because we know that even in hospitals with younger populations, most falls will tend to occur in the oldest patients with more complex conditions and a longer length of stay.[4]

As shown in **Table 3**, a risk prediction tool was used in only half of the successful trials, and even in these trials some components were made available to all patients regardless of their risk score, suggesting risk scores are not an essential element of successful fall prevention. Alternate approaches used in successful interventions

Table 1
Design and results of multifactorial falls prevention trials in hospitals, 1999 to 2009[a]

References	Study Design	Setting	Participants	Participants' Mean Age (Years)[b]	Mean Length of Stay (Days)[b]	Quality Score in Oliver et al, 2007[c]	Quality Criteria Met in Coussement et al, 2008[d,112]	Results[e]
Barker et al,[120] 2009	Before-and-after study	Small acute hospital in Australia	271,095 patients admitted over 3 years before, and 6 years after intervention	47	3	—	—	Fall and fall-injury rate data presented as time-series plots. Fall rates per 1000 OBDs for the 3 years preintervention (1999: 2.71, 2000: 2.69, 2001: 3.96) were similar to those during the intervention (2002: 3.65, 2003: 3.63, 2004: 3.63, 2005: 3.71, 2006: 4.21, 2007: 3.55). Fall injury rates per 1000 OBDs during the preintervention period (1999: 1.55, 2000: 1.39, 2001: 1.65) were higher than those during the intervention period (2002: 1.31, 2003: 0.98, 2004: 0.61, 2005: 0.65, 2006: 0.71, 2007: 0.68)

Barry et al,[57] 2001	Before-and-after study	Small long-stay and rehabilitation hospital in Ireland	All patients admitted to 95 beds for 1 year preintervention and 2 years postintervention	81	200+[f]	10/31	—	B 156 admissions, 39 fallers, 71 falls, 15 minor injury, 6 hip fracture, 2 other fractures A Year One 172 admissions, 36 fallers, 56 falls, 13 minor injury, 1 hip fracture A Year Two 149 admissions, 26 fallers, 36 falls, 4 minor injury, no fractures *"Chi square test and Fischer exact test were used as appropriate"* Reduction in falls and fallers not significant Only in Year Two versus preintervention, decrease in injurious falls $P<.01$ In Year One and Year Two versus preintervention, decrease in fractures $P<.05$
Brandis,[16] 1999	Before-and-after study	An acute hospital in Australia (including pediatric wards)	All patients admitted to 500 beds for 1 year preintervention and second year postintervention (no data provided for first year of intervention)	UN	UN	5/31	—	B 201 fallers, 270 falls, 130 minor injuries, 8 fractures, 1.74 falls per 1000 OBDs A Year Two 190 fallers, 258 falls, 133 minor injury, 3 fractures, 1.61 falls per 1000 OBDs Significance not tested

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References	Study Design	Setting	Participants	Participants' Mean Age (Years)[b]	Mean Length of Stay (Days)[b]	Quality Score in Oliver et al, 2007[c]	Quality Criteria Met in Coussement et al, 2008[d,112]	Results[e]
Cumming et al,[55] 2008	Cluster RCT	24 acute and rehabilitation elderly care wards in 12 Australian hospitals	3999 patients admitted during the 3-month study period on each ward	79	12	—	—	I B 8.25 falls per 1000 OBDs I A 9.26 falls per 1000 OBDs C B 7.62 falls per 1000 OBDs C A 9.20 falls per 1000 OBDs Unadjusted incidence rate ratio 1.02 (95% CI 0.70–1.49) *P* = .92 Various adjusted rates and subgroup rates analyzed and also non significant Differences between patient characteristics in I & C described and appear similar although not tested for statistical significance

Fonda et al,[29] 2006	Before-and-after study	Four elderly acute and rehabilitation wards in an Australian acute hospital	All admitted patients (1905 before, 2056 after) over 1 year before, 2 years after	82	19	24/31	—	B 465 falls 27 serious injuries 12.5 falls per 1000 OBDs I Year 1 489 falls 17 serious injuries 11.3 falls per 1000 OBDs I Year 2 413 falls 7 serious injuries 10.1 falls per 1000 OBDs Percentage reduction in falls rate B to Year 2 19.2% (95% CI 16.7%–21.7%) $P = .001$ (chi-squared) Percentage reduction in injury rate B to Year 2 76.8% (95% CI 74.1%–79.5%) $P<.001$ (chi-squared) Mean length of stay had decreased by 2 days and unit had increased from 96 beds to 120 beds

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Grenier-Sennelier et al,[121] 2002	Before-and-after study	A 400-bed rehabilitation hospital in France	All admitted patients over 2 years before and 2 years after (ca 800 admissions per year)	76	36	—	—	The proportion of fallers was declining[g] significantly before intervention (44.6% in 1995, 36.3% in 1996) and initially increased significantly (*P*<.01) after intervention (40.7% in 1997) before decreasing to 31.0% in 1998. Multiple fallers also decreased between the 2 preintervention years and in 1995 versus 1998 (*P* = .03)
Haines et al,[92] 2004	RCT	Three subacute wards within an Australian rehabilitation and elderly care hospital	626 patients consenting to randomization drawn from 1040 consecutive admissions	80	32	24/31	14/20	I 105 falls in 54 fallers C 149 falls in 71 fallers Relative risk 0.78 (95% CI 0.56–1.06) Nelson-Aalen cumulative hazard estimate diverged at day 45. Log rank test (*P* = .004) and Peto extension (*P* = .045) showed fewer falls in I

Healey et al,[10] 2004	Cluster RCT	Four acute and 4 rehabilitation wards in one acute and 2 rehabilitation hospitals in the UK	All admitted patients over 1 year (3386 patients)	81	19	18/31	6/20	I 180 falls 49 injurious falls 11.38 falls per 1000 OBDs C 319 falls 62 injurious falls 19.92 falls per 1000 OBDs Incidence rate ratio I:C 0.59 (95% CI 0.49–0.70)[h] *P*<.001 I rate ratio B:A 0.79 (95% CI 0.95) Crate ratio B:A 1.12 (95% CI 0.96–1.31) Ratio of relative risks 0.71 (0.55–0.93) *P*<.006
Koh et al,[122] 2009	Cluster RCT	Two acute hospitals in Singapore	All admissions during 1 year before and 6 months after	UN	UN	—	—	Falls rates differed between control and intervention preintervention (0.6 vs 1.4 falls per 1000 OBDs) and there were no significant changes (*P* value not given) postintervention (0.6 vs 1.1 falls per 1000 OBDs)

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Krauss et al,[123] 2008	Before-and-after study with contempo-raneous cohort	General medical wards in an acute academic hospital	All admissions during 9 months before and 9 months after period (N not given)	UN	UN	—	—	I B 6.64 per 1000 OBDs I A 5.09 per 1000 OBDs (*P* = .15)[i] C B 7.37 per 1000 OBDs C A 6.24 per 1000 OBDs (*P* = .41) No significant differences in injury rates (*P* = .53) I A 48 fallers, 57 falls C A 70 fallers, 78 falls Fallers and falls before not described
Oliver et al,[124] 2002	Before-and-after study measure	An elderly medical unit within an acute hospital in England	3200 patients admitted annually; data collected for 1 year preintervention and 1 year postintervention	80	UN	5/31	—	B 211 fallers, 294 falls, 11.1 falls per 1000 OBDs, 86 injuries A 175 fallers, 367 falls, 13.8 falls per 1000 OBDs, 82 Injuries Increased falls *P* = .015 Multiple fallers *P* = .06

Schwendimann et al,[7] 2006	Before-and-after study	Internal medicine, geriatric and surgical wards in a 300-bed Swiss acute hospital	All admissions (34,972) over an 18-month before and 42-month after period	67	12	—	9/20	Fall rates are presented graphically and a nonsignificant reduction from 9.1 falls per 1000 OBDs in early 1999 to 8.6 in late 2003 is noted (*P* = .086).[j] Proportions of major injuries appear to increase significantly (*P* = .014) while overall proportions of injury show no significant change (*P* = .169 chi-squared)[k] Significant changes in mean age, gender ratio and length of stay between before and after periods (all *P*<.001)

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Stenvall et al,[53] 2007	RCT	Orthogeriatric ward (intervention) and orthopedic ward and geriatric ward (control) in a Swedish acute hospital	199 consecutively admitted patients with femoral neck fracture consenting to randomization[l] and without complex needs	82	35	—	—	I 18 falls, 3 injurious falls, no fractures, 6.29 falls per 1000 OBDs C 60 falls, 15 injurious falls, 4 fractures, 16.28 falls per 1000 OBDs Incidence rate ratio 0.38 (95% CI 0.20–0.76) after adjustments Kaplan-Meier survival to first fall significant (log rank 0.008) C had significantly higher levels of depression and antidepressant use pre-randomization (*P* = .031, *P* = .009) and a significantly longer length of stay (38 vs 28 days *P* = .028)

Uden et al,[125] 1999	Before-and-after study	A geriatric department in an acute hospital in Sweden	47 randomly selected patients from the year before intervention, all 332 admitted patients in the intervention year	75	50	—	—	B 17% (8/47) were fallers no fractures A 22% (151/332) were fallers 2 fractures Significance not tested and increases attributed to better recording of falls in notes
Van der Helm et al,[56] 2006[m]	Before-and-after study	One internal medicine ward and one neurology ward within an acute hospital in the Netherlands	All admitted patients (2670) during a 6-month before and 18-month after period	UN	10	—	—	Internal medicine B 9 falls per 1000 OBDs A 8 falls per 1000 OBDs (rising to 9 in some quarters) Neurology B 16 falls per 1000 OBDs B 16 falls per 1000 OBDs[n]
Vassallo et al,[113] 2004	Cohort study[o]	Three rehabilitation wards within a UK rehabilitation hospital	825 patients (the first 275 patients to be admitted to each of the 2 control and 1 intervention wards)	82	24	10/31	11/20	C 111/550 fallers 170 falls, 45 injurious falls, 11.5 falls per 1000 OBDs[p] I 39/275 fallers, 72 falls 12.3 falls per 1000 OBDs[q] Difference in falls and OBD said to be significant at *P* = .045 using Mann-Whitney[r] Intervention group had a significantly shorter length of stay (*P*<.001)

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References	Study Design	Setting	Participants	Participants' Mean Age (Years)[b]	Mean Length of Stay (Days)[b]	Quality Score in Oliver et al, 2007[c]	Quality Criteria Met in Coussement et al, 2008[d,112]	Results[e]
Von Renteln-Kruse and Krause,[126] 2007	Before-and-after study	Elderly acute and rehabilitation wards in an acute hospital in Germany	4272 patients admitted in a 23-month[s] before period, 2982 admitted in a 16-month after period	80	20	—	—	I 468 falls 330 fallers 129 injurious falls 9 fractures 8.2 falls per 1000 OBDs C 893 falls 611 fallers 129 injurious falls 10 fractures 10.0 falls per 1000 OBDs Incidence rate ratio 0.82 (95% CI 0.73–0.92) Injury rate ratio 0.84 (95% CI 0.67–1.04)

[a] This table was constructed using all studies identified by any of the 3 systematic reviews described above (Cameron et al, 2010,[54] Coussement et al, 2008,[112] Oliver et al, 2007[1]) and an additional update search, whereby the publication date was between 1st January 1999 and 31st December 2009 and the location of the trial was a hospital that was not used as a long-term residence (defined as mean length of stay exceeding a year), and for before-and-after studies an "after" period of at least 9 months was described.
[b] UN, unknown (not described in original study).
[c] The scoring system used was Downs and Black (1998).[129]
[d] The scoring was a 10-point criteria devised by the investigators, each of which could be scored as zero, 1, or 2.
[e] OBDs, occupied bed days; I, intervention (RCT/contemporaneous cohort); C, Control (RCT/contemporaneous cohort); B, Before; A, After.
[f] Based on the investigators' description of "about" 150 admissions a year, 90% occupancy and 95 beds.
[g] The investigators describe $P<.1$ as significant; they may have accepted a 90% probability level or this may have been a typographical error.
[h] Note that using a log rate ratio Cameron et al (2010)[54] produce expanded 95% confidence intervals (CIs) of 0.26–1.34.
[i] The investigators also select a 5-month postintervention period for subanalysis and in that period note the rate on intervention wards (3.81) was significantly lower ($P = .43$) than the 9-months preintervention rate (6.64) but such unplanned subanalysis is likely to lead to Type 1 errors.[14] Group-by-period interaction effects

model the difference between intervention and control groups in change across before and after intervention periods in fall outcomes using Generalized Estimating Equation analyses.

[j] The graphical presentation has a wide scale but suggests if other 6-month periods in the before and after phase of the study had been compared, higher rates would have been seen in some postintervention periods than in some preintervention periods.

[k] The analysis is performed by comparison of each calendar year (including a calendar year that encompassed 6 months before intervention and 6 months after intervention).

[l] There were apparently no ward capacity issues as there is no mention of any patients not being admitted to the ward to which they were randomized.

[m] Note that the investigators describe the "before" period as a pilot study, but actually appear to be describing the falls rate and practice before the intervention, that is, a baseline rather than the piloting of the intervention.

[n] The results are presented for varying intervals, including by quarter and as the first 12 months after intervention and subsequent 6 months, with CIs for some but not all. Number of falls and fallers given only for whole period of study (before and after combined).

[o] Although the investigators refer to the study as quasi-randomized and Oliver et al (2007)[1] refer to it as a cluster RCT, it appears the intervention ward was selected (not randomized) on the basis of being the ward where the researchers worked, and the quasi-randomization relates only to the fact that patients would be allocated from a waiting list to whichever ward was the first to have an empty bed. The study also refers to "matching" patients, but this appears to be comparison of the cohorts for differences rather than matching at individual patient level.

[p] Calculated from 170 falls in 14,791 OBD.

[q] Calculated from 72 falls in 5855 OBD.

[r] Based on the more conventional incidence rate ratio and 95% CIs in Oliver et al (2007)[1] and Coussement et al (2008)[112] reviews, the increase in falls rate was nonsignificant, and the relative risk of being a faller may have been lower in the intervention group 0.70 (95% CI 0.50–0.98) although confounded by the significantly shorter length of stay in the intervention group.

[s] A separate publication (von Renteln-Kruse and Krause, 2004)[130] describes a review of reported falls from January 2000 to December 2002 when 5946 patients were admitted of whom 1015 were fallers and who had 1596 falls. This suggests that the proportion of fallers had been reducing substantially year-on-year even before the intervention was introduced (ie, 17% [1015/5946] of patients fell before intervention in 2000–2002, 14% [611/4272] of patients fell before intervention in 2003–2004, and 11% [330/2982] of patients fell after intervention in 2005-early 2006).

Table 2
Components of multi-factorial falls prevention trials in hospitals, 1999 to 2009[a]

References	Environment Modified	Alert Wristband	Bedside Risk Sign	Hip Protectors	Staff Education	Patient Education	Bedrail Review	Vest/Belt/Cuff Restraint	Footwear	Toileting Schedules	Exercise	Movement Alarms	Medication Review	Urine Screening	Postfall Review	Other Interventions[b]	Statistically Significant Reductions in Falls or Injuries? (see Table 1 for Details)
Barker et al, 2009[120]	—	—	✓	—	—	—	—	—	—	✓	—	✓	—	—	—	Low beds Introduction of a computerized falls reporting and analysis system[c]	Possibly injuries
Barry et al,[57] 2001	✓	—	—	✓	✓	—	—	—	—	—	—	—	?	—	✓		Injuries only
Brandis,[16] 1999	✓	✓	✓	✓	—	—	—	—	—	—	—	—	—	—	—	Falls history and continence assessment added to standard admission documentation	No
Cumming et al,[55] 2008	—	—	—	—	✓	✓	✓	—	—	—	✓	✓	—	—	—		No
Fonda et al,[29] 2006	✓	✓	—	—	—	—	—	↓	✓	✓	—	✓	?	—	✓	Low beds, volunteer observers	Yes falls. Yes injuries
Grenier-Sennelier et al,[121] 2002	—	—	—	—	—	✓	—	✓	✓	—	—	—	✓	—	✓	Improved assessment of mobility and self-efficacy	No
Haines et al,[92] 2004	—	—	—	22%	—	✓	—	—	—	—	✓	—	—	—	—		Yes falls
Healey et al,[10] 2004	—	—	—	—	—	✓	✓	—	✓	✓	—	—	✓	✓	✓	Vision testing, lying and standing blood pressure	Yes falls

Koh et al,[122] 2009	—	✓	✓	—	✓	—	—	—	—	—	—	—	—	—	—	"Stand by me" notices to prompt staff to wait outside toilets ready to assist. Mobility level signs at bedside	No
Krauss et al,[123] 2008	—	✓	✓	—	✓	✓	—	—	—	—	—	✓	(✓)	—	—		No
Oliver et al,[124] 2002	—	—	—	—	—	—	—	—	—	—	—	—	?	—	—	Nursing and medical checklist for remediable risk factors, content not described and compliance poor	No
Schwendimann et al,[7] 2006	—	—	✓	✓	—	✓	↓	—	—	✓	✓	—	✓	—	✓		No
Stenvall et al,[53] 2007	—	—	—	—	✓	—	—	—	—	—	—	—	—	✓	✓	Additional therapy and nurse staffing Routine dietary protein supplementation Protocol driven delirium screening	Yes falls
Uden et al,[125] 1999	—	—	—	—	—	✓	↑	—	✓	—	—	✓	—	—	—	Carer education	No
Van der Helm et al,[56] 2006	(✓)	—	—	—	—	—	↑	↑	—	—	—	—	—	—	—		No
Vassallo et al,[113] 2004	—	✓	—	—	—	✓	✓	—	✓	—	—	—	✓	—	—	Medical review	Possibly (fallers)
von Renteln-Kruse and Krause,[126] 2007	—	—	✓	0.5%	✓	✓	—	—	✓	✓	—	—	—	—	—	Bedside commodes	Yes falls

Shading = significant reduction in falls and/or injuries; ✓ = component included within the intervention; (✓) = component planned but not implemented; ? = component implied but not explicit; ↓ = intervention discouraged use of this component; ↑ = intervention encouraged use of this component.

[a] (✓) indicates intervention in design but not applied in practice (eg, environmental hazards identified but not addressed). ? indicates that the article implies, but does not specify, that an intervention was included. For bedrails and body restraints, ↓ indicates the intervention was to discourage their use, ↑ indicates the intervention aimed to encourage their use, while ✓ indicates either direction not described or a neutral risk versus benefit review was required.

[b] Where interventions are described that would be considered very standard practice for control as well as intervention (eg, call bell left in reach, walking aids provided as appropriate), these are not listed.

[c] This potentially confounded the findings as this changed the method of collecting outcome data on falls at the same time as the intervention was introduced.

Table 3
Application of multifactorial falls prevention trials in hospitals, 1999 to 2009

References	Mean Age (Years)	Mean Length of Stay	Cost Estimate: Environment & Equipment[a]	Cost Estimate: Extra Staff WTE[b]	Individualized?	Use of Risk Score	Assessment Performed By	Intervention Performed By	Professionals Involved	Statistically Significant Reductions in Falls or Injuries? (see Table 1 for Details)
Barker et al,[120] 2009	<70	<week	Low	Nil	Yes	Local[c]	Ward staff	Ward staff	Nursing only	Possibly injuries
Barry et al,[57] 2001	>80	>month	Moderate	Nil	Yes	Local	Ward staff	Ward staff	Multiprofessional	Yes injuries
Brandis,[16] 1999	<70	Un	Low	Nil	No	No	Ward staff	Ward staff	Nursing only	No
Cumming et al,[55] 2008	<70–79	month	Low	1.4	Yes	No	Research staff	Ward staff	Nursing and Physiotherapy	No
Fonda et al,[29] 2006	>80	<month	Moderate	Nil	Yes	Local	Ward staff	Ward staff	Multiprofessional	Yes falls Yes injuries
Grenier-Sennelier et al,[121] 2002	70–79	>month	Low	Nil	Yes	Local	Ward staff	Ward staff	Nursing only	No
Haines et al,[92] 2004	>80	>month	Low	0.4	Yes	No	Ward staff	Research staff	Physiotherapy and Occupational Therapy	Yes falls
Healey et al,[10] 2004	>80	<month	Low	Nil	Yes	No	Ward staff	Ward staff	Multiprofessional	Yes falls

Koh et al,[122] 2009	Un	UN	Low	Nil	Yes	Local	Ward staff	Ward staff	Nursing only	No
Krauss et al,[123] 2008	<70	Un	Low	Nil	Yes	No	Ward staff	Ward staff	Nursing only	No
Oliver et al,[124] 2002	>80	Un	Low	Nil	Yes	STRATIFY	Ward staff	Ward staff	Multiprofessional	No
Schwendimann et al,[7] 2006	<70	<month	Moderate	Nil	Yes	Local	Ward staff	Ward staff	Multiprofessional	No
Stenvall et al,[53] 2007	>80	>month	Low	3.2	Yes	No	Research and ward staff	Research and ward staff	Multiprofessional	Yes falls
Uden et al,[125] 1999	70–79	>month	Low	Nil	Yes	No	Ward staff	Ward staff	Nursing only	No
Van der Helm et al,[56] 2006	>80	<month	Low	Nil	No	Local	Ward staff	Ward staff	Nursing only	No
Vassallo et al,[113] 2004	>80	<month	Low	Nil	Yes	Downton	Ward staff	Ward staff	Multiprofessional	Possibly fallers
von Renteln-Kruse and Krause,[126] 2007	>80	<month	Low	Nil	Yes	STRATIFY	Ward staff	Ward staff	Multiprofessional	Yes falls

Shading = significant reduction in falls and/or injuries.

[a] Low = some equipment costs (eg, hip protectors, slippers, alarms) for a limited proportion of patients or very minor environmental modifications, Moderate = more extensive environmental modifications and furniture purchase.

[b] The Whole Time Equivalents (WTEs) described are those staff that appeared to be used to apply the intervention rather than solely collect data for research purposes; extra workload for current staff not included.

[c] While based on STRATIFY, extensive changes were made.

included applying a multifactorial intervention to all of a vulnerable patient cohort[53] or using a history of falling as a trigger for intervention.[10] In addition, having multiprofessional involvement is likely to be essential; no hospital trials that focused solely on changing nursing practice succeeded in reducing falls or injuries, as is also the case in care home settings.[54] It also seems that an approach of visiting specialists performing assessments with most interventions left to ward staff to implement[55] did not prove to be effective. Support from management to improve the environment may also be a critical success factor; one unsuccessful study[56] identified failure of management to address environmental hazards in the ward environment as a major factor in demoralizing front-line staff, while some successful trials appeared to use environmental improvements to engage and motivate staff.[29,57]

A description of costs of the intervention programs is provided in **Table 3**, identifying the additional environmental and staffing costs specified in each trial. Contrasting these data against the success of the trial suggests that programs with low or moderate costs can be successful, and that high-cost programs are not guaranteed success, particularly where the extra resources have been used to predominantly carry out assessments rather than apply interventions.

Some of the components of multifactorial trials have also been explored in single-intervention studies (**Table 4**). Next, some single fall prevention interventions are listed, for which there is some empiric evidence to inform practice in the hospital setting.

Use or Removal of Bedrails

While bedrails are often grouped for discussion with vest, belt, and cuff devices or restraining chairs, under the umbrella term of "restraints," a separate discussion of their effect is important given the differences in design and use. An automatic definition of bilateral bedrails as "restraint" fails to consider the implications of using them on patients who are not independently mobile (eg, a patient who is quadriplegic). Defining restraint as "stopping them from doing something they appear to want to do"[58] allows a more balanced discussion of the ethical issues. However, day-to-day practice may not always be ethically based; there are legitimate concerns about the possible infringement of dignity or autonomy in bedrails being used indiscriminately.

Healey and colleagues[59] performed a systematic review to describe the effect of bedrails on fall and injury prevention and any adverse effects. The review included studies from care home settings but might reasonably be expected to be relevant to hospitals, because the mechanism of a fall from bed will be the same. The review identified 5 before-and-after studies of bedrail reduction, 3 case-control or cohort studies, and 16 articles describing direct injury from bedrails (although in these case reports, many of the injuries were associated with poorly designed or incorrectly fitted devices and there may also be large numbers of injurious falls from bed in persons without bedrails applied—as borne out by analysis of data from reported falls[4] and litigation cases[25]). Despite the weak methodological quality of many of the studies, they tend to suggest that evangelical missions to eliminate bedrails even for highly dependent patients can be as harmful as routine and unthinking bedrail use. Because comparison of bedrail use between hospitals[60] suggests great variation in individual practice, hospitals should focus on eliminating inappropriate bedrail use—bedrails should only be used for those for whom they have been individually prescribed and regularly reviewed—rather than aim to reduce overall bedrail use. While recent commentators[61] suggest that levels of bedrail use above 1 in 10 beds are unacceptable, this fails to recognize individual patient needs; 1 in 10 beds with bedrails could be far too high for a unit caring for mobile patients with dementia, and far too low for a unit caring for hoist-dependent patients with postural instability following stroke. The greatest tragedy of the reports of fatal bedrail entrapment is that almost all could have been avoided if freely available advice on safe dimensions of bed, bedrail, and mattress combinations had been heeded.[62,63]

Physical Restraint: Use or Removal (Cuff, Belt and Vest Devices)

The use of commercially designed cuff, belt, and vest devices intended to stop patients from leaving their bed or chair is not universal; there are countries (including the United Kingdom) where such devices are not an accepted part of health care practice[64] and where none are imported or marketed.[58] Irrespective of evidence for association with increased risk of falls in a hospital setting,[65] there are also wider issues about the ethics of restraint use in terms of restricting liberty or autonomy and also about other potential harms such as worsened delirium, pressure ulcers, or physical deconditioning/loss of function.[66] There have also been regulatory moves (eg, the Omnibus Reconciliation Act in the United States[67] or the 2005 Mental Capacity Act in the United Kingdom[68]) designed to limit the use of restraint devices. The relative dearth of evidence on the relationship between falls and restraint use in hospital settings is probably academic, given these wider harms and the ethical and legal context. The authors would suggest that the use of restraints should be kept to an absolute minimum, frequently reviewed, and never used as a substitute for adequate levels of individualized assessment or supervision.[69]

Movement Alarm Devices

Several companies market bed or chair monitor alarms designed to detect patient movement and alert staff with an audible buzzer or via a bleep, with the assumption that staff can then intervene to prevent falls. Most commercial devices are pressure sensitive, but there are other potential mechanisms such as infrared movement detectors. Until recently, only one small null RCT[70] was available, but further trials have recently been completed.

Shorr and colleagues,[50] described in an abstract a large (N = 16 general medical-surgical nursing units with 18 months total follow-up) cluster randomized trial in a United States community hospital using bed and chair alarms over 18 months. Despite an alarm use prevalence of 64.41/1000 OBDs on the intervention wards versus 1.79/1000 OBDs on the control wards, there were no significant differences in fall rates, relative risk of being a faller, or percentage of patients subjected to physical restraint. By contrast, Sahota[71] reported a 12-month uncontrolled before-and-after study in a United Kingdom teaching hospital (N = 209 before and 153 after) on patients recovering from hip fracture, using bed sensors linked to a central pager for all patients with no exclusions. There was a significant reduction in odds of being a faller (average odds ratio 0.55, 95% confidence interval [CI] 0.32–0.94), but no significant reduction in fall rate.

Low-Low Beds

The potential benefit of beds that lower closer to the floor than regular high-low beds on minimizing fall outcomes are twofold. First, if a patient were to fall from bed, the distance to the floor would be less and the potential for injury reduced. Second, the ability for confused and unsteady patients to stand from the bed unaided (thereby placing themselves at a high immediate risk of falls) is also reduced. This latter approach potentially indicates that use of low-low beds could be considered as a form of covert restraint. However, there is also a cultural overlay, as many older adults internationally may not usually sleep on an elevated bed. A matched, cluster

Table 4
Single and dual intervention studies, 1999 to 2009[a]

References	Study Design	Setting	Participants	Intervention	Participants' Mean Age (Years)	Mean Length of Stay (Days)	Results[b]	Comments
Barreca et al,[73] 2004	RCT	Stroke rehabilitation ward in Canada	48 medically stable stroke patients with modest impairment	Exercise (3 × 45 min additional group exercise weekly)	68	80	4 fallers in control group 3 fallers in intervention group *P* = .70 (2 tailed Mann-Whitney U-test)	
Barrett et al,[127] 2004	Uncontrolled before-and-after	Acute hospital in the UK	All patients admitted during a 1 year before and 4 year after study period	Yellow wristband and patient leaflet	—	—	B 2271 falls per year, 710 injurious falls, of which fractures 28 A 2157–2470 falls per year, 519–725 injurious falls of which 14–21 fractures Reduction in number of injurious falls said to be significant at *P*<.05	The reduction in injurious falls was based on comparing 710 injurious falls in the preintervention year (1998) with 605 injurious falls in 2000 (second year postintervention). Comparisons with other "after" years would not have yielded the same results eg, numbers of injurious falls in 1999 (first year postintervention) were higher than in 1998 (725 vs 710)
Boswell et al,[79] 2001	Uncontrolled before-and-after	An acute hospital in the USA	Unclear how many patients had sitters	Paid companions	—	—	Falls per sitter shift of 8 hours increased *"marginally"* by 0.0019 SNT	

Burleigh et al,[86] 2007	RCT	Acute geriatric unit in the UK	205 patients meeting criteria and consenting to randomization	Calcium 1.2 g and Vitamin D 800 iu in intervention (calcium alone in control)	83	30	C 45 fallers 3 fractures I 36 fallers 1 fracture Relative risk of being a faller 0.82 (95%CI 0.59–1.16) *P* = .263 All subgroup analysis also NS	
Donoghue et al,[77] 2005	Uncontrolled before-and-after	One elderly care ward in an Australian acute hospital	Admissions during an 18-month before and 18-month after period	Volunteer observers (12 h per weekday) in one bay in one ward	—	—	B 65 falls, 16.4 falls per 1000 OBDs (selected quarter) or 15.6 falls per 1000 OBDs (unspecified period) A 29 falls, 8.4 falls per 1000 OBDs (selected quarter) or 8.8 falls per 1000 OBDs (unspecified period) Odds ratio 0.56 (95%CI 0.45–0.68 44% reduction in rate said to be significant at *P*<.000 using *"Fisher's exact Chisquared test"* [sic] 51% reduction in selected quarter SNT. No falls occurred in observation bay while volunteers were present	Probably not actually odds ratio but a rate ratio for the unspecified period (8.8 falls per 1000 OBDs vs 15.6 falls per 1000 OBDs = rate ratio of 0.56). There does appear to be selection of "worst" before periods and "best" after periods as for 6 months before intervention and for a year after intervention the month-by-month rates actually appear very similar, fluctuating between 5 and 15 falls per 1000 OBDs. In addition the 2 months when falls were highest in the after period are discarded from analysis because they coincided with a holiday period when it was difficult to recruit volunteers

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Table 4
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References	Study Design	Setting	Participants	Intervention	Participants' Mean Age (Years)	Mean Length of Stay (Days)	Results[b]	Comments
Donald et al,[74] 2000	RCT	Elderly rehabilitation ward within a community hospital in England	54 successive admissions (all consented to randomization)	Vinyl or carpeted bedroom plus routine or additional physiotherapy	83	30	Vinyl + routine physiotherapy 0 falls Vinyl + additional physiotherapy 1 fall Carpet + routine physiotherapy 7 falls Carpet + additional physiotherapy 3 falls Relative risk of being a faller on carpet versus vinyl 8.3 (95% CI 0.95–73) *P* = .05 (?) No fractures in any group. Mean length of stay in vinyl group 22.7 days and in carpet group 36.1 days. More of the carpet group had been admitted because of a fall (6 vs 4) and Barthel scores were higher than vinyl group	

Giles et al,[78] 2006	Uncontrolled before-and-after	One medical wards and one dementia ward in an Australian acute hospital	"High-risk patients" allocated to observation bays	Volunteer observers (8 h each weekday) in one bay in each of two wards	—	—	B 70 falls 14.5 falls per 1000 OBDs A 82 falls 15.5 falls per 1000 OBDs Rate ratio 1.07 (95%CI 0.77-1.49) *"no falls occurred when the volunteers were present"*	
Haumschild et al,[104] 2003	Uncontrolled before-and-after	Rehabilitation hospital in the USA	Intervention applied to all admissions 1 year before, 1 year after but analysis based on 200 random sample from each year	Pharmacist-led medication review and adjustment	79	—	Ambiguously worded and either falls or fallers " the number of falls was reduced from 30 patients in the preintervention group to 16 postintervention" (p. 1031) $P = .05$	
Jarvis et al,[75] 2007	RCT	Rehabilitation ward in the UK	29 female patients excluding those with stroke or cognitive impairment	Ten physiotherapy sessions per week versus 3 sessions for controls	—	—	Relative risk of being a faller 0.46 (95% CI 0.15–1.44)	No abstract or full paper obtainable; data extracted from Cameron et al, 2010[54]
Kwok et al,[128] 2006	RCT	Two stroke rehabilitation wards in a convalescent hospital in Hong Kong	180 consecutively admitted *"patients perceived to be at risk of falls"* individually randomized to enter the control or intervention ward	Bed and chair movement alarms	76	21	55.6% (50/90) of the intervention group accepted bed/chair alarms Four falls in intervention group (3 while sensor in use) and 3 falls in control group. NTS	Note high concurrent use of restraints in both intervention and control at 79.4% (143/180)

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Table 4
(*continued*)

References	Study Design	Setting	Participants	Intervention	Participants' Mean Age (Years)	Mean Length of Stay (Days)	Results[b]	Comments
Mador et al,[85] 2004	RCT	Two acute academic hospitals in Australia	71 older patients with confusion and behavioral disturbance	Individualized advice from a nurse specialist on nonpharmacologic behavioral management	82	9	I 10 fallers C 4 fallers $P = .083$	
Peterson et al,[105] 2005	Interrupted time-series	An acute hospital in the USA	3718 patients aged over 65 years prescribed psychotropic medications over a 24-week period	Alerts in computerized prescribing system prompting lower dosing for older patients, avoidance of antipsychotics, and time-limited rather than "as required" prescriptions	75	4	B 60 falls, 13 injurious falls, 6.4 falls per 1000 OBDs A 24 falls, 5 injurious falls, 2.8 falls per 1000 OBDs Logistic regression indicated odds ratio of falls 0.50 (95% CI 0.30–0.82, $P = .001$) Reduction in injurious falls rate, $P = .09$	

Sahota et al,[71] 2009	Uncontrolled before-and-after study	An orthogeriatric rehabilitation ward in the UK	209 patients over 12 months before and 153 patients over 12 months after	Bed and chair alarms as standard for all patients	—	—	After adjustments for age, odds ratio of being a faller 0.55, (95% CI 0.32, 0.94) Falls per patient including multiple falls decreased from 0.38 to 0.33	Only brief results are given, as this was a research letter describing a pilot study. The study may have been confounded by much lower occupancy in the after period (209 vs 153 patients in respective years, but length of stay said to have not changed significantly)

[a] This table was constructed using all studies identified by any of the 3 systematic reviews described above (Cameron et al, 2010,[54] Coussement et al, 2008,[112] Oliver et al, 2007[1]) and an additional update search, where the publication date was between 1 January, 1999 and 31 December, 2009 and the location of the trial was a hospital that was not used as a long-term residence (defined as mean length of stay exceeding a year), and for before-and-after studies an "after" period of at least 9 months was described.
[b] I, Intervention (RCT/cohort); C, Control (RCT/cohort); B, Before; A, After; NS, not significant (no *P* value given); SNT, significance not tested.

RCT across 18 hospital wards in Australia with 6 months of intervention period data found that wards that did not previously have access to low-low beds that were provided with 1 low-low bed for every 12 on a ward did not experience a lower rate of falls per 1000 days, nor a lower rate of bed-falls, nor a lower rate of fall injury when compared with matched control wards.[72]

Exercise or Additional Physiotherapy

Only 3 small individually RCTs from hospitals[73–75] have investigated the effect of exercise in isolation. These exercise programs were very different in their content and delivery, and each trial was individually insufficiently powered to detect important levels of reductions in falls. Exercise has been employed as a key component in 2 multifactorial interventions. Haines and colleagues[76] published a subanalysis of participants referred for exercise in addition to usual care physiotherapy compared with comparable patients from the control group within a multifactorial RCT in a rehabilitation unit. Intervention group participants had approximately half the rate of falls of control group participants ($P = .003$). (A copy of the exercise program manual can be downloaded from http://www.mednwh.unimelb.edu.au/research/pdf_docs/Exercise%20manual%20for%20RCT.pdf.) Conversely, exercise was a component of another sizeable cluster RCT[55] of a multifactorial program that did not reduce falls outcomes, though the participants in this study had a much shorter length of stay and the content of the exercise component was not described. Thus it is possible that specific exercise programs to reduce falls may be effective for preventing falls in hospitals, but this is less likely on wards with shorter lengths of stay.

Increased Observation or Assistance

It makes intuitive sense that more proactive assistance or observation might reduce the risk of a fall. In terms of empiric evidence, 2 studies[77,78] evaluated the effectiveness of using volunteer observers to alert staff when "high-risk" patients attempted to stand or walk (observers were present during weekdays in one bay per ward). One of these studies[78] found a nonsignificant increase in falls overall, although no falls occurred while patients were being directly observed by volunteers. The results of the second study[77] appear promising, but the rate ratio of 0.56 (95% CI, 0.45–0.68) appears to be based on selection of "worst" quarter in the before period and "best" quarter in the after period. Boswell and colleagues,[79] in a study of paid observers in an acute hospital, noted a marginal increase in falls expressed as a rate per 8-hour shift. There may be potential in the approach of volunteer observers but further work is needed, and recruiting volunteers to work outside social hours may prove almost impossible.

Intermittent but regular observation through hourly "rounding" by staff—checking if patients are comfortable, offering use of the toilet, and ensuring they have everything they need within reach—may also have potential to reduce falls, but as yet only anecdotal reports or studies of poor quality have been published.

Patient Education

We know from observational studies on fall prevention interventions in community settings that older people prefer fall prevention messages to be packaged in a particular way,[80,81] emphasizing the positive benefits of interventions (enhancing independence and quality of life) rather than the negative (ie, risk of falls). We also know that providing information to hospital patients using video media rather than written material has preferential effects on patient knowledge, motivation, and confidence to perform fall prevention activities.[82] Subgroup analysis of an education program examined in an RCT of a multifactorial intervention has found that cognitively intact patients who were allocated to receive the education program experienced a 50% reduction in falls compared with comparable patients in the control group.[83] In terms of empiric evidence for patient education as a single intervention, there is one large RCT (N = 1206) being conducted in a mixture of acute and subacute hospital wards across 2 hospitals in Australia shortly to be reported on.[84] Preliminary results recently presented indicate that provision of multimedia patient education with trained health professional follow-up is likely to be beneficial for preventing falls among patients whose gross cognitive function is intact.[84] Preliminary results also indicate that providing the video and written education materials alone is ineffective, thus highlighting the importance of the intensive trained health professional follow-up.

Specialist Support to Manage Dementia

One small (N = 71) RCT[85] has been undertaken on whether specialist nurse advice and support could reduce falls in acute hospital patients with dementia; a range of diversional therapies was introduced but there was no significant effect on falls. This null finding should not detract from the clinical and ethical imperatives to meet the needs of patients with dementia who are acutely ill and at high risk of delirium.[36]

Calcium or Vitamin D to Prevent Falls and Injuries

Burleigh and colleagues[86] published the only RCT to date of vitamin D supplementation in hospital inpatients (vitamin D3 800 IU daily orally, and 1.2 g oral calcium versus calcium alone, with 225 randomized patients, and treatment until discharge) and found no overall effect on falls or fractures. The null result is intuitively unsurprising, as the effects of vitamin D would not become apparent in the short duration of most hospital admissions. Therefore, although appropriate patients should be commenced on calcium/vitamin D (and receive all other appropriate investigations and treatment for osteoporosis) while in hospital to prevent further injuries post discharge, this is unlikely to deliver benefit while they are inpatients.

Hip Protectors

Systematic review and meta-analysis of hip protector use in long-term care facilities[1,87] following adjustment for clustering has shown a modest pooled effect on rates of hip fracture, although the Cochrane review[87(p1)] suggests that "accumulating evidence casts some doubt on the effectiveness of hip protectors in reducing the incidence of hip fractures in older people." Data from nonhospital settings suggests that hip protectors have a larger effect size in patients whose hip protectors are positioned correctly at the time of their fall[88–90] and, crucially, actually covering the greater trochanter,[91] but the very groups at highest risk of fracture (eg, those with dementia, delirium, postural instability, continence or eyesight problems) are those that are the most poorly compliant. There are no RCTs of hip protectors in acute hospital settings, though they have been used as a part of a multifactorial intervention[92] where adherence to use emerged as a key issue threatening viability of this intervention in the hospital setting,[93] and the same number of fractures was seen in intervention and control groups, with one hip fracture occurring while a patient was wearing hip protectors. Hospital patients have also indicated that hip protectors are not a preferred treatment approach.[46] In the long run, current trials exploring flooring material to reduce the impact of falls may be more promising,[94–96] given some emerging observational evidence on flooring materials and their effect on rates of fall-related injuries.[97,98]

Medication Review and Adjustment

We know that drugs are implicated in the causation of many falls in hospitals[99–101] and that people in these settings are often on multiple coprescriptions of “culprit” drugs, often inappropriately.[102] We also know that systematic review and adjustment of medication in long-term care can reduce falls and prescribing costs.[103] However, few hospital studies have been identified on systematic medication review and adjustment as a single intervention.

Haumschild and colleagues[104] used a specialist pharmacist to provide targeted medication review and advice on adjustment in a small (N = 400) before-and-after hospital-based study. The investigators reported a significantly reduced prescribing rate of several types of “culprit” medication and a reduced fall rate ratio of 0.53 ($P<.05$). Peterson and colleagues,[105] in a large (N = 3718) time-interrupted series, described a computer-based system to advise doctors on contraindications and reduced doses in older patients at the point of prescription of neuroleptics and sedatives in a United States hospital. In addition to significant improvements in prescribing safety and quality and reductions in prescriptions, fall rates for patients in the intervention group were significantly lower (2.8 vs 6.4 falls per 1000 OBDs, $P<.001$).

Prevention and Management of Delirium

The components of successful programs for reducing the likelihood of delirium,[106] such as avoiding neuroleptics, sedatives, and hypnotics, full medication review, access to physical therapy and early mobilization, regular assistance to use the toilet, and avoidance of restraints, have much in common with the more successful multifactorial and single fall prevention interventions described, and therefore might be expected to reduce falls. However, delirium avoidance programs have only informally reported reductions in falls,[106,107] although one successful multifactorial fall prevention study discussed here[53] was also reported as achieving significant reductions in delirium.[108] Given the well-established general benefits of preventing and managing delirium,[36] it remains a clinical imperative even if the effect on fall prevention is not yet empirically proven.

SINGLE INTERVENTIONS WITHOUT EMPIRIC EVIDENCE

Despite the inclusion of the following single interventions as points of good practice (eg, Ref.[3]) and as components of some of the multifactorial interventions outlined here, and despite the evidence of some of these conditions as significant risk factors/causes of falls, and despite the likelihood that providing these interventions will improve other aspects of patient care, and despite their obvious intuitive value or in some cases their value in community settings, there is no direct empiric evidence (null or positive) for the following single interventions in preventing falls or fall-related injuries in hospital—predominantly because the studies have not been performed.

- Continence management or promotion
- Education and training for staff or relatives
- Correction of visual impairment (although it should be noted that very high levels of impairment of vision and hearing exist amongst the inpatient population[109,110])
- Recognition or management of dizziness, syncope, presyncope, or postural hypotension
- Attention to safer footwear
- Environmental modifications (including flooring material) to prevent falls or injuries.

SYSTEMATIC REVIEWS AND META-ANALYSES

There have been several recent systematic reviews focusing explicitly on the prevention of falls and fall injuries in hospitals (and long-term care facilities), which summarize and incorporate many of the trials set out above. Inevitably their conclusions depend on how restricted the inclusion criteria were, what the census dates for inclusion were, how the investigators decided to group and aggregate interventions and settings, and what statistical adjustments were made in meta-analysis.

Oliver and colleagues[1] did not restrict their search to RCTs but also included studies of nonrandomized design whereby the data allowed comparison of fall or fracture rate ratio or relative risk of falling. Adjustment was made for clustering. Thirteen studies of multifactorial interventions in hospital were included, with a pooled effect of an 18% reduction in fall rates (rate ratio 0.82, 95% CI 0.68–0.997), but with no significant effect on fractures or relative risk of an individual falling. This result might relate to the relative lack of power in terms of fallers rather than falls, or might suggest fall prevention interventions in hospitals tend to reduce subsequent rather than initial falls. Although the review identified a few small studies for single interventions in hospitals, there was no consistent evidence for any of these. The fact that meta-analysis included some studies that were not RCTs attracted comment.[111]

Coussement and colleagues[112] reported a systematic review of hospital fall prevention programs, which allowed for the inclusion of some prospective controlled-design studies. Only 8 studies met their inclusion criteria, including 4 studies of multifactorial interventions.[7,10,92,113] After adjustment for clustering, there was no significant pooled effect of multifactorial interventions on fall rate ratio or on relative risk of being a faller (rate ratio 0.82, 95% CI 0.70–1.03). Again there was no consistent evidence for any of the single intervention studies. The investigators also concluded that even the included studies were generally of suboptimal methodological quality.

Stern and Jayasekara[114] for the Joanna Briggs Institute included 5 RCTs and 2 subgroup analyses of RCTs, including 4 RCTs of multifactorial interventions.[10,53,55,92] Although the stated intention was to describe RCTs in acute hospitals, one of the RCTs and the 2 subgroup analyses were from subacute hospitals. The findings of their meta-analysis are only available to subscribers, but they concluded that there is some evidence to support the use of multifactorial interventions.

The updated Cochrane Review[54] was limited to RCTs. Eleven hospital-based studies were included. For multifactorial interventions, 4 RCTs[10,53,55,92] were pooled for meta-analysis, and a significant reduction in fall rate ratio was found (0.69, 95% CI 0.49–0.96) as well as in the relative risk of being a faller (0.73, 95% CI 0.56–0.96), although it was concluded that these interventions may only be effective for patients with longer lengths of stay. This conclusion appears to relate mainly to the null result of Cumming and colleagues,[55] which as discussed earlier could be explained by the lack of medical involvement and the use of visiting specialists, rather than solely by their patients' length of stay. For exercise the Cochrane Review pooled 3 small RCTs[73–75] and concluded that exercise may be effective in hospital (relative risk of being a faller 0.44, 95% CI 0.20–0.97) but a cautionary note was attached, given the small pooled size of the studies (N = 131) and poor quality of Donald and colleagues.[74] There was no clear evidence around any other single intervention.

To summarize, despite their differing inclusion criteria and the addition of more recently published studies in the latest reviews, these systematic reviews are surprisingly consistent in their findings, all suggesting that in acute hospitals no single interventions are fully supported by current evidence, and that multifactorial interventions may reduce falls by 18% to 31%. However, their differences in inclusion criteria, and the addition of further studies as they are published, appears to modify pooled 95% CIs for fall rate ratios in multifactorial studies marginally to either side of the borderline of statistical significance.

POTENTIAL HARM RESULTING FROM FOCUSING ON FALL PREVENTION IN HOSPITAL

Some reimbursement systems have recently changed their approach and do not fund the treatment of complications regarded as "preventable" (or even withhold payment

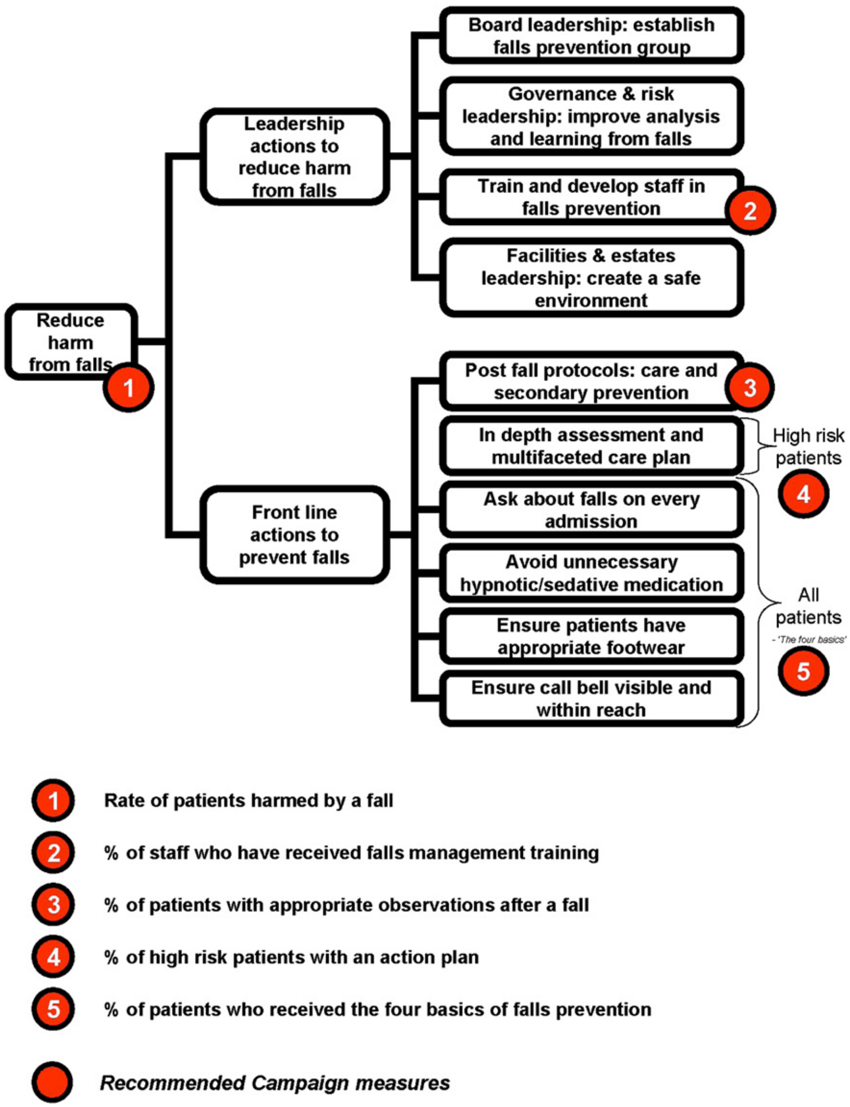

Fig. 1. Driver diagram from the English "How-to" guide for preventing harm from falls. (*From* Patient Safety First. The "How to" guide to reducing harm from falls. Available at: www.patientsafetyfirst.nhs.uk. Accessed January 10, 2010.)

for the whole treatment episode if a preventable complication occurs), and this "never event" approach has been applied to falls in hospitals.[106,115] This situation could motivate health care providers to innovate and invest in fall prevention strategies. Conversely, it could lead to a risk-averse, overly custodial approach to patient care, dominated by fear of complaint, litigation, or failure to reimburse. This approach could impact on rehabilitation, increase length of stay, or lead to loss of patient function or fitness, because we know that bed rest has several harmful effects in hospital

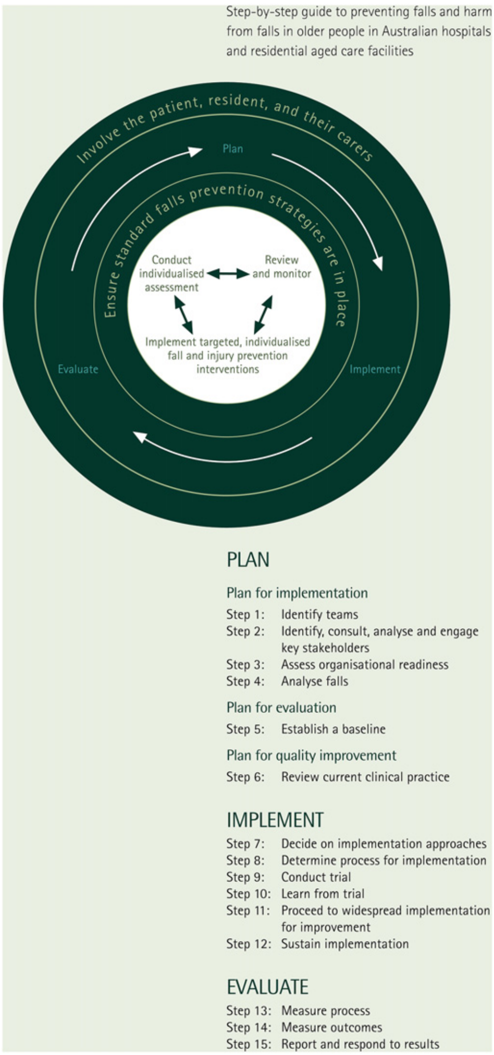

Fig. 2. Australian Commission on Safety and Quality in Health care overview diagram. (*From* Australian Commission on Safety and Quality in Health Care. Preventing falls and harm from falls in older people. Best practice guidelines for Australian hospitals and residential aged care facilities. Canberra: Australian Commission on Safety and Quality in Health care; 2009. Available at: http://www.health.gov.au/Internet/safety/publishing.nsf/content/FallsGuidelines. Accessed March 20, 2010. Copyright © Commonwealth of Australia 2009.)

inpatients.[23,116] A risk-averse approach could lead to the inappropriate use of restraint devices or bedrails,[23,59] or chemical restraint in the form of sedating medications (even though they tend to increase fall risk). There is also a risk that an excessive focus on fall prevention could lead to intrusive levels of observation that compromise dignity or make patients feel restricted. However, so little empiric evidence on adverse effects of fall prevention activities on other clinical areas has been incorporated into clinical trials that one has very little with which to substantiate or refute these concerns.

IMPLICATIONS FOR CLINICAL AND ORGANIZATIONAL PRACTICE

It should be pointed out that good practice in fall prevention is not simply about clinical practice, organizational policies, or the empiric evidence base. There are also ethical considerations (eg, the balance between respect for autonomy, personhood, and liberty versus a duty of care to maintain safety, and the balance between a duty of care to all patients vs “high-risk” ones); cultural considerations (eg, the attitudes toward risk of patients, public, caregivers, and different cultural groups); and legal

Box 2
Universal recommendations: the environment

While environmental modifications have formed part of the “black box” of several multifactorial fall prevention interventions (see **Table 2**), the advice given here is generally drawn from expert opinion and analysis of the hazards noted in reports of falls.[4] Areas that should be considered include:

Flooring: Nonslip surfaces; prompt cleaning of spills and urine, quick-dry and low-shine cleaning methods; avoiding flooring patterns that create the illusion of slopes or steps for people with visual impairment; visible highlighting of steps

Lighting: Adequate and even lighting, including stairs; avoiding glare; way-finding night lighting to the toilet; making sure night lighting is used consistently and safely

Observation: Improving lines of sight from staff to patients through dispersed nursing stations, observation windows, or mirrors

Threats to mobilizing: Promptly reducing clutter and other trip hazards in patients’ rooms and wards; installing handrails; prompt assessment for walking aids of the correct height and type and that are well maintained and kept within easy reach

Signposting: ensuring toilets are easy to find, with signage suitable for those with visual impairment, cognitive problems, or language barriers

Personal aids and possessions: spectacles or hearing aids kept clean, working and available; drinks, tissues or other personal possessions within easy reach; call bells in reach for patients able to use them; catheters, intravenous lines and oxygen tubing secure and not trailing

Furniture: chairs available in a range of heights; beds kept at the correct height for safe standing for mobile patients; beds kept at the lowest height for nonmobile patients (including low-low beds); furniture should be stable for handhold walking; brakes applied to beds and wheeled chairs

Footwear: unsafe footwear can further compound fall risk especially in those with gait, balance, lower limb and proprioceptive problems; the optimum characteristics of footwear to minimize fall risk has been summarized in a footwear checklist.[118] Note that the “nonslip” properties of some socks marketed as nonslip socks has been brought into question[119]

In addition, a failure to act on environmental hazards is not only a risk in itself, but is likely to demotivate staff and adversely affect any other efforts for fall prevention.

considerations (of necessity these are specific to each country but might include negligence law, human rights law, and rulings on mental capacity or restriction of liberty). The authors' following advice does not have the full force of a formal multi-stakeholder, interdisciplinary guideline group behind it (although these recommendations have much in common with guidance that does do so in various countries[3,5]). It should also be noted that hospital settings vary considerably in a range of key factors including patient case mix, staffing, and local procedures and practices. Therefore it is difficult, particularly given the evidence base to date, to make sweeping recommendations about use of interventions that will be beneficial to all hospitals.

However, the authors would argue that there are reasonable grounds to consider the following as elements of good practice at both organizational and clinical levels. Pronovost and colleagues[117] described the key factors in translating evidence into practice to improve safety and quality in hospitals—so-called large-scale knowledge transition—suggesting that even where there is good evidence on best practice to prevent morbidity and death, this is not implemented. Pronovost and colleagues pointed out that health professionals work in a health team in a larger hospital system and set out an explicit method for knowledge transition in a collaborative model. The

Box 3
Crucial organizational actions for fall prevention

a. Provision of appropriate levels of resources specifically earmarked for fall prevention, so that fall prevention is not lost amongst other competing clinical activities

b. Recognition that "zero falls" can only be achieved by unacceptable restrictions on patients' privacy, dignity and autonomy

c. Recognition that fall prevention needs multidisciplinary buy-in, including nursing, medical, pharmacy and therapy staff, and support staff responsible for housekeeping and building maintenance

d. Detailed and scrupulously completed incident reporting and investigation, providing clear information about the timing, circumstances and consequences of the fall, used to identify patterns and trends as part of institutional learning from "Board to ward" within a continuous quality improvement process. Good examples of learning from fall incidents or litigation can be found in several of the key references cited in this review[4,25,29]

e. Comparisons of fall rates between hospitals or units are highly susceptible to confounding by recording bias or case mix, and should never be used as a crude performance indicator[3,5,9]

f. Adoption of an ethical rather than technical definition of restraint in terms of "stopping them from doing something they appear to want to do"[58] or "the intentional restriction of a person's voluntary movement or behavior"[64]

g. Ensure all bedrails and bed/mattress combinations not compliant with current dimensional guidance[62,63] are identified and scrapped

h. While direct links between staffing levels and fall risks have not been identified,[8] organizations should recognize that any deficiencies in staffing levels and skill mix are likely to have an adverse effect on falls

i. If the organization requires the use of a fall risk prediction tool, the organization should test how well the tool predicts falls in its own inpatient population (for example, through using a freely available effectiveness tool to calculate this, www.patientsafetyfirst.nhs.uk)

j. Provide support to implement multifactorial fall prevention programs outlined in **Box 4** through staff education, appointed leaders, patient involvement, role models, and champions

Box 4
Clinical interventions to prevent falls and injury from falls

a. Common reversible risk factors for falls should be identified in all patients with interventions targeted to improve these (these include delirium, postural instability, visual impairment, culprit medication, postural hypotension and syncope, urinary incontinence and frequency, behavioral disturbance. and agitation)

b. When falls do occur, this should be used as a prompt not simply to fill out incident forms but to identify any change in status (particularly considering the possibility of deterioration in their original medical condition precipitating a fall), to identify new risk factors and to put a plan for secondary prevention of falls in place

c. Proactive medication review should take place for all patients and residents with a view to reducing inappropriate prescribing and prioritizing medication implicated in risk of falls

d. Although better recognition of dementia and delirium and improved staff skills in caring for confused patients has not been proven to reduce the likelihood of falls, it remains an ethical imperative given the associations between these conditions and increased morbidity and mortality

e. Interventions likely only to reap benefits after discharge from hospital should be initiated while the patient is in hospital care, including identification and treatment of osteoporosis, supplementation with calcium and vitamin D in patients likely to be deficient, and referral to fall prevention programs post discharge for those patients likely to remain at high risk of falling in their own home

f. For selected high-risk individuals who are at significant risk of fracture who will wear hip protector devices and are given sufficient reinforcement and support to wear them, hip protectors should be considered, but not relied on

g. The use of body restraints (vest, belt, or cuff devices, or restraining chairs) should be avoided wherever possible. Their use is generally a proxy for inadequate management of behavioral disturbance or medical comorbidity

h. Bedrails should not be used for patients who do not want them, who could be independently mobile without them, or who are confused enough and mobile enough to be a risk of climbing over them. Where bedrail use is appropriate, it should be frequently reviewed and individually tailored, with attention to the combined dimensions of bed, mattress, and bedrail, to avoid entrapment risk

i. Although several hospitals are already using bed and chair alarm devices, it should be borne in mind that there is no evidence that these devices have a beneficial effect on fall rates, nor have potential adverse effects (eg, impairment of confidence, restriction of movement, diversion of staff attention away from patients without alarms, and so forth) been considered

j. Although fall risk prediction tools are in widespread use, there is no clear evidence to recommend these. It is probably better to look at common reversible risk factors (by all means using a paper or electronic format to prompt this assessment) in all patients. If a tool is used it should be one that has been widely validated with tests of predictive validity in a population similar to the local patient population, its local limitations should be evaluated as discussed in **Box 3**, and it should be used as an aid to clinical judgment rather than a substitute for it

k. Exercise provided specifically to address balance and functional mobility may reduce falls risk though this may depend heavily on the anticipated length of stay of the patient in hospital. Broader consideration should also be given to the deleterious effects of prolonged bed rest and the wider benefits of exercise than mere fall prevention.

English Patient Safety First team has also followed this approach in its "How-to guide,"[5] building in advice on organizational enablers and hospital-wide strategy (**Fig. 1**). This guide has been echoed in implementation advice from the Australian Commission on Safety and Quality Guidelines (**Fig. 2**).[3] Therefore, to be most effective, fall prevention interventions should be targeted at both point of care and strategic levels.

It follows from the evidence and considerations set out herein that a best-practice approach for preventing falls in hospitals includes 4 key components:

1. Implementation of a safer environment of care for the whole patient cohort (**Box 2**)
2. Identification of specific modifiable fall risk factors
3. Implementation of interventions targeting those risk factors so as to prevent falls
4. Interventions to reduce the risk of injury to those people who do fall.

To deliver this whole-system approach, the crucial organizational factors are described in **Box 3**, with equally important clinical actions that need to be delivered at the front line of care described in **Box 4**.

SUMMARY

Individuals who fall tend to have multiple interacting risk factors, and so we should not be surprised that fall prevention is a complex rather than a straightforward challenge. Previous fall prevention programs in the hospital setting have usually only been successful in reducing falls when multiple interventions were included; implementation of one part does not seem enough to improve outcomes. To be most effective, action needs to be taken both by leaders and by front-line staff, to be championed by all members of the interdisciplinary team including support workers, and tailored to the wishes and needs of individual patients.

REFERENCES

1. Oliver D, Connelly J, Victor C, et al. Strategies to prevent falls and fractures in hospitals and care homes and effect of cognitive impairment. Systematic review and meta-analyses. BMJ 2007;334:82–7.
2. Hubbard R. The ageing of the population; implications for multidisciplinary care in hospital. Age Ageing 2004;33:479–82.
3. Australian Commission on Safety and Quality in Healthcare. Preventing falls and harm from falls in older people. Best practice guidelines for Australian hospitals and residential aged care facilities. Canberra (Australia): Australian Commission on Safety and Quality in Healthcare; 2009. Available at: http://www.health.gov.au/Internet/safety/publishing.nsf/content/FallsGuidelines. Accessed March 20, 2010.
4. National Patient Safety Agency. Slips trips and falls in hospital. London: NPSA; 2007.
5. Patient Safety First. The "How to" guide to reducing harm from falls. Available at:www.patientsafetyfirst.nhs.uk. Accessed January 10, 2010.
6. Tan KM, Austin B, Shaughnassy M, et al. Falls in an acute hospital and their relationship to restraint use. Ir J Med Sci 2005;174(3):28–31.
7. Schwendimann R, Buhler H, De Geest S, et al. Falls and consequent injuries in hospitalised patients; effects of an interdisciplinary falls prevention programme. BMC Health Serv Res 2006;6:69.

8. Dunton N, Gajewski B, Taunton RL, et al. Nurse staffing and patient falls on acute care hospital units. Nurs Outlook 2004;52:53–9.
9. Healey F, Scobie S, Oliver D, et al. Falls in English and Welsh Hospitals: a national observational study based on retrospective analysis of 12 months of patient safety incident reports. Qual Saf Health Care 2008;17(6):424–30.
10. Healey F, Monro A, Cockram A, et al. Using targeted risk factor reduction to prevent falls in older hospital inpatients. Age Ageing 2004;33:390–5.
11. Nyberg L, Gustafson Y, Janson A, et al. Incidence of falls in three different types of geriatric care. A Swedish prospective study. Scand J Soc Med 1997;25:8–13.
12. Weintraub D, Spurlock M. Change in the rate of restraint use and falls on a psychogeriatric inpatient unit: impact of the health care financing administration's new restraint and seclusion standards for hospitals. J Geriatr Psychiatry Neurol 2002;15(2):91–4.
13. National Patient Safety Agency. Slips trips and falls data update. NPSA: London; 2010. Available at: http://www.nrls.npsa.nhs.uk/resources/patient-safety-topics/patient-accidents-falls/?entryid45=74567. Accessed August 1, 2010.
14. Sari AB, Sheldon TA, Cracknell A, et al. Sensitivity of routine system for reporting patient safety incidents in an NHS hospital. BMJ 2007;334:79.
15. Haines T, Massey B, Fleming J, et al. Inconsistency in classification and reporting of in-hospital falls. J Am Geriatr Soc 2009;57(3):517–23.
16. Brandis S. A collaborative occupational therapy and nursing approach to falls prevention in hospital inpatients. J Qual Clin Pract 1999;19(4):215–20.
17. Halfon P, Eggli Y, Van Melle G, et al. Risk of falls for hospitalized patients: a predictive model based on routinely available data. J Clin Epidemiol 2001; 54:1258–66.
18. Hitcho E, Krauss M, Birge S, et al. Characteristics and circumstances of falls in a hospital setting. J Gen Intern Med 2004;19:732–9.
19. Nadkarni JB, Iyengar KP, Dussa C, et al. Orthopaedic injuries following falls by hospital in-patients. Gerontology 2005;51(5):329–33.
20. Bates D, Pruess K, Souney P, et al. Serious falls in hospitalized patients: correlates and resource utilization. Am J Med 1995;99:137–43.
21. Hill KD, Vu M, Walsh W. Falls in the acute hospital setting—impact on resource utilisation. Aust Health Rev 2007;31(3):471–7.
22. Murray GR, Cameron ID, Cumming RG. The consequences of falls in acute and subacute hospitals in Australia that result in proximal femoral fracture. J Am Geriatr Soc 2007;55(4):577–82.
23. Mahoney JE. Immobility and falls. Clin Geriatr Med 1998;14:699–726.
24. Murphy J, Isaacs B. The post fall syndrome. A study of 36 elderly inpatients. Gerontology 1982;28:265–70.
25. Oliver D, Killick S, Even T, et al. Do falls and falls-injuries in hospital indicate negligent care – and how big is the risk? A retrospective analysis of the NHS Litigation Authority Database of clinical negligence claims, resulting from falls in hospitals in England 1995 to 2006. Qual Saf Health Care 2008;17(6):431–6.
26. Oliver D. Preventing falls and falls injuries in hospital. A major risk management challenge. Clin Risk 2007;13(5):173–81.
27. Morse JM. Preventing patient falls. 2nd edition. Thousand Oaks (CA): Sage Publications; 2000.
28. O'Byrne-Maguire. Epidemiological study of falls in Ireland based on incident and claims data created on STARSWeb from 2004–2008. Abstract presented at the 10th International Conference of Falls and postural stability. Blackpool, July 9, 2009.

29. Fonda D, Cook J, Sandler V, et al. Sustained reduction in serious fall-related injuries in older people in hospital. Med J Aust 2006;184(8):379–82.
30. Hill A-M, Hoffmann T, Hill K, et al. Measuring falls events in acute hospitals—a comparison of three reporting methods to identify missing data in the hospital reporting systems. J Am Geriatr Soc 2010;58(7):1347–52.
31. Gillespie L, Robertson C, Gillespie W, et al. Interventions for preventing falls for older people living in the community. Cochrane Databse Syst Rev 2009;2:CD007146.
32. Oliver D, Daly F, Martin FC. Risk factors and risk assessment tools for falls in hospital inpatients. A systematic review. Age Ageing 2004;33:122–30.
33. Scott V, Votova K, Scanlan A, et al. Multifactorial and functional mobility assessment tools for falls risk among older adults in the community, home-support, long-term care and acute settings. Age Ageing 2007;36(2):130–40.
34. National Ageing and Research Institute. An analysis of research on preventing falls and falls injury in older people: community, residential care and hospital settings (2004 update). Report to the Australian Government, Department of Health and Ageing, Injury Prevention Section. Canberra (Australia): Australian Government Department of Health and Ageing; 2004.
35. Shaw FE. Falls in cognitive impairment and dementia. Clin Geriatr Med 2002;18(2):159–73.
36. British Geriatrics Society. Guidelines for the prevention, investigation and management of older people in hospital with delirium. London: BGS; 2006. Available at: http://alzheimers.org.uk/countingthecost. Accessed January 22, 2010.
37. Sammet K. Autonomy of protection from harm. Judgement of German Courts on care for the elderly in nursing homes. J Med Ethics 2007;33:534–7.
38. Myers H. Hospital falls risk assessment tools: a critique of the literature. Int J Nurs Pract 2003;9:233–5.
39. Perell K, Nelson A, Goldman L, et al. Fall risk assessment measures; an analytic review. J Gerontol 2001;46:M671–6.
40. Haines TP, Hill K, Walshe W, et al. Design-related bias in hospital falls risk screening tool predictive accuracy evaluations: systematic review and meta-analysis. J Gerontol A Biol Sci Med Sci 2007;62(6):664–72.
41. Oliver D, Healey F. Falls risk assessment tools for hospital inpatients. Do they work? Nursing Times Feb 2009. Available at: http://www.nursingtimes.net/nursing-practice-clinical-research/falls-risk-prediction-tools-for-hospital-inpatients-do-they-work/1999146.article. Accessed December 4, 2009.
42. Oliver D, Papaioannou A, Giangregorio L, et al. A systematic review and meta-analysis of studies using the STRATIFY tool for prediction of falls in hospital patients: how well does it work? Age Ageing 2008;37(6):621–7.
43. Oliver D, Britton M, Seed P, et al. Development and evaluation of an evidence-based risk assessment tool (STRATIFY) to predict which elderly patients will fall: case control and cohort studies. Br Med J 1997;315:1049–51.
44. Vassallo M, Stockdale R, Sharma J, et al. A comparative study of the use of four falls risk assessment tools on acute medical wards. J Am Geriatr Soc 2005;53:1034–8.
45. Schwendimann R, De Geest S, Milisen K. Evaluation of the Morse Falls Scale in hospitalised patients. Age Ageing 2006;35(3):311–3.
46. Haines T, McPhail S. Patient preference for falls prevention in hospitals revealed through willingness-to-pay, contingent valuation survey. J Eval Clin Pract, submitted for publication.

47. Medical Research Council (UK). Medical Research Council Developing and evaluating complex interventions: new guidance MRC 2008. Accessed at: http://www.mrc.ac.uk/Utilities/Documentrecord/index.htm?d=MRC003372. Accessed May 10, 2009.
48. Guyatt GH, Oxman AD, Vist GE, et al. GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. BMJ 2008;336:924–6.
49. Lamb SE, Jorstad-Stein EC, Hauer K, et al. Prevention of falls network Europe (PROFANE) outcomes consensus group. Development of a common outcome dataset for fall injury prevention trials. J Am Geriatr Soc 2005;53: 1618–22.
50. Shorr R, Mion L, Rosenblatt L, et al. Ascertainment of patient falls in hospital using an evaluation service: comparison with incident reports. J Am Geriatr Soc 2007;55(Supp 4):S1–246.
51. Olgilvie D, Egan M, Hamilton V, et al. Systematic reviews of health effects of social interventions: 2. Best available evidence: how low should you go? J Epidemiol Community Health 2005;59:886–92.
52. American Geriatrics Society, British Geriatrics Society, American Association of Orthopaedic Surgeons Panel on falls Prevention. Guideline for the prevention of falls in older persons. J Am Geriatr Soc 2001;49:664–72.
53. Stenvall M, Oloffson B, Lundstrom M. A multidisciplinary, multifactorial intervention programme reduces falls and injuries after femoral neck fracture. Osteoporos Int 2007;18:167–75.
54. Cameron I, Murray GR, Gillespie LD, et al. Interventions for preventing falls in older people in residential care facilities and hospitals. Cochrane library 2010. Available at: http://mrw.interscience.wiley.com/cochrane/clsysrev/articles/CD005465/frame.html. Accessed March 21, 2010.
55. Cumming RG, Sherrington C, Lord SR, et al. Cluster randomised trial of a targeted multifactorial intervention to prevent falls among older people in hospital. BMJ 2008;336(7647):758–60.
56. van der Helm J, Goossens A, Bossuyt P. When implementation fails: the case of a nursing guideline for fall prevention. Jt Comm J Qual Patient Saf 2006;32(3): 152–60.
57. Barry E, Laffoy M, Matthews E, et al. Preventing accidental falls among older people in long stay units. Ir Med J 2001;94(6):172–5.
58. National Patient Safety Agency. Resources for reviewing and developing a bedrail policy. London: National Patient Safety Agency; 2007.
59. Healey F, Oliver D, Milne A, et al. The effect of bedrails on falls and injury: a systematic review of clinical studies. Age Ageing 2008;37:368–78.
60. Healey F, Cronberg A, Oliver D. Bedrail use in English and Welsh hospitals. J Am Geriatr Soc 2009;557:1887–91.
61. Miles SH. The new old age: safe in bed? New York Times March 10 2010. Available at: http://newoldage.blogs.nytimes.com/2010/03/10/safe-in-bed/. Accessed May 10, 2010.
62. Food and Drug Administration USA. Hospital bed system dimensional and assessment guidance to reduce entrapment from bedrails. Washington, DC: FDA; 2004. Available at: http://www/fda.gov/cdrh/beds/guidance. Accessed May 10, 2009.
63. Medicines and Healthcare Products Regulatory Agency. Safe use of bedrails. London: MHRA; 2006. Available at: www.mhra.gov.uk. Accessed May 10, 2009.
64. Royal College of Nursing. Let's talk about restraint: rights, risks and responsibility. London: RCN; 2007.

65. Evans D, Wood J, Lambert L. A review of physical restraint minimisation in the acute care setting. J Adv Nurs 2002;40:616–25.
66. Evans D, Wood J, Lambert L. Patient injury and physical restraint devices: a systematic review. J Adv Nurs 2003;41(3):274–82.
67. Omnibus Budget Reconciliation Act 1987 USA government.
68. Mental Capacity Act 2005 Her Majesty's Government (UK) 2005. Available at: http://www.dh.gov.uk/en/Publicationsandstatistics/Bulletins/theweek/Chiefexecutivebulletin/DH_4108436. Accessed May 10, 2010.
69. Dibartolo V. Nine steps to effective restraint use. Regist Nurse 1998;61:23–4.
70. Tideiksaar R, Feiner CF, Maby J. Falls prevention: the efficacy of a non intrusive falls monitor in an acute care setting. Mt Sinai Med J 1993;60(6):522–7.
71. Sahota O. Vitamin D and inpatient falls. Age Ageing 2009;38(3):339–40.
72. Haines T, Bell R, Varghese P. Pragmatic, cluster randomised trial of a policy to introduce low-low beds to hospital wards for the prevention of falls and fall-injuries. J Am Geriatr Soc 2010;58(3):435–41.
73. Barreca S, Sigouin CS, Lambert C, et al. Effects of extra training on the ability of stroke survivors to perform an independent sit-to-stand: a randomized controlled trial. J Geriatr Phys Ther 2004;27:59–64.
74. Donald IP, Pitt K, Armstrong E, et al. Preventing falls on an elderly care rehabilitation ward. Clin Rehabil 2000;14:178–85.
75. Jarvis N, Kerr K, Mockett S. Pilot study to explore the feasibility of a randomised controlled trial to determine the dose effect of physiotherapy on patients admitted to hospital following a fall. Practical Evidence-based Physiotherapy 2007;2(2):4–12.
76. Haines T, Hill K, Bennell K, et al. Additional exercise for older subacute hospital inpatients to prevent falls: benefits and barriers to implementation and evaluation. Clin Rehabil 2007;21(8):742–53.
77. Donoghue J, Graham J, Mitten-Lewis S, et al. A volunteer companion-observer intervention reduces falls on an acute aged care ward. Int J Health Care Qual Assur Inc Leadersh Health Serv 2005;18(1):24–31.
78. Giles LC, Bolch D, Rouvray R, et al. Can volunteer companions prevent falls among inpatients? A feasibility study using a pre-post comparative design. BMC Geriatr 2006;6:11.
79. Boswell D, Ramsey J, Smith M, et al. The cost-effectiveness of a patient-sitter program in an acute care hospital: a test of the impact of sitters on the incidence of falls and patient satisfaction. Qual Manag Health Care 2001;10:10–6.
80. Help the Aged. Falls prevention; don't mention the F word. Advice to practitioners on communicating fall prevention messages to older people. London: Help the Aged; 2008.
81. Yardley L, Donovan-Hall M, Francis K, et al. Older people's views of advice about falls prevention: a qualitative study. Health Educ Res 2006;21(4):508.
82. Hill A, McPhail S, Hoffman T, et al. A randomized trial of DVD versus written delivery of patient education materials for the provision of falls prevention education. J Am Geriatr Soc 2009;57(8):1458–63.
83. Haines T, Hill K, Bennell K, et al. Patient education to prevent falls in subacute care. Clin Rehabil 2006;20:970–9.
84. Haines T, Hill A, Hill K, et al. Patient education to prevent falls amongst older hospital inpatients: a randomized controlled trial. Arch Intern Med, submitted for publication.

85. Mador JE, Giles L, Whitehead C, et al. A randomized controlled trial of a behavior advisory service for hospitalized older patients with confusion. Int J Geriatr Psychiatry 2004;19(9):858–63.
86. Burleigh E, McColl J, Potter J. Does vitamin D stop inpatients falling? A randomised controlled trial. Age Ageing 2007;36(5):507–13.
87. Parker MJ, Gillespie W, Gillespie LJ. Effectiveness of hip protectors for preventing hip fractures in elderly people: systematic review Cochrane Database of systematic reviews 2005. Available at: www.cochrane.org/reviews/en/ab001255.html. Accessed March 21, 2010.
88. van Schoor NM, Deville WL, Bouter LM, et al. Acceptance and compliance with external hip protectors: a systematic review of the literature. Osteoporos Int 2002;13(12):917–24.
89. Campbell AJ. Purity, pragmatism and hip protector pads [editorial]. Age Ageing 2001;30:431–2.
90. Cryer C, Knox A, Martin D, et al. Hip protector compliance among older people living in residential care homes. Inj Prev 2002;8:202–6.
91. Minns RJ, Marsh AM, Chuck A, et al. Are hip protectors correctly positioned in use? Age Ageing 2007;36:140–4.
92. Haines T, Bennell K, Osborne R, et al. Effectiveness of targeted falls prevention programme in subacute hospital setting: randomised controlled trial. BMJ 2004; 328:676–9.
93. Haines T, Hill K, Bennell K, et al. Hip protector use amongst older hospital inpatients: compliance and functional consequences. Age Ageing 2006;35(5):520–3.
94. Drahota A, Gal D, Windsor J. Flooring as an intervention to reduce injuries from falls in healthcare settings: an overview. Quality in Ageing and Older Adults 2007;8(1):3–9.
95. Robertson MC, Milburn PD, Carman AB, et al. Safety flooring: energy absorption, postural stability, and gait patterns. Paper presented at 3rd Australian and New Zealand Falls Prevention Society Conference Melbourne, Australia 12–14 October 2008.
96. University of Portsmouth Hip-hop flooring study. Available at: http://www.port.ac.uk/research/hiphop/aboutthestudy/. Accessed May 21, 2010.
97. Simpson A, Lamb S, Roberts P. Does the type of flooring affect the risk of hip fracture? Age Ageing 2004;33:242–6.
98. Brown P, Njogu F, Kerse N, et al. Cost effectiveness of impact absorbent flooring and hip protectors among institutionalized elderly. Paper from the School of Population Health, University of Auckland, October 2008.
99. Lord SR, Sherrington C, Menz HB. Falls in older people: risk factors and strategies for prevention. 2nd edition. Cambridge (UK): Cambridge University Press; 2007.
100. Hartikainen S, Lonnroos E, Lohivouri K. Medication as a risk factor for falls: critical systematic review. J Gerontol A Biol Sci Med Sci 2007;62(10):1172–81.
101. Wootton R, Bryson E, Elsasser U, et al. Risk factors for fractured neck of femur in the elderly. Age Ageing 1982;11(3):160.
102. Milton J, Jackson S. Inappropriate polypharmacy. Reducing the burden of inappropriate medication. Clin Med 2007;7:514–7.
103. Zermansky A, Alldred D, Petty D, et al. Clinical medication review by a pharmacist of elderly people living in care homes: randomised controlled trial. Age Ageing 2006;35:586–91.
104. Haumschild M, Karfonta TL, Haumschild MS, et al. Clinical and economic outcomes of a fall-focussed pharmaceutical intervention programme. Am J Health Syst Pharm 2003;60:1029–32.

105. Peterson J, Kuperman G, Shek C, et al. Guided prescription of psychotropic medications for geriatric inpatients. Arch Intern Med 2005;165:802–7.
106. Inouye SK, Brown CJ, Tinetti ME. Medicare nonpayment, hospital falls, and unintended consequences. N Engl J Med 2009;360:2390–3.
107. Bradley EH, Webster TR, Schlesinger M, et al. Patterns of diffusion of evidence-based clinical programmes: a case study of the Hospital Elder Life Program. Qual Saf Health Care 2006;15:334–8.
108. Lundstrom M, Olofsson B, Stenvall M, et al. Postoperative delirium in old patients with femoral neck fracture: a randomized intervention study. Aging Clin Exp Res 2007;19(3):178.
109. Jack CI, Smith T, Neoh C, et al. Prevalence of low vision in elderly patients admitted to an acute geriatric unit in Liverpool: elderly people who fall are more likely to have low vision. Gerontology 1995;41(5):280–5.
110. Grue EV, Kirkevold M, Ranhoff AH. Prevalence of vision, hearing, and combined vision and hearing impairments in patients with hip fractures. J Clin Nurs 2009; 18(21):3037–49.
111. Cameron ID, Kurrle S. Preventing falls in elderly people living in hospitals and care homes. BMJ 2007;334:53–4.
112. Coussement J, De Paepe L, Schwendimann R, et al. Interventions for preventing falls in acute and chronic care settings. J Am Geriatr Soc 2007;56(1):29–36.
113. Vassallo M, Vignaraja R, Sharma JC, et al. The effect of changing practice on fall prevention in a rehabilitative hospital: the hospital injury prevention study. J Am Geriatr Soc 2004;52:335–9.
114. Stern C, Jayasekara R. Interventions to reduce the incidence of falls in older adult patients in acute-care hospitals: a systematic review. International Journal of Evidence-based Healthcare 2009;7(4):243–9.
115. Rosenthal M. Non-payment for performance? Medicare's new reimbursement rule. N Engl J Med 2007;357:1573.
116. Nigam Y, Knight J, Jones A. Effects of bedrest 3: musculoskeletal and immune systems, skin and self-perception. Nurs Times 2009;105(23):18–22.
117. Pronovost P, Berenholtz S, Needham D. Translating evidence into practice: a model for large scale knowledge translation. BMJ 2008;337:a1714.
118. Menz H, Sherrington C. The footwear assessment form: a reliable clinical tool to assess footwear characteristics of relevance to postural stability in older adults. Clin Rehabil 2000;14(6):657.
119. Chari S, Haines T, Economedis A, et al. Are non-slip socks really 'non-slip'? An analysis of slip resistance. BMC Geriatr 2009;9:39.
120. Barker A, Kamar J, Morton A, et al. Bridging the gap between research and practice: review of a targeted hospital inpatient fall prevention programme. Qual Saf Health Care 2009;18(6):467–72.
121. Grenier-Sennelier C, Lombard I, Jeny-Loeper C, et al. Designing adverse event prevention programs using quality management methods: the case of falls in hospital. Int J Qual Health Care 2002;14(5):419.
122. Koh S, Hafiza N, Lee J, et al. Impact of fall prevention programme in acute hospital settings in Singapore. Singapore Med J 2009;50(4):425–30.
123. Krauss MJ, Tutlam N, Costantinou E, et al. Intervention to prevent falls on the medical service in a teaching hospital. Infect Control Hosp Epidemiol 2008; 29:539–45.
124. Oliver D, Martin F, Seed P. Preventing patient falls. Age Ageing 2002;31(1):75–6.
125. Uden G, Ehnfors M, Sjostrom K. Use of initial risk assessment and recording as the main nursing intervention in identifying risk of falls. J Adv Nurs 1999;29(1):145–52.

126. von Renteln-Kruse W, Krause T. Incidence of in-hospital falls in geriatric patients before and after the introduction of an interdisciplinary team-based fall-prevention intervention. J Am Geriatr Soc 2007;55:2068–74.
127. Barrett JA, Bradshaw M, Hutchinson K, et al. Reduction of falls-related injuries using a hospital inpatient falls prevention program. J Am Geriatr Soc 2004;52(11):1969.
128. Kwok T, Mok F, Chien WT, et al. Does access to bed-chair pressure sensors reduce physical restraint use in the rehabilitative care setting? J Clin Nurs 2006;15(5):581–7.
129. Downs SH, Black N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. J Epidemiol Community Health 1998;52(6):377–84.
130. von Renteln-Kruse W, Krause T. [Fall events in geriatric hospital in-patients. Results of prospective recording over a 3 year period]. Z Gerontol Geriatr 2004;37(1):9–14 [in German].