Minimising the Risk of Falls & Fall-related Injuries

Guidelines for Acute, Sub-acute and Residential Care Settings

Research Supplement

Victoria
The Place To Be

THE VICTORIAN QUALITY COUNCIL
Safety and Quality in Health

Published by the Metropolitan Health and Aged Care Services Division
Victorian Government Department of Human Services
Melbourne Victoria
July 2004

Design by Watts Design. 3290

Disclaimer

This document should not be considered prescriptive. Health care staff should work with patient/residents and their families/carers to ensure that the most appropriate care and treatment is provided to the individual. Some flexibility will be required to adapt these Guidelines to specific settings, local circumstances and to individual patient/resident needs.

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Introduction

This Research Supplement is one of the resources developed as part of a project funded by the Victorian Quality Council (VQC), and undertaken by the National Ageing Research Institute (NARI) and Word Design Interactive (WDI): “Development of Guidelines and Implementation Tools for falls prevention in acute, sub-acute and residential care settings”.

Other components of the project resources are:

- “Minimising the risk of falls and fall-related injuries: Guidelines for acute, sub-acute and residential care settings” (incorporating a process model and guideline statements)
- Implementation Supplement (The VQC is developing a generic change and implementation best practice model due to be released before the end of 2004)
- Tools Supplement
- Education Supplement
- Ward Kit (incorporating a Quick Reference Guide and Posters)

Structure of the Research Supplement

The Research Supplement reviews current research evidence in support of falls and fall-related injury risk minimisation activities in hospital and residential care settings. This document has been structured to complement the format of the “Minimising the risk of falls and fall-related injuries: Guidelines for acute, sub-acute and residential care settings” document, and should be read in conjunction with the Guidelines document.

Method of literature retrieval and review

The primary source of research papers investigating the effectiveness of falls prevention programs was through electronic searching of the published, peer reviewed literature. Searches were conducted using the PubMed and Ovid search engines, primarily targeting research papers published since 2000, the date of a prior research review conducted by NARI [1]. Search terms included combinations of:

- fall/injury/fracture
- setting type, eg hospital, aged care, residential aged care
- falls risk factors, for example, polypharmacy, environment, activity, dizziness, vision, and cognition
- falls prevention program types, for example education and exercise (balance, strength); and
- effectiveness/evidence.

Studies were also located by searching the reference lists at the end of relevant journal and review articles, as well as searching existing files held by the project team.

All identified intervention studies were reviewed independently by two reviewers, using a standardised template, and the level of evidence for each study was rated independently by the two raters (see Table 1). If there was disagreement on the level of evidence for a specific paper, a third rater reviewed the paper to determine the final grading. Summary tables describing each of the randomised trials identified as part of the research review are included at the end of this Research Supplement.

Levels of evidence of effectiveness

"Best practice" is based on the best (highest grade) evidence available. Levels of evidence of effectiveness describe the strength of the research evidence supporting each recommended strategy to reduce the risk of falls or fall-related injury.

The levels of evidence used to inform the Guidelines were based on the National Health and Medical Research Council (NHMRC) rating scale [2]. From strongest to weakest, the levels of evidence used are described in Table 1:

Table 1. Levels of evidence

Level of evidence	Description
I	Evidence obtained from a systematic review of all relevant randomised controlled trials
II	Evidence obtained from at least one properly designed randomised controlled trial
III - 1	Evidence obtained from well designed pseudo-randomised controlled trials (alternate allocation or some other method)
III - 2	Evidence obtained from comparative studies with concurrent controls and allocation not randomised (cohort studies), case control studies, or interrupted time-series with a control group
III - 3	Evidence obtained from comparative studies with historical control, two or more single-arm studies, or interrupted time series without a parallel control group
IV	Evidence obtained from case series, either post-test or pre-test and post-test

Where there is no formal research evidence, guidelines have been informed by expert opinion and the findings of an expert working party. For the purposes of this project, this level of evidence has been termed Consensus Opinion.

Definitions

The following terms and definitions have been used throughout the Research Supplement:

Behavioural risk factors
Behavioural risk factors relate to the type of activities undertaken and how they are performed. Generally, the more complex and physically demanding the activity, the greater the inherent risk.

Environmental (extrinsic) falls risk factors
Environmental (extrinsic) falls risk factors include hazards in the environment which increase the risk of falling, such as uneven or slippery surfaces, poor lighting, inappropriate placement of frequently used items (eg too high or low), and poorly stored items in walkway areas [3]. Environmental falls risk factors have been sub-divided into individual environment and general environment (see definitions).

Evidence-based practice
Evidence-based practice is the application of the best available research evidence to clinical practice.

Fall
There are many definitions of a fall reported in the research literature. It is important that a standard definition of a fall is used consistently by all staff within an organisation. For the purposes of these guidelines, the definition of a fall is:

"A sudden, unintentional change in position causing an individual to land at a lower level, on an object, the floor, the ground or other surface" (abbreviated) [4].

This includes:

- *slips*
- *trips*
- *falling into other people*
- *being lowered*
- *loss of balance, and*
- *legs giving way. If a patient/resident is found on the floor, it should be assumed that they have fallen unless they are cognitively unimpaired and indicate that they put themselves there on purpose.*

Other definitions of falls have been reported, and an alternative definition may be considered more appropriate in a specific setting. Some other reported definitions are:

a) "Unintentionally coming to the ground or some lower level and other than as a consequence of sustaining a violent blow, loss of consciousness, sudden onset of paralysis as in stroke or an epileptic seizure" [5]

b) "Unintentionally coming to rest on the ground, floor, or other lower level" [6].

Fall-related injury risk minimisation
Approach to minimise risk of injuries related to falling, involving both a patient/resident centred approach (eg falls risk screening, assessment, and development of an action list) and an organisational level approach.

Falls risk minimisation
An approach to minimise risk of falling, involving both a patient/resident centred approach (eg falls risk screening, assessment, and development of an action list) and an organisational level approach.

Falls risk screening
Falls risk screening is a brief (often less than 5 items) check to identify patient/residents at risk of falling. It is used to identify patient/residents who need to have a more detailed assessment of their falls risk carried out. Falls risk screening does not generally provide a framework for planning interventions, but indicates those who should have a comprehensive falls risk assessment performed.

Falls risk assessment (comprehensive falls risk assessment)
Falls risk assessment is a systematic and comprehensive process to identify an individual patient/resident's risk factors for falling.
Once identified, these risk factors are used as the basis for developing an Action List, for inclusion in the patient/resident's plan for daily care.

General environmental falls risk factors
General environmental falls risk factors are those environmental hazards outside of the patient/resident's immediate area of activity/function (all areas other than the patient/resident's individual environment). This may include corridors, common dining room, therapy areas, and outdoors areas accessed by patient/residents.

High falls risk populations

High falls risk patient/resident populations are more likely than their peers to experience falls. Studies in hospital and residential care settings have identified high falls risk populations to include patient/residents with:

- history of falls, falls with injury, or fall related fracture
- neurological conditions such as stroke and Parkinson's disease
- cognitive problems such as dementia or delirium
- depression
- lower limb (leg) arthritis
- acute infections such as urinary tract infection, chest infections
- haematological/oncology conditions, or
- visual impairment.

Incidental activity

Activities performed as part of routine daily tasks that have a physical conditioning component. Examples include walking, transfers, and performing personal activities of daily living such as dressing.

Individual environmental falls risk factors

Individual environmental falls risk factors are those environmental hazards within the patient/resident's immediate area of activity/function. This usually relates to the area around the bed, and within the bedroom, and may include en-suite toilets and bathroom.

Modifiable causes of falls risk factors

Falls risk factors can have a range of possible causes which may be modifiable or non-modifiable. A modifiable falls risk factor is able to be improved with intervention or treatment.

Multidisciplinary

Involvement by two or more staff groups (eg nursing, physiotherapy, medical, and occupational therapy).

Multi-factorial

Relating to more than one risk factor. A falls/fall-related injury risk minimisation program is multi-factorial if it addresses more than one falls risk factor.

Non-modifiable causes of falls risk factors

Causes of falls risk factors that are not able to be improved with intervention or treatment. In these situations, strategies to minimise risk of injuries (eg use of hip protectors) and environmental modifications are important.

Older people

Although falls can occur at all ages, the frequency and severity of fall-related injuries increases with age [7]. For the purposes of the Guidelines, the term "older person" has been used to refer to people aged 65 years and older. The Guidelines also apply to younger people with increased risk of falling (see high falls risk populations).

Personal (intrinsic) falls risk factors

Personal (intrinsic) falls risk factors include age-related declines in systems involved in effective balance performance (eg the reduction in eyesight, sensation, balance and strength associated with ageing), as well as health problems affecting these systems (for example, cataract or glaucoma, peripheral neuropathy, and arthritis) [8].

02 Background

Background

Falls are a common public health problem, becoming increasingly more frequent with increasing age [7]. Although falls can occur at all ages [9], they become particularly problematic for older people or those from high falls risk populations when compounded by an acute health problem requiring hospitalisation, or for those requiring admission to residential care settings.

Falls are the highest ranked cause of hospital admissions for unintentional injury in Victoria (43%), accounting for more than double the number of injury related hospital admissions for transport related injury [10]. Falls also constitute 27% of all injury related emergency department presentations (non-admissions).

Falls in hospital settings

In the acute hospital setting, falls rates have been reported as between 2-7 falls per 1000 bed days [11]. This translates to up to four falls per day in a 500-bed hospital, or over 1400 falls per year. In sub-acute hospital settings, falls are more common, with up to 46% of patients from some high-risk clinical groups (such as stroke patients) falling at least once during their hospitalisation.

Falls are one of a number of types of adverse events that occur in hospitals. Others include medication errors and incidents involving aggression. Falls accounted for 38% of adverse events in the hospital setting in one Australian study [12], and even higher proportion of incidents in sub-acute settings (75%) [13].

Incidence rates vary between wards and departments in hospitals. One study reported that departments such as gynaecology, obstetrics, and paediatric intensive care had no falls [9]. The highest falls incidence in this study was in the geriatric rehabilitation department. Falls occurred more often in medical than surgical wards. The occurrence of an initial fall in hospital increased the risk of subsequent falls for that patient during their hospitalisation [9].

Risk of falling for patients in hospital does not stop when they are discharged home. Mahoney et al reported that 15% of older patients discharged home from hospital fell in the first month after returning home, and 11% of these falls resulted in serious injuries [14]. This highlights the importance of appropriate discharge planning, referral to appropriate services following discharge, and institution of activities to ensure safety within the home prior to discharge.

Consequences of falls in hospitals can vary from no effect at all, through to severe injuries or even death. Between 30-40% of falls in hospitals cause injuries [9, 15], with most common injuries being soft tissue injuries, fractures and cranial trauma. Falls can also cause increased risk of complications, increased need for additional diagnostic procedures, and increased stress for the patient and family. Even when no injury has occurred, the patient often loses confidence in their mobility, which can cause them to reduce their walking and other activities. Over time, this results in deconditioning and increases their risk of further falls.

In the small number of instances where a death occurs due to a fall, the State Coroner's Office will investigate the circumstances of the death. In Victoria, the State Coroner's Office has developed an investigation standard to assist coroners with these investigations (see Tools section). The standard aims to contribute to the State Coroner's understanding of the many factors involved in falls, to improve the efficacy of the coronial investigative process, and assist health care organisations to better manage their reporting requirements.

In a study in which fallers were matched to non-fallers on age, gender, and length of stay to time of fall, fallers in hospitals were identified as having significantly greater length of stay than non-faller (an average increase of 7.5 days/ faller) [16]. There was an estimated increased cost of hospitalisation of $US4233 for each faller, and a significantly higher proportion of fallers were discharged to residential care settings [16].

Falls in residential care settings

Falls rates in residential care settings are often considerably higher than those in community or hospital settings. Over 60% of residents have been reported to fall at least once each year in some settings [17, 18], although more commonly, falls rates in the 30-50% range have been reported [19-21]. Falls may account for up to 83% of reported incidents in residential care settings [22].

Injuries appear to be a more common outcome of falls in residential care settings compared to the community and hospital settings, probably related to the increased level of frailty of many residents. Fifty-four percent of fallers sustained injuries in one study, with 33% of the fallers sustaining a fracture [23]. Another study which focussed on serious injuries reported that 20% of fallers suffered serious injuries, and that 56% of the fractures sustained were hip fractures [24]. Less than 15% of older people in residential care settings who fracture their hip regain their pre-injury ambulatory status [25]. Falls can occur in both ambulatory and non-ambulatory residents, although the rate of falls has been reported to be over twice as high for ambulatory residents [24]. Falls in residential care settings may also result in resident and care-giver stress [26]. Fifteen percent of falls requiring hospitalisation in Australia occurred in residential institutions.

Costs associated with falls in residential care settings in Finland have been estimated as 944EURO/fall [27]. This amount is equivalent to approximately $AUD1560/fall.

Summary

In summary, falls in hospitals and residential care settings are a common problem, both for older people and for those from high falls risk populations. The magnitude of the problem, the range of consequences that impact negatively on independence, function, and quality life, and the costs associated with management of the consequences of falls, reflect the high priority which should be given to this problem.

The patient/resident centred steps of the Process Model

This Research Supplement is structured around the four steps of the Process Model, within an overall quality improvement framework, as described in the document “Minimising the risk of falls and fall-related injuries: Guidelines for acute, sub-acute and residential care settings”.

Step 1: Conduct falls risk screen

Falls risk screening may provide an efficient means of determining which patient/residents need to have a comprehensive falls risk assessment (Step 2). Although clinical judgement of falls risk is considered one way to determine an older person's falls risk status, research has shown that this approach has limited accuracy when used in isolation [28-31].

Advantages of screening

Falls risk screening provides a more scientific basis for identifying older people at increased risk of falls or fall-related injuries. The main advantages of an effective screening process are:

- it can be quickly applied, and repeated at regular intervals if required
- it can be used as part of the nursing care plan; and
- it can reduce the proportion of older people identified who require a comprehensive assessment.

Falls risk screening tools

Examples of published falls risk screening tools used in the hospital setting include the STRATIFY, a five-item tool [32, 33]; the Conley scale, a six-item scale [34]; and the Morse Scale, a six-item scale [35]. Each of these have been shown to have intermediate to high accuracy in the classification of patient/resident's risk of falls. However, in some instances these tools have been shown to classify the majority of patient/residents as being at high risk, limiting the usefulness of the screening process [36].

In a setting where the majority of people are considered to be at increased risk of falling (eg in some residential care settings), a screening process may be redundant. In such cases, comprehensive falls risk assessment (Step 2) should be undertaken for each person to identify specific risk factors, and to develop a falls/fall-related injury risk minimisation Action List (Step 3).

Each of the screening tools mentioned above reports a threshold score for identifying patient/residents at high risk of falling. For example, the STRATIFY uses a threshold score of 2 or more to indicate high risk of falling. When the threshold score of the tool is exceeded, a falls risk assessment (Step 2) should be conducted, to identify risk factors contributing to the high falls risk, and to form the basis for development of a falls/fall-related injury risk minimisation Action List (Step 3).

Frequency of application

Falls occur more commonly in the period immediately following a transition between settings [37]. Any change to the environment such as a change of rooms, or transfer to another ward or unit, should trigger a review of falls risk. Falls risk also varies over time for many patient/residents. While falls are commonly seen in the early period after an admission to hospital or residential care setting [9, 38], increased falls risk has also been shown to be associated with increased length of stay in the hospital setting [9]. This is most likely due to the increased co-morbidity, frailty and severity of disease often seen in patient/residents with longer length of stay. Falls risk should be seen as ongoing, and the application of a falls risk screen should reflect this.

The most appropriate frequency for the application of falls risk screening has not been established, however it has been reported as:

- admission to a ward or unit [32-35]
- daily, particularly in hospital settings, as part of the care plan [39]
- weekly, following initial administration on admission [32], or
- after a fall, or any sudden change in the health or functional status of the older person, for example a urinary tract infection, pneumonia or delirium.

Ongoing observation by staff of people identified as at increased risk of falling should form an integral part of care, and can supplement information derived from a falls risk screen. Falls risk can change quickly, and observation of any change in status may inform the decision to repeat a falls risk screen.

A common risk screening tool

Many older people with an elevated risk of falling also have risk factors for a number of other conditions that also impact negatively on their health. Use of a common risk screen, which flags increased risk for falls, delirium, skin breakdown, and polypharmacy may be more useful in some settings than an individual screen for each of these conditions.

At a minimum, a history of previous falls, or observation of unsteadiness during walking, turning, or transferring should serve as indicators for a comprehensive falls risk assessment.

Step 2: Conduct falls risk assessment

Identifying the factors contributing to a patient/resident's increased risk of falling is an essential step in the development of a targeted falls and fall-related injury risk minimisation Action List. This approach has been shown to reduce falls in hospital [40] and residential care [41, 42] settings.

Falls risk assessment tools

Falls risk assessment tools have the potential to accurately quantify falls risk and provide a sound basis for decision-making on specific interventions to be implemented. In randomised controlled trials in residential care facilities, multiple targeted intervention programs based on a comprehensive risk assessment have resulted in significant reductions in falls, injuries, or fall-related hospitalisations [41-43]. Similar results have been reported for sub-acute hospital settings [40].

An effective falls risk assessment will:

a) accurately classify an older person's likelihood of falling (reported as sensitivity and specificity in the research literature – values of 0.75 or above for both of these measures are generally considered to reflect good prediction accuracy)

b) not classify everyone as at high risk, or at low risk (ie identify a range of levels of falls risk within the setting)

c) provide a basis for determining the most useful falls and fall-related injury risk minimisation interventions to institute for an individual; and

d) provide a basis for determining comparative falls risk, so that the most appropriate "at risk" patient/residents are able to benefit from additional limited high cost resources that may be available, such as bed alarms.

Recent reviews have shown that few of the many available falls risk assessment tools have been subjected to formal evaluation [44-46]. Examples of falls risk assessment tools reported in the literature include:

- a tool developed by Mercer for the acute hospital setting, not subjected to reliability or predictive accuracy analyses [47]
- a multidisciplinary tool developed by Patrick et al [48] for use in the rehabilitation setting, not subjected to reliability or predictive accuracy analyses
- a multidisciplinary tool developed by Haines et al [40] which formed the basis of a successful falls prevention program in the sub-acute hospital setting. The predictive accuracy of this tool has been investigated but has yet to be published
- the Downton Index, shown to have intermediate falls risk prediction accuracy in residential care facilities [49], and a sub-acute setting with stroke patients [50]; and
- the Falls Risk for Hospitalised Older People (FRHOP), a multidisciplinary tool developed in the sub-acute settings, with good reliability and intermediate levels of predictive accuracy [13].

Identification of falls risk factors should result in the development of a falls/fall-related injury risk minimisation Action List, which should be documented and incorporated into the plan for daily care (see Step 3). Several studies have highlighted poor documentation and implementation of actions when processes have been reviewed over time [30, 51]. When a falls risk assessment tool is introduced, it should be supported with regular training for staff, and intermittent audits to ensure the tool is being used effectively.

Frequency of application

Falls risk can vary over time, so intermittent review is indicated. Recommendations on frequency to repeat falls risk assessment vary in the research literature, and include:

a) daily, particularly in hospital settings [47, 52]

b) weekly, often in sub-acute hospital settings [53]

c) monthly or less frequently, sometimes used in residential care facilities [54]; or

d) when there is a fall, or a sudden change in the health or functional status of the older person, for example a urinary tract infection, pneumonia, or delirium, which can all increase an individual's risk of falling.

In addition, falls risk is greater following a change in environment such as transferring from one setting to another [37, 55], or even moving rooms, so falls risk assessments should be repeated when these type of changes occur.

Responsibility for implementation

The allocation of responsibility for completing the falls risk assessment, implementing actions, communicating information about risk and management strategies, and monitoring risk over time should be clearly outlined in policy and procedure manuals. In many hospitals and residential care facilities, nursing staff have primary responsibility for the initial falls risk assessment and development of the plan for daily care, bringing in medical and other health professionals as indicated based on the initial assessment. In settings in which other disciplines such as doctors, physiotherapists, and occupational therapists are involved in initial assessments of all older people (eg sub-acute hospitals) or high falls risk populations, a multidisciplinary falls risk assessment process can be used. When a multidisciplinary assessment process is used, allocation of one staff member to be responsible for ensuring completion by all disciplines and that appropriate actions are implemented, may facilitate a co-ordinated approach.

Wherever possible, a common approach to falls risk screening and assessment should be adopted within a setting (for example, between several units within a residential care facility; or between emergency departments and wards in a hospital setting), and between settings that have strong health service linkages (for example, between an acute hospital and its major sub-acute centre).

Personal falls risk factors

Falls are usually the result of an interaction between a number of personal (intrinsic) risk factors and environmental (extrinsic) risk factors. Personal falls risk factors most commonly identified in hospital [30, 45] and residential care settings [18, 23], and which form the basis of many falls risk assessment tools include:

- history of falls in the past 12 months
- leg muscle weakness and deconditioning
- poor balance/unsteadiness in walking
- medications
- cognitive impairment (confusion, delirium and dementia)
- incontinence
- sensory loss
- postural (orthostatic) hypotension
- loss of confidence/fear of falling
- poor condition of feet and inappropriate footwear; and
- poor nutritional status.

A falls risk assessment tool should incorporate assessment on most or all of these domains.

Personal falls risk factors have a range of possible causes. Identification of the risk factor on the falls risk assessment often indicates the need for further assessment and investigations to determine the cause (eg diagnosis) associated with the risk factor. Causes for falls risk factors may be modifiable (able to be improved with treatment) or non-modifiable (not able to be improved with treatment). Where modifiable causes are identified, the Action List will include treatment of the cause of the risk factor, as well as other actions to reduce risk of falling in the presence of that risk factor. Even for non-modifiable causes of falls risk factors, treatment can help to reduce the magnitude of the effect of the risk factor (eg for a patient/resident with Parkinson's disease, exercise can help to improve steadiness during walking even though the exercise does not affect the underlying disease). Actions to minimise risk of fall-related injury (such as hip protectors) should also be implemented for patient/residents with non-modifiable causes of personal falls risk factors.

Each of the main personal falls and fall-related injury risk factors are described in greater detail below. Interventions targeting these risk factors are described in Step 3.

a) Leg muscle weakness and deconditioning

People of all ages need to maintain a certain level of physical activity or exercise to maintain their current functional status. Low levels of physical activity or exercise have been shown to be associated with increased falls risk in the community setting [56], as well as in residents in residential care facilities [17]. Older people in hospital and residential care facilities are particularly susceptible to deconditioning if activity levels are reduced. Even young people who are confined to bed-rest have been shown to lose up to 1.5 percent of their muscle mass per day [57].

b) Poor balance/unsteadiness in walking

Effective balance is important to reduce the likelihood of falling in situations when balance is threatened. Balance is a complex process, and there are many factors that can cause poor balance. Effective balance requires efficient and accurate sensory (visual, vestibular, and somatosensory) input, central integration and execution of appropriate motor responses to maintain stability during activity. Health problems affecting any of these systems will increase a person's risk of falling [58-60].

Impaired balance, and unsteadiness during walking, transferring and turning, are also common consequences of many diagnoses, such as stroke [61], Parkinson's disease [62], and dementia [55].

c) *Medications*

As the number of medications taken increases, falls risk also increases [63]. Use of four or more medications has been shown to be a strong risk factor for falls [64]. Many older people in residential care and hospital settings are taking more than four medications.

As well as the number of medications, there are specific types of medications which in their own right are associated with a high risk of falling [65, 66]. These include:

- Psychotropic medications [66]. These medications are commonly prescribed for anxiety problems, behavioural problems such as aggression, and sleep disturbance. They include medications under the broad classifications of benzodiazepines, major tranquillisers, and anti-depressants. A community based Australian study identified that 17% of people over 65 were taking one or more benzodiazepines [67]. The use of these high risk medications is even higher in residential care settings, with a survey of nursing homes in Sydney identifying 49% of residents taking one or more psychotropic medications regularly [68]. Because these medications are addictive, ceasing their use requires a gradual, systematic weaning of the dose, along with the introduction of non-pharmacological alternatives such as relaxation strategies, support and reassurance, avoidance of daytime naps, avoidance of heavy meal before sleep, and increased exercise [69]. Even short acting benzodiazepines are associated with increased falls risk [70].
- Diuretic medications, type 1a anti-arrhythmics, and digoxin, have all been shown to have significant association with increased falls [65].

d) *Cognitive impairment (confusion/delirium/dementia)*

Cognitive impairment is a common symptom for older people in hospital and residential care settings, with up to 40% of older people admitted to hospitals [38], and approximately half of people in residential care settings having at least mild cognitive impairment [71]. Cognitive impairment is a strong risk factor for falls and fall-related injuries [71-73].

There are a number of different behaviours that contribute to increased falls risk in people with cognitive impairment, including agitation, wandering, and impulsiveness. Discussion with families and carers, and observation may result in identification of some triggers for the behaviour, and some potential strategies to reduce the high risk behaviour. Examples of the latter may include changes to routines, having familiar items available, and ensuring personal needs such as toileting are met on a regular basis.

An important condition to be differentiated for people with cognitive impairment is that of delirium. Delirium (sometimes also called acute confusional state) is a relatively common, but often reversible, cause of confusion [74]. It is usually of relatively sudden onset, and characterised by fluctuating attention and confusion. Delirium is often caused by an acute medical condition such as metabolic disorders (eg unstable diabetes), infection, hypoxia, or some medications [3]. Accurate and early diagnosis is important. One program that involved screening for delirium and a management program which included a sleep enhancement protocol, early mobilisation, appropriate sensory loss management, and hydration protocol in older patients in hospital achieved a significant reduction in the number of episodes of delirium [74].

e) *Incontinence*

Incontinence can be considered a risk factor for falls in two ways. First, if there is a urinary accident, then there is potential for a slip on the wet floor surface. Second, where there is an urge incontinence problem (that is, a sudden and often uncontrollable urge to go to the toilet), then the risk of falling is increased with the stress and haste in trying to get to the toilet quickly [75].

One of the most common causes of urinary incontinence is acute illness such as a urinary tract infection, pneumonia or delirium. A person's mobility and functional limitations (eg slow speed of walking) might also be a cause of episodes of incontinence.

f) *Sensory loss*

The sensory systems provide valuable information about the interaction between the body and its environment, and play a key role in avoiding falls. The sensory systems include:

- Vision. Problems with vision increase risk of falling and fall-related injuries [76, 77]. A recent study in Melbourne indicated that the most common cause of bilateral vision impairment was uncorrected refractive error, which could have been corrected simply by using glasses, or upgrading the strength of the glasses worn [78]. Problems associated with bi-focal or multi-focal glasses have been reported to be associated with falls on steps and curbs and trips [79], most likely related to the person not tilting the head sufficiently to be looking through the appropriate lens section when negotiating steps or curbs. Vision problems are even more common in residential care settings, with 22% of residents identified as having profound visual impairment (blindness) [80].

- Somatosensory system, or sensation of the position and movements of the body. This includes the sense of light touch and awareness of joint positions that are important for safe mobility and function. Reduced somatosensory sensation results in balance disturbance and increased risk of falling [58]. A common cause of somatosensory loss is peripheral neuropathy, often associated with diabetes.
- Vestibular system (inner ear). The vestibular system has an important role in sensing movement and body alignment, and in effective balance. Vestibular problems are commonly associated with the symptom of dizziness, and increased risk of falling [60].
- Hearing. Effective hearing is important for safe mobility and function. It provides supplementary information about the environment that may not be available to the other senses, for example, if someone or something (such as a wheelchair or trolley) is coming along the corridor near the door entrance being approached.

g) Postural (orthostatic) hypotension

Postural (orthostatic) hypotension is defined as a drop in systolic blood pressure of 20mmHg or more after moving from the lying to the standing position [81]. There are many possible causes of postural hypotension, including:

- certain medications, such as anti-hypertensives, anti-Parkinson's disease medication, anti-depressants, and diuretics [82]
- some acute illnesses, such as stroke, depression, Parkinson's disease, and diabetes [73] (p 59)
- following periods of bedrest (for example post-operatively); in these cases, the symptoms usually resolve with gradual increase in sitting out of bed, and mobility.

Reduction in systolic blood pressure of 20mmHg or more has also been noted to occur in 38% of older people in residential care settings soon after eating a meal (post-prandial hypotension), and in 44% when standing after eating a meal [83]. This study also highlighted that an absolute measure of systolic blood pressure of less than 115mmHg after a meal was associated with increased risk of falling. Using tilt table assessments for older people Heitterachi et al [81] identified that both postural hypotension and instability in blood pressure following tilting were associated with increased risk of falling.

The link between postural hypotension and falls is not as strong as that identified for many other intrinsic falls risk factors, with mixed results reported in several studies [19, 83-85]. However, the variable results reported in the research literature may in part be due to different samples being assessed and different methods of measuring and classifying orthostatic hypotension. Nonetheless, the weight of evidence indicates that postural hypotension is an important contributory factor that should be investigated.

h) Loss of confidence or fear of falling

Loss of confidence or fear of falling is a common consequence of falls [86, 87], which can also predispose an individual to changes in balance performance [88] and increased risk of future falls [89, 90].

It is appropriate for a person with impaired balance to have some reduced confidence in mobility, as this will provide a basis for them limiting their mobility and activity to that within their safety limits. Increased falls risk can occur when the level of loss of confidence is out of proportion to the level of balance impairment. This can occur in two ways:

- Over-confidence, where balance is poor, but the person has no/minimal loss of confidence or fear of falling. In these situations, the person often undertakes activities that have a high risk of falling, for example trying to walk independently when assistance is required. This is sometimes evident in people who have had a stroke, or cognitive impairment
- Under-confidence, where there is an excessively high fear of falling, with relatively minor balance impairment. Although this is relatively uncommon, it can cause marked stress in the individual, and often frustration in staff who do not understand the psychological nature of this problem. This type of presentation is considered a true phobia, and like other phobias such as fear of open spaces, often requires referral to a psychologist to help address the fear.

i) Poor condition of feet and inappropriate footwear

A person's feet and footwear are the point of interaction between the ground and the individual in any situation whenever balance is threatened and a fall might occur. The better the support and grip of the shoe, and the better the structure of the foot inside the shoe, the greater the chance of avoiding a fall in these situations.

Foot problems which can contribute to increased risk of falling include:

- severe bunion, toe deformity (eg hammer toes), ulcer, deformed nail [91]
- plantar calluses, corns on the toes [92], and
- restricted foot joint mobility [91].

Despite high prevalence of foot problems among older people and those who have fallen, research indicates that less than half see a podiatrist over a 12-month period [93].

Similarly, poor footwear has been cited as a factor that reduces stability and increases risk of falling [94-96]. Sherrington and Menz identified that the majority of a sample of people with a fall related hip fracture

were wearing footwear with at least one sub-optimal feature at the time of the fall [97]. The most common footwear problems identified in the hospital and residential care settings are:

- slippers
- shoes with poor fastenings
- sandals/thongs
- high heeled shoes
- worn soles/heels, and
- poor grip soles [13].

j) Poor nutritional status

Good nutrition is important for many aspects of health. A healthy and balanced diet ensures that the patient/resident has adequate intakes of all necessary macro and micro nutrients. Nutritional status can be poor through a number of mechanisms, including difficulties associated with meal preparation, dexterity problems limiting ability to cut food and feed self independently, oral or dental problems, dislike of the type of food served, and problems affecting absorption of nutrients.

Two aspects of good nutrition that are of particular importance in falls and fall-related injury risk minimisation are that the diet is sufficient to maintain physical function (especially muscle strength), and to maximise bone strength.

Problems with bone strength and quality are common with increasing age, and with reduced mobility. If bone strength and quality are reduced, less force is required for a fall to cause a fracture. Osteoporosis is a common problem for older people which is characterised by low bone mass, and reduced quality of the structure of bone. Factors contributing to risk of osteoporosis include reduced physical activity, low dietary calcium, smoking and alcohol consumption, and medications such as cortico-steroids [98]. Low bone mineral density has been shown to increase fracture risk three-fold in ambulatory females in residential care [99].

Another common factor influencing bone is osteomalacia, which is characterised by inadequate mineral deposit in bone, related to vitamin D deficiency. Adequate levels of vitamin D are essential for optimal bone strength. Up to 76% of those in residential care settings are vitamin D deficient [100, 101] predisposing these people to increased fracture risk.

As well as the negative effect of low vitamin D on bone strength, it can also result in muscle weakness, particularly in proximal muscle groups [102].

Fall-related injury risk factors

There are several additional risk factors which predispose people who fall to injury (particularly to fracture) [24, 103]. These can be considered broadly under the heading of nutritional falls risk factors, and include:

- osteoporosis (changes in bone structure resulting in weakening of bone and increased susceptibility to fracture)
- osteomalacia (related to low vitamin D levels, reducing the strength of bones and increasing susceptibility to fracture); or
- low body mass index.

Additional intervention strategies need to be considered for those with increased risk of fracture.

Environmental falls risk factors

Environmental falls risk factors have been divided into individual environmental risk factors (those in the patient/resident's immediate environment and commonly used areas), and general environmental risk factors. Individual environmental falls risk factors should be considered whenever personal risk factors are assessed, as the two are inter-related.
The suitability of the patient/resident's individual environment may change as a result of a change in their functional or cognitive status, a change in their routines, or a change in their environment (eg changing rooms). Some of the individual environmental falls risk factors include:

- walking aids out of reach
- IV drip stands, power cords not positioned properly
- call bell out of reach
- inadequate lighting in the patient/resident's room (poor lighting, lack of night lights, or excessive sun glare)
- clutter
- inappropriate chair height/type
- hoists/lifting machines left in rooms or corridors, and
- restraints/cotsides.

Individual environmental falls risk factors are reviewed below.

Individual environmental falls risk factors

Individual environmental falls risk factors interact continuously with the personal falls risk factors to affect the patient/resident's falls risk at a given time. An Individual Environmental Falls Risk Assessment can be used to assess the presence of individual environmental falls risk factors.

Some examples of the patient/resident's individual environment that can increase a patient/resident's risk of falling are:

a) Inappropriate bed height

Bed height is the distance from the floor to the top surface of the mattress, and is usually adjustable. An ideal height for a bed or chair is generally considered to be a height at which the feet are able to be in contact with the floor, when the hips are bent 90 degrees [104]. This height gives good support, and is appropriate for ease of transfers. Staff need to remember to return a bed to the appropriate height if the height is adjusted for any procedures.

b) Bed brakes not on or broken

Bed or wheelchair brakes not being on, or being broken have been identified as contributors to falls [105].

c) Call bell out of reach

Having the call bell and other objects that patient/residents need to use intermittently out of reach will often result in the patient/resident attempting to stand and/or reach for the object, even when it may not be safe to do. Care should be taken to place these objects within reach after activities such as room cleaning, a medical or other assessment, or transferring a patient/resident.

d) Walking aids out of reach

For patient/residents who require a walking aid for safe mobility, storing the aid out of reach will often result in the patient/resident attempting to get up to access it. For many of these patient/residents, trying to stand or walk without the walking aid will result in reduced stability [106] and increase the risk of falling.

e) Slippery surfaces

Slippery surfaces create a slipping hazard for people with increased risk of falling. Floor surfaces in hospitals and residential care facilities are regularly cleaned. It is important that any shiny surfaces that have been cleaned are clearly signed, and that alternative routes are available for patient/residents until the surface is dry. Floor surfaces may also be slippery following a patient/resident being incontinent. Meddaugh et al [107] identified that 38% of falls in a residential care setting were due to residents slipping on urine. They targeted this risk factor by introducing “treaded slippers/socks” which resulted in a reduction in falls due to slipping in urine down to 5% in the following 3 months.

f) Clutter

Areas around the bed can be filled with a range of personal, and hospital/residential care setting items that can increase clutter and exacerbate the risk of falling [108].

g) Restraint use

Use of restraints such as vests, cotsides and medications specifically used to sedate a person for convenience or disciplinary purposes [155] have been shown to be associated with increased fall-related injuries [153,154].

h) Other

Other examples of individual environmental risk factors include inadequate lighting [105, 109], inadequate rail support in the bathroom and toilet [8], poor condition of walking aids (eg worn stoppers), inadequate storage of equipment items such as IV drip stands or lifting machines [104], and loose floor coverings.

Step 3: Develop and Implement an Action List

One or more falls risk factors may be identified using the falls risk assessment process (Step 2), and one or more actions may be implemented to address each identified falls risk factor. Results from randomised controlled trials in the hospital and residential care settings have demonstrated significant reduction in falls rates associated with a multiple intervention action plan, developed from a falls risk assessment [41, 42, 110].

Falls and fall-related injury risk increases with the number of risk factors present [111], and therefore the more strategies that can be introduced to reduce an individual's risk factors, the greater the likelihood that falls and fall-related injuries will be avoided.

The research evidence supporting use of interventions addressing each of the main personal falls and fall-related injury risk factors are described below. In addition, randomised controlled trials in the hospital and residential care settings are described in greater detail in the research summary tables at the end of this document.

Personal falls risk factors

a) Leg muscle weakness and deconditioning

Exercise has been shown to result in a range of health benefits for older people, even those who are frail, cognitively impaired, and in residential care settings [112, 113]. While studies using randomised controlled design methodology have demonstrated physical improvements such as increased muscle strength, balance and function, few have investigated the effect on falls rates in hospital and residential care settings [112, 114].

There are a number of different types of exercise that can be undertaken in hospital or residential care settings that can improve function for older people. These include:

- One-to-one supervised exercise, conducted with a physiotherapist, allied health assistant, or activity co-ordinator. Exercise often includes balance, strengthening, walking, or functional activities. This approach has been shown to result in improved mobility and less use of walking aids and wheelchairs in a residential care setting [115]. Another randomised trial has shown that increased levels of physiotherapy and occupational therapy in a residential care setting can result in improved functional outcomes and cost savings over time [116]. Neither of these studies investigated falls rates as an outcome.
- Group exercises, which can incorporate balance, strengthening, fitness, and functional activities. This type of program has been shown to achieve improved mobility and function in older people in residential care settings [117], although this study was under-powered to identify a change in falls rates. A randomised controlled trial evaluating a multi-factorial program which included group exercise among a number of interventions in the sub-acute hospital setting achieved a significant reduction in falls [40].
- Incidental activity, which is activity undertaken as part of daily routines, has a potential health benefit. This can include walking an older person to the toilet instead of using a commode and encouraging independence with functional activities rather than doing tasks for the older person (even though it may be quicker!) [118]. Increasing the number and amount of incidental activities during a day can help to maintain muscle mass, strength, and mobility, and to reduce agitation in patient/residents in residential care settings. Falls outcomes have not been investigated using this approach [118].

Although little research has investigated exercise or physical activity programs for older people in hospital settings, it is likely that similar approaches may help to improve functional outcomes, and potentially also reduce falls rates. If patient/residents at risk of falls do need to be confined to bed for health problems, then bed exercises may be able to be undertaken to minimise the associated complications. In such cases, early mobilisation should be encouraged when health problems have been stabilised.

Referral to either individual or group exercise programs has formed part of several multi-factorial falls prevention programs that have shown significant reductions in falls in residential care facilities [42, 110, 119].

b) Poor balance/unsteadiness in walking

In many cases, balance can be improved with special balance exercises [117, 120]. Additionally, exercise which includes balance and functional training has resulted in trends towards reduced falls in the residential care setting [117], in patients following hip fracture [120], and were incorporated in a multi-factorial intervention in a hospital setting which achieved a significant reduction in falls [110].

To improve balance performance, exercise needs to have a balance component (ie not only incorporate a strengthening program) [121]. It appears that exercises performed when seated are unlikely to be of sufficient challenge to improve standing balance and steadiness during walking, or to reduce falls risk [122], although they may have other health benefits.

If balance performance is poor, or there is considerable unsteadiness during walking and transferring, the use of a walking aid such as a stick (cane), tripod, or frame, can improve safety if properly fitted and used appropriately. Walking aids have been shown to reduce falls risk for those with intermediate levels of activity [56].

When there is consideration to introduce a walking aid, or to change a person's walking aid, it is desirable to have a physiotherapy assessment at the same time. The physiotherapist will assess the individual's balance, determine the need for an exercise program, and identify the most appropriate walking aid and provide training and instruction regarding correct use. It is important that changes in walking aids and recommendations for patterns of use are conveyed to all staff involved, to ensure consistency of the feedback provided to the patient/resident.

c) Medications

In the community setting, one of the most successful randomised trials of single interventions to reduce falls involved the reduction in the use of psychotropic medications [123]. Weaning older people off these medications needs to be done slowly, and the patient/resident may benefit from concurrent non-pharmacological strategies, such as relaxation, use of music, and psychological support to help them manage without the medication. Guidelines have been published outlining recommended strategies for successful reduction of use of psychotropic medications [124]. No randomised controlled trials similar to the study by Campbell et al [123] have been conducted in hospital or residential care settings.

Admission to hospital or residential care is an opportunity for a review of the indication for each of the medications being taken, and for consideration of options for rationalising the number of medications taken.

Staff in residential care settings have a key role in facilitating medication reviews by general practitioners or pharmacists, which can be conducted through the Medication Review Program. One study reported that a pharmacist-initiated medication review in a long stay rehabilitation/residential care facility resulted in up to 18% reduction in use of medications associated with high falls risk such as sedatives and hypnotics, and a 47% reduction in the number of falls following introduction of the program [125].

Medication to reduce fracture risk

The presence of a previous fracture is a strong risk factor for further falls and fall-related injuries [126]. There are additional medication options available (other than vitamin D and calcium supplementation described in the nutrition section) to target osteoporosis and to reduce fracture risk for people who have had a "minimal trauma" fracture. These medications act to reduce the rate of bone re-absorption, and include bisphosphonates, and Selective Estrogen Receptor Modulators (SERMs). The most commonly used medications of this type are alendronate, risedronate, etidronate, and raloxifene. These medications can only be obtained on the Pharmaceutical Benefits Scheme (PBS) if the individual has had a previous "minimal trauma" fracture.

A recent meta-analysis of the effectiveness of these medications identified that each was associated with significant reductions in vertebral fractures [127].

Alendronate and risedronate also significantly reduced non-vertebral fractures [127]. Alendronate, risedronate, etidronate and raloxifene all resulted in significant improvements in bone mineral density relative to control subjects at both vertebral and non-vertebral (eg hip and wrist) sites [127].

d) Cognitive Impairment (confusion/delirium/dementia)

Unfortunately, most of the research studies that have demonstrated effective interventions in reducing falls among older people have excluded people with cognitive impairment. However, there are some promising recent studies which suggest that while falls prevention strategies may be more challenging to institute for older people with cognitive impairments, that some positive outcomes can be achieved. A randomised trial of a comprehensive multidisciplinary assessment and risk factor management program for older people with cognitive impairment who presented to an emergency department after a fall identified trends for reduced falls and fall-related injuries [128]. The majority of participants in this study were from residential care settings. Another successful multi-factorial falls prevention program in residential care settings [42] was shown to be effective in reducing fractures in the sub-group of residents with impaired cognition [129]. This intervention included:

- educating staff
- modifying the environment
- implementing exercise programs
- supplying and repairing aids
- reviewing medication (dosages and timing)
- providing free hip protectors, and
- having post-fall problem-solving conferences.

Similarly, a randomised trial in a sub-acute hospital setting of a multi-factorial intervention that included a falls risk screen and use of a falls risk alert card, an exercise program, an individualised education program (if appropriate), and hip protectors reported a significant reduction in falls for all patients. This study included all consecutive admissions, including those with cognitive impairment [110].

e) Incontinence

Continence management programs have not been evaluated in isolation using randomised controlled trials to reduce risk of falling. However, one multi-factorial program in residential care which incorporated toileting regimes into a falls prevention program reported a reduction in falls [130]. In addition, a randomised trial in residential care that utilised a prompted voiding regime together with increased physical activity identified reduced agitation and improved mobility as outcomes [118]. Over half of the residents in this study had cognitive impairment. Unfortunately, falls were not monitored as an outcome in this study. Using a pre-post design, Bakarich et al found significantly fewer falls in at risk patients who were assessed for confusion and mobility status and toileted every two to four hours [131].

In cases where incontinence is caused by an acute illness such as urinary tract infection or delirium, identification and management of the acute illness should result in improvement in continence, and reduced risk of falling. Where functional limitations such as reduced dexterity due to a stroke or arthritis, or reduced mobility are contributors to incontinence, strategies such as easy to undo fasteners, improving mobility, or reducing the distance to be walked to the toilet, may reduce incontinence episodes. It would, however, be desirable for the patient/resident to do some additional walking at other times to maintain mobility.

f) Sensory loss

There has been very little research focus on interventions to improve problems associated with sensory loss and the effect on falls. However, there is some encouraging evidence, primarily from pre-post design studies, that interventions targeting sensory loss may have a beneficial effect on falls rates:

- Vision. Vision may be impaired simply because the patient/resident has not had a recent update in their prescription lenses, or their glasses are dirty. Some vision problems such as cataracts are treated with minor surgical procedures, which can result in reduced risk of falling [132]. Problems associated with bi-focal or multi-focal glasses have been reported to be associated with falls on steps and curbs and trips [79], most likely related to the person not tilting the head sufficiently to be looking through the appropriate lens section when negotiating steps or curbs. These problems may be able to be corrected with training, or with the patient/resident reverting to use of separate pairs of glasses for near and far vision.
- Somatosensory system. Some causes of peripheral neuropathy (such as vitamin B_{12} deficiency) can be treated effectively.
- Vestibular system (inner ear). One of the most common causes of dizziness (benign paroxysmal positional vertigo) can be treated effectively with a therapeutic manoeuvre called particle repositioning [133].
- Hearing. Some hearing problems can be treated (eg wax in the ears) or hearing augmented with the use of hearing aids. Hearing problems are often exacerbated by background noise.

There have been no randomised controlled trials evaluating the effectiveness of any of these interventions in reducing falls.

g) Postural (orthostatic) hypotension

A pre-post study conducted among older patients in a psychiatric hospital, which promoted the importance of identification of postural hypotension, and institution of an appropriate management plan resulted in a significant reduction in repeat fallers [134].

h) Loss of confidence/fear of falling

In many cases, mild to moderate levels of fear of falling or loss of confidence will improve with a targeted balance training and mobility program [135, 136]. In the community setting, a program incorporating both psychological and exercise components resulted in significant improvements in fear of falling [137]. Use of hip protectors has also been shown to reduce fear of falling in older women who had two or more falls, or one fall requiring hospitalisation in the preceding 12 months [138]. Although there are no studies investigating fear of falling among older people in residential care or hospital settings, it is likely that similar approaches to these may be useful.

For the subgroup that have poor balance but no loss of confidence, strategies to increase surveillance, reduce overall risk, and reduce risk of injuries should be considered.

i) Poor condition of feet, and inappropriate footwear

Many foot problems can be improved with management by a podiatrist. In addition, people with loss of feeling in the feet (eg peripheral neuropathy) are prone to developing pressure problems, cuts, and other injuries, and should be provided with information about the importance of monitoring foot condition, and indicators on when to seek assistance.

All patient/residents should be encouraged to have shoes brought in from home if they do not have them when admitted to a hospital or residential care facility. Slippers usually do not provide good support, and therefore are not recommended footwear in hospitals and residential care settings.

There is very little research investigating the effect of footwear and foot-care on falls. However, balance and stability have been shown to be influenced by footwear. Shoes that have a high collar are associated with reduced amount of postural sway relative to shoes with a low collar, indicating improvement in stability [139]. No difference was observed for different sole hardness.

j) Poor nutritional status

Reduced levels of vitamin D can reduce bone strength and increase risk of fracture. Common ways of obtaining sufficient vitamin D include:

- eating foods rich in vitamin D (recommended by: National Health and Medical Research Council. Recommended dietary intakes for use in Australia. Canberra: AGPS, 1991). Some foods such as margarine have added vitamin D as a food supplement. Also fish (especially fatty fish), meat, milk and eggs are rich in vitamin D [101].
- exposing skin to sunlight. It is recommended that people receive at least approximately 1-2 hours of direct sunlight exposure per week to the uncovered face and arms to maintain sufficient vitamin D levels [140]. Most people in hospital and residential care settings do not receive any sunlight exposure, and their vitamin D levels can drop quickly.

Importantly, taking vitamin D with calcium supplements has been shown to reduce fracture rates for older people in residential care [141, 142] and in a long-stay geriatric care unit [143]. A recent systematic review [144] indicated that the evidence of association between vitamin D supplementation and reduced falls was inconclusive.

Hip protectors

For patient/residents with osteoporosis or osteomalacia, a history of previous fall-related fracture, or with high falls risk which appears to be primarily due to non-modifiable causes, hip protectors may be beneficial in reducing risk of hip fractures. Hip protectors are protective shields worn over the hips to absorb or dissipate forces applied to the hips in the event of a fall causing impact on the hip. Hip protectors have been shown to reduce risk of hip fractures in a number of randomised trials, and a systematic review [145-149]. Most of the research has been conducted in residential care facilities, using a cluster randomised design.

Studies in this area have consistently identified limited compliance among older people in accepting use of hip protectors when recommended, and even lower rates of people maintaining their use of hip protectors over an extended period of time [150, 151].

Identified barriers to compliance with use of hip protectors include:

- being uncomfortable (too tight/poor fit)
- appearance of the hip protector
- extra effort associated with wearing the hip protector
- urinary incontinence (although some hip protectors can accommodate continence pads), and
- physical difficulties (eg poor dexterity) [150].

Individual environmental falls risk factors

There is limited research in hospital and residential care settings into assessment and management of individual environmental falls risk factors. Several randomised controlled trials using multi-factorial interventions in the residential care setting have incorporated an environmental checklist or assessment and modifications to the environment and resulted in significant reduction in falls [41, 42, 119]. The most common environmental modifications implemented in the study by Becker et al [119] included changes in lighting, adjustments to bed and chair heights, reducing clutter in the patient/resident's room, installation of extra rails in the toilets and bathroom, and maintenance of walking aids. The effectiveness of the environmental modifications in isolation could not be evaluated in any of these studies.

Despite the limited research evidence in this area, several contributors to a patient/resident's individual environmental falls risk that are important to consider include:

a) Routine nursing care

Many activities that constitute best practice in nursing, and that should be part of routine care, can impact on falls risk. Some of these can be considered under the umbrella of the patient/resident's individual environment, such as:

- ensuring the patient/resident's immediate environment is free of clutter/nursing equipment etc, that might constitute a falls hazard
- making sure the patient/resident's call button is within reach, or
- ensuring equipment is appropriate for the patient/resident, for example the bed is at the correct height and has brakes locked, or that the chair is the correct height.

An audit process in acute hospital and residential care settings identified that some of these activities are not regularly instituted [152]. Furthermore, routine auditing of these activities resulted in substantial improvement in these activities being implemented.

b) Orientation to the environment

Falls appear to occur more commonly in the immediate period following a transition between settings, for example when patient/residents are initially admitted to hospital, after a transfer to another hospital or admission to a residential care facility (even for a period of respite care) [37, 55]. Lack of familiarity with new surroundings, routines and staff, often combined with an acute illness, predispose an older person in these transitions to increased risk of falling.

Even if the move into a new setting is only for a short period (eg short hospital stay for medical investigations of unsteadiness, or a period of respite care in a residential care facility), it can cause some older people to become confused or agitated. It is also a time when staff are becoming familiar with new patient/residents and their routines and preferences. Strategies need to be implemented to improve safety during these periods.

c) Restraint reduction

Restraint use has been shown to be associated with increased fall-related injuries, and has in a small number of cases, caused death [153, 154].

Restraint use is "the intentional restriction of a person's voluntary movement or behaviour by the use of any manual, physical, or mechanical device [or medications] that restricts freedom of movement… or where part of the intended pharmacological effect of the drug is to sedate the person for convenience or disciplinary purposes" [155] (p 7).

Restraint can include any of the following:

- cot-sides
- vests
- waist restraints
- wrist/ankle restraints
- other mechanical restraints, such as tables locked onto chairs, or
- medications, which are used with a primary purpose of limiting a person's movement and activity.

In some hospital and residential care settings, restraints are introduced as a management option for patient/residents with increased risk of falling, without consideration of alternatives. This is despite several studies identifying increased risk of fall-related injuries when restraints are actually used [154].

It has been shown that a restraint education program combined with a resident-centred unit-based consultation program, which focussed on residents with behaviours that posed clinical challenges such as cognitively impaired residents with multiple falls, can reduce the use of physical restraints in nursing homes [156]. In addition, this method was also found to reduce the number of serious fall-related injuries compared to restraint education alone [156].

Queensland Health Guidelines [155] (p 7) cite three key steps in decision making regarding restraint use:

- "restraint should only be used to prevent or minimise harm to the patient or staff, and to optimise the patient's health status;
- restraint should only be used when all other alternatives have been considered and regarded as inappropriate or ineffective; and
- restraint should always be the least restrictive to achieve the desired outcome, and its use should be monitored and evaluated continually."

Therefore, although some form of restraint may need to be considered for a small number of patient/residents, this should be after other options have been excluded, and should give due consideration to the rights and wishes of the patient/resident and their family. If restraints are to be used, strict documentation policies need to be adhered to [155].

Organisational Activities

a) General environmental hazard assessment/environmental audits

General environment hazards are those outside of patient/resident's immediate area of activity/function. Examples of general environment hazards include:

- unstable rails in retail therapy department
- ward equipment stored in corridors
- moss or weeds growing in outdoors walking paths for patient/residents, and
- elevator/lift doors which close too quickly.

The majority of falls in hospitals and residential care facilities relating to environmental hazards occur in individual environment areas such as around the bed and toilet.

Environmental hazard assessments or audits are often routinely performed in hospitals and residential care facilities as part of their Occupational Health and Safety program. Many of the hazards identified in this type of assessment also increase an individual's risk of falls or injury. However, these assessments often need some modification to adequately address the key issues in environmental safety to minimise risk of falling. Wherever possible, it is desirable to have only one tool which addresses both aspects of environmental safety, instead of two processes with considerable duplication.

While many of the recommendations for maintaining a safe environment make good sense, and are considered often to be part of "routine care", audits of some of these practices in hospital and residential care facilities have indicated that many of these simple environmental problems do occur, and that an intermittent audit process with staff feedback can markedly reduce the presence of these environmental hazards [152].

General environmental hazard assessments are often recommended on a monthly basis, or after a fall occurs.

Processes should be established for environmental hazards to be reported, and for planned approaches to address the identified hazard/s over the short and longer terms. Some environmental hazards are structural, and will require substantial resources to fully remove the hazard risk. In such instances, the ward/unit/facility should implement short term strategies to minimise the environmental risk, and work with management to develop a plan to address the environmental hazards more permanently.

b) Increased surveillance options

Many falls in hospitals and residential care settings are not witnessed. Strategies to increase observation or surveillance of high falls risk patient/residents are considered an important approach to reducing falls, particularly for patient/residents with cognitive impairment. A number of approaches have been suggested to increasing observation or surveillance.

Location

Some areas of wards in hospitals or units in residential care facilities have increased capacity for observation compared to others. For example, rooms near a nurses station often have a greater volume of nursing and other staff activity. These rooms are sometimes used for observing people with increased need for medical attention, but can also be used for increased monitoring of people with high falls risk.

Bed/chair alarms

Bed and chair alarms are devices which can be linked to a nurse call alarm system to warn staff when a patient/resident at risk of falling is moving to get out of bed or off a chair. In a randomised trial in a hospital setting bed alarms demonstrated a strong trend towards reduced falls [163]. This approach also resulted in a reduction in the use of restraints in the group of patients with the bed alarms.

Other innovative approaches to monitoring of patient/residents at risk of falling who try to stand unsupervised have been reported. In a pre-post design study, Kelly et al [164] reported a small monitoring device attached to the thigh, which can send a remote signal to the nurse call system, was effective in substantially reducing falls in the period when the monitoring devices were being used.

Sitters

Sitters are people who have the role of sitting with patient/residents at high risk of falling, and seeking assistance if these people try to stand up from bed or chair unsupervised.

Sitters may be:

- family and friends or a patient or resident
- volunteers; or
- paid individuals with little or no healthcare background [165].

There has been little research published investigating the effectiveness of sitters. One study identified a small increase in falls rates but improved patient/resident satisfaction with staff response to call bells/overall care when paid sitters were used in a hospital setting [165].

Flagging of those with high risk

When increased falls risk has been identified based on a falls risk assessment, strategies should be adopted to ensure ongoing communication of the high risk status of vulnerable individuals to all staff involved in their care, the older person themselves, and their family/carers/support network. The aim is to serve as a constant reminder about the person's risk of falling. Methods that have been used to communicate falls risk status (in addition to formal verbal and written communication) have included:

- coloured stickers (positioned on case notes, walking aids, bedheads)
- use of a sign or graphic on or near the bedhead (although the issue of confidentiality needs to be considered), and
- use of coloured wrist bracelets.

These approaches in isolation have not resulted in reduced falls [166], but may be considered part of a multiple intervention program. One randomised controlled trial in the hospital setting which used falls risk alert cards as part of a multi-factorial intervention based on risk assessment found a significant reduction in falls [110].

c) Discharge planning

Fifteen percent of older people discharged home from hospital have one or more falls in the first month after their return home, and 11% of these falls result in serious injuries [167]. An effective falls prevention program in hospital or residential care settings is likely to result in identification of a range of individual falls risk factors and development of an individual falls/fall-related injury prevention Action List. For patient/residents who need to move between settings, for example, after:

- being discharged home or to a residential care facility from a hospital, or

- being transferred from a residential care facility to a hospital

there is a need for effective communication of falls related issues in the discharge/transfer plan. Information that should be conveyed includes:

- identified falls risk factors
- strategies introduced to minimise future falls risk, and
- personal, and individual and general environmental falls risk factors influencing outcomes.

This information will facilitate staff awareness in the receiving setting and allow the implementation of appropriate falls and fall-related injury minimisation strategies in a timely manner in the new setting.

Step 4: Respond to a falls incident appropriately

Appropriate response to a fall incident involves providing the immediate and longer term care to the patient/resident, and completing the required documentation.

a) Caring for the patient/resident

Effective care includes assessing the patient/resident for any injuries, which may require having formal investigations such as x-rays or scans performed and management of other immediate effects of the falls such as shock or loss of confidence. Ongoing monitoring is also important as some injuries may not be apparent at the time of the fall. Reporting of all falls, even if injuries are not apparent, and regular observation after the fall should be implemented. This is particularly important where there is a possibility that the patient/resident has knocked their head during the fall [157].

b) Using a standard definition

It is important that a standard definition of fall is adopted by an organisation, so that everyone is clear as to what constitutes a fall, and therefore what warrants completion of an incident form. There are many definitions of a fall reported in the research literature. For the purposes of these guidelines, the definition of a fall which is recommended is "a sudden, unintentional change in position causing an individual to land at a lower level, on an object, the floor, the ground or other surface" (abbreviated) [4].

This means that any time a person comes to rest on a lower surface inadvertently, and whether or not they actually came to rest on the floor, or another piece of furniture or wall, that an Incident Report should be completed. Incident Reports should be completed for every fall, not only for observed falls, or if an injury occurs.

Other definitions of falls have been reported, and may be considered more appropriate in a specific setting. It is important that all staff are aware of the definition adopted within a specific facility. Two other definitions reported in the research literature are:

- "unintentionally coming to the ground or some lower level and other than as a consequence of sustaining a violent blow, loss of consciousness, sudden onset of paralysis as in stroke or an epileptic seizure" [5]
- "unintentionally coming to rest on the ground, floor, or other lower level" [6].

c) Documentation of falls incidents

Systematic approaches to the documentation of falls should be routine in hospitals and residential care facilities. Information about each fall, the circumstances leading to the fall, any preceding sensations or symptoms reported by the older person, and the consequences of the fall should be included in an Incident Report (refer to the Victorian Coroners Standard in the Tools Supplement).

d) Collating Incident Reports and systems for feedback

Falls Incident Reports should be reviewed by the Charge Nurse or Nurse Unit Manager, then forwarded to a central location for integration with other Incident Reports, and feedback provided to staff. Processes vary for this to occur. In some hospital and residential care facilities, computerised systems are used for incident reporting. In other facilities, paper based Incident Reports are completed. The latter should ideally be computerised to enable collation of information for a ward/unit/facility, and for this information to be conveyed back to staff. Advantages of a computerised Incident Reporting system include the speed of information being conveyed, and the capacity for regular analyses and feedback.

Information from Incident Reports can be used for a number of purposes:

- to monitor falls incidence over time
- to identify patterns in falls circumstances in a ward/unit/facility
- to identify potential interventions for individuals or for the entire ward/unit/facility [158], or
- to provide regular feedback about the effectiveness of falls prevention programs for a ward/unit/facility.

Falls and fall-related injury data can be collected and reported in a number of ways. The selected method will depend upon the intended use of the data. (refer to section f).

e) Review patient/resident and risk minimisation strategies

If a patient/resident falls it is important to review their documented risk factors and strategies in place for minimising falls risk. The rationale for this is that risk factors may change or strategies for minimising risk may need to be altered. Having a fall is also a strong predictor of future falls [38]. Approximately a third of fallers in hospitals and residential care facilities are multiple fallers [159,160].

Using falls data for quality improvement

f) Comparison over time, or with other organisations

If comparing falls and fall-related injuries in a hospital or residential care setting over time, it is preferable to report the data in falls/1000 bed days, as this will take into account any fluctuations over time with respect to bed occupancy, bed closures, etc.
To calculate falls/1000 bed days for each month, use the following formula:

Number of falls for the month/(number of patient bed days occupied in that period/1000)

A similar calculation can be made to establish fall-related injuries/1000 bed days [161].

Another advantage of calculating falls rates in this way is that it enables comparisons to be made with reported rates in other similar settings, as it is the most commonly used method for reporting falls and fall-related injury data in the research literature.

g) Setting a target

Facilities may want to set a target falls rate to work towards. Falls rates often fluctuate over time due to a range of factors, and therefore baseline information should be reviewed for at least the preceding 6 months to determine the average falls rate to use as the baseline measure. A target reduction level can then be set by:

- determining a clinically meaningful reduction in the baseline rate (often 20 – 30% reductions have been set as targets), or
- using a statistical method (calculating 95% confidence intervals), which involves analysis of the preceding 6 – 12 months falls data statistically. The 95% confidence interval analysis will identify a lower limit, beyond which a statistically significant reduction in falls has occurred.

h) Providing local data to ward or unit staff

Following baseline data collection to establish the targets for the falls prevention project, data should be provided back to ward or unit staff on a regular (eg monthly) basis.

When providing falls/fall-related injury data back to wards or units to keep them informed about progress, the data needs to be in a clinically meaningful form. The most tangible statistic for ward/unit staff will be the actual number of patient/residents who have fallen each month, and the number of falls.

The Process Model and Quality Improvement

Given the magnitude of the problem of falls and fall-related injuries in residential care and hospital settings, and the increasing evidence that many falls can be prevented, there is a need for a systematic, organisation-wide approach to falls and fall-related risk minimisation in hospital and residential care settings. There is little research evaluating the effectiveness of these type of interventions on reducing falls in hospitals or residential care settings.

The patient/resident-centred component of the Process Model, used as a basis for this Research Supplement, needs to exist within an organisational framework of activities, processes, and policies and procedures for the monitoring and improvement of safety and quality of care. (see page 40, “Minimising the risk of falls and fall-related injuries: Guidelines for acute, sub-acute and residential care settings” document).

Using a survey of the context in which falls occurred in a hospital setting, Grenier-Sennelier et al identified organisational causes as a main contributory factor in 66% of falls [162]. Some of the factors the authors identified were general environmental hazards, problems with equipment, lack of supervision/ observation, and poor co-ordination of patient/professional care.

Reviewing and modifying activities which form part of routine practice can influence falls risk. Fo example increasing staff availability for supervision of patient/residents, particularly at times which are associated with most falls occurring (commonly meal times and showering/personal care times) may reduce the likelihood of falls. Changes such as staggering times for staff breaks, and reviewing frequency and timing of showering/personal care to reflect the patient/resident’s preferences and routines prior to hospitalisation or admission to residential care, may result in increased staff capacity for observation [173].

Other falls prevention guidelines

Several recent guidelines for falls prevention across the community, hospital, and/or residential care settings which may be useful include:

- Registered Nurses Association of Ontario (2002). Nursing best practice guidelines: Prevention of falls and fall-related injuries in the older adult. Ontario, Canada [168]
- Queensland Health (2001). Falls prevention best practice guidelines for public hospitals and State Government residential aged care facilities. Brisbane (updated in 2003 with a community supplement) [169]
- Feder, G., Cryer, C., Donovan, S. and Carter, Y. (2000). "Guidelines for the prevention of falls in people over 65." British Medical Journal 321: 1007-11 [170]
- American Geriatrics Society, British Geriatrics Society, Academy of Orthopaedic Surgeons and panel on falls prevention (2001). "Guidelines for the prevention of falls in older persons." Journal of the American Geriatrics Society 49: 664-72 [171]
- American Medical Directors Association and American Health Care Association (1998). “Falls and Fall Risk: Clinical Practice Guidelines” [172].

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Research summary tables

The following Tables summarise the randomised controlled trials in hospital and residential care settings that have demonstrated a significant effect of intervention on reducing falls or fall-related injuries.

Restraints

Evans, D., Wood, J., & Lambert, L. (2003). Patient injury and physical restraint devices: a systematic review. *J Adv Nurs*, 41(3), 274-282.	
Design:	Systematic review
Participants:	N/A
Intervention(s):	Reviewed studies that involved people in an acute care hospital or residential care facility that investigated the use of physical restraints and reported outcomes related to direct or indirect injury. The type of research design did not matter.
Results/Conclusion:	Acute setting: o Restrained patients are more likely to fall during hospitalisation, have an increased length of hospitalisation, are more likely to develop bladder and bowel incontinence, and have mobility-related problems than are non-restrained patients. Residential care: o Restrained residents are more likely to fall, suffer serious fall-related injury or fall-related fracture, have an increased incidence of bladder & bowel incontinence, have the same amount or more agitated behaviours, have greater cognitive decline, and have an increase in disorientation and dependence during physical ADL's and walking than non-restrained residents.
Level of Evidence:	I

Evans, L. K., Strumpf, N. E., Allen-Taylor, L., Capezuti, E., Maislin, G., & Jacobsen, B. (1997). A clinical trial to reduce restraints in nursing homes. *Journal of American Geriatrics Society*, 45, 675-681.	
Design:	Randomised controlled trial
Participants:	463 nursing home residents, aged older than 60 years. Control group: n=184, Intervention group A: n=152, Intervention group B: n=127
Intervention(s):	Intervention A: restraint education that involved increasing staff awareness of restraint hazards and knowledge about assessing and managing resident behaviours likely to lead to use of restraints. Intervention B: restraint education as well as 12 hours per week of unit-based nursing consultation to facilitate restraint reduction in residents with more complex conditions.
Results/Conclusion:	o Intervention B resulted in statistically significant reduction in restraint prevalence (when compared with baseline measures), whereas Intervention A and the control group did not. o Significant difference in serious fall-related injuries between intervention A and B (p=0.026). o Results suggest that a 6 month long educational program combined with unit-base, resident-centred consultation can reduce use of physical restraints in nursing homes effectively and safely.
Level of Evidence:	II (randomisation by unit)

Multi-factorial Interventions

Becker, C., Kron, M., Lindemann, U., Sturm, E., Eichner, B., Walter-Jung, B., et al. (2003). Effectiveness of a multifaceted intervention on falls in nursing home residents. *J Am Geriatr Soc*, 51(3), 306-313.	
Design:	Cluster randomised controlled trial.
Participants:	981 residents (mean age of 85) from 6 nursing homes. Intervention group: 3 nursing homes, n=509; Control group: 3 nursing homes, n=472.
Intervention(s):	Multi-factorial intervention that included: o staff and resident education o advice on environmental adaptations o exercise o hip protectors o feedback to facility on falls data.
Results/Conclusion:	o Significant difference between the intervention and control groups for the incidence density rate of falls (RR=0.55, 95% CI = 0.41-0.73) (p<0.001), incidence density rate of frequent fallers (RR=0.56, 95% CI = 0.35-0.89) (p=0.015) and incidence density rate of all fallers (RR=0.75, 95% CI = 0.35-0.98) (p=0.038). o No significant difference found between the intervention and control groups for the incidence density rate of hip fractures (RR=1.11, 95% CI = 0.49-2.51) (p=.801) – however adherence to hip protectors was low. o Data supports the notion that multi-factorial interventions are likely to be beneficial in long term care populations.
Level of Evidence:	II (randomised by unit)

Haines T, Bennell K, Osborne R, Hill K. (2004). Effectiveness of a targeted falls prevention program in a sub-acute hospital setting - a randomised controlled trial. *British Medical Journal,* 328(7441): 676.	
Design:	Randomised controlled trial
Participants:	616 consecutive patients admitted to sub-acute hospital wards.
Intervention(s):	Multidisciplinary risk assessment and targeted interventions, including: o Falls risk alert card with an information brochure o Provision of hip protectors o Group exercise program o Patient education program.
Results/Conclusion:	o Significant reduction (30%) in the number of falls in the intervention group compared with the control group. o Non-significant trend for the reduction in the proportion of patients who had a fall related injury (28% lower in the intervention group, p=0.2).
Level of Evidence:	II

Jensen, J., Lundin-Olsson, L., Nyberg, L., & Gustafson, Y. (2002). Fall and injury prevention in older people living in residential care facilities. A cluster randomized trial. *Ann Intern Med*, 136(10), 733-741.	
Design:	Cluster randomised controlled trial.
Participants:	A total of 402 residents from 9 nursing homes, who were all older than 65 years of age. Intervention group: 4 nursing homes, n=194; Control group: 5 nursing homes, n=208.
Intervention(s):	Multi-factorial (multi-disciplinary) program for 11 weeks which included: o staff education o environmental modification o exercise o supply or repair of aids o change in medications o hip protectors o post-fall problem-solving conference o staff guidance.
Results/Conclusion:	o Significant difference between the intervention and the control groups in the number of residents who fell (risk ratio = 0.78, 95% CI = 0.64-0.96). o When adjusted for baseline factors there was a significant difference between the intervention and control groups for multiple fallers (OR=0.58, 95% CI = 0.38-0.89). o When adjusted for baseline factors there was a significant difference between the intervention and control groups for the incidence of falls / 1000 person-days (incidence rate ratios = 0.60, 95% CI = 0.50-0.73). o Significant difference between the intervention and control groups for the time to first fall (hazard ratio = 0.71, 95% CI = 0.54-0.94). o When adjusted there was a significant difference between the intervention and control groups for having a femoral fracture (OR=0.23, 95% CI = 0.06-0.94).
Level of Evidence:	II (randomised by unit)

Jensen, J., Nyberg, L., Gustafson, Y., & Lundin-Olsson, L. (2003). Fall and injury prevention in residential care--effects in residents with higher and lower levels of cognition. *J Am Geriatr Soc*, 51(5), 627-635.	
Design:	Cluster randomised trial.
Participants:	362 residents from 9 residential care facilities, aged 65 and older. Intervention group: 4 nursing homes, n=186; Control group: 5 nursing homes, n=192. Low cognition: MMSE < 19, High cognition: MMSE ≥ 19.
Intervention(s):	Multi-factorial program targeting both general & resident-specific risk factors, including: o staff education o environmental modification o exercise o supply or repair of aids o change in medications o hip protectors o post-fall problem-solving conference o staff guidance.
Results/Conclusion:	o Significant difference between intervention and control groups for reduction in number of falls in higher cognition group but not for lower cognition group (adjusted incidence rate ratio for falls, p=0.016 and p=0.121 respectively). o Significant difference between intervention and control groups for time to first fall in higher cognition group but not for lower cognition group (adjusted hazard ratio, p<0.001 and p=0.420 respectively). o Concluded that those in the lower cognition group did not respond as well to this multi-factorial intervention compared to those in the higher cognition group, indicating that further investigation is needed to determine effective falls prevention interventions for those with lower cognition.
Level of Evidence:	II (randomised by unit) - subanalysis

Ray, W. A., Taylor, J. A., Meador, K. G., Thapa, P. B., Brown, A. K., Kalihara, H. K., et al. (1997). A randomised trial of a consultation service to reduce falls in nursing homes. *Journal of American Medical Association*, 278(7), 557-562.	
Design:	Randomised controlled trial.
Participants:	482 nursing home residents at high risk for falling and with a potential safety problem that could be addressed by the intervention. Intervention group: n=221, Control group: n=261. Participating facilities stratified by number of beds, then randomly allocated to intervention or control group.
Intervention(s):	Multidisciplinary, comprehensive structured individual assessment, with specific safety recommendations that targeted suboptimal practices for environmental and personal safety, wheelchair use, psychotropic drug use and transferring and ambulation.
Results/Conclusion:	o Fewer recurrent fallers in the intervention facilities compared to the control facilities (95% CI = 2.4%-35.8%, p=0.03). o 31% fewer injurious falls in the intervention facilities compared with the control facilities, however this was not statistically significant. o Subgroup analyses suggested greatest benefits for residents for whom the recommended interventions were carried out or who had 3 or more falls in the preceding year.
Level of Evidence:	II (randomised by setting after stratification by number of beds)

Hip Protectors

Harada, A., Mizuno, M., Takemura, M., Tokuda, H., Okuizumi, H., & Niino, N. (2001). Hip fracture prevention trial using hip protectors in Japanese nursing homes. *Osteoporos Int*, 12(3), 215-221.	
Design:	Randomised controlled trial
Participants:	164 female Japanese residents from 6 nursing homes with a mean age of 83.2 years. Intervention group: n = 89; Control group: n = 76.
Intervention(s):	○ 3 sets of hip protectors per year with instructions to wear them 24 hours a day.
Results/Conclusion:	○ Compliance rate (wearing the hip protector for 24 hours) of 70%. ○ There was a significant difference between the intervention group and the control group for both number of hip fractures (1 vs 8, p=0.013) and annual hip fracture rate (1.2 vs 9.7, p=0.013). ○ The 1 hip fracture that occurred in the intervention group happened while the resident was not wearing their hip protector. ○ Concluded that the hip protector is a beneficial device for the prevention of hip fractures in the frail elderly who are at high risk of falling and have low bone strength.
Level of Evidence:	II

Kannus, P., Parkkari, J., Niemi, S., Pasanen, M., Palvanen, M., Jarvinen, M., et al. (2000). Prevention of hip fracture in elderly people with use of a hip protector. *N Engl J Med*, 343(21), 1506-1513.	
Design:	Cluster randomised trial
Participants:	Elderly adults from 22 community based health care centres that had treatment units (geriatric long-stay facilities or outpatient care units for supported living at home). Intervention group: n=446 at baseline and total of 653. Control group: n = 981 at baseline and total of 1148.
Intervention(s):	Hip protector, where patients were provided with information on the use of hip protectors and were required to wear them whenever they were on their feet and especially when they were at high risk of falling.
Results/Conclusion:	○ Mean compliance rate (number days protector was worn as % of all available follow-up days) = 48%. ○ Few adverse effects resulting from use of hip protector. ○ 13 fractures in intervention group (21.3 hip fractures per 1000 person years) compared with 67 in control group (46 hip fractures per 1000 person years) (relative hazard of hip fracture in intervention group: 0.4; 95% CI = 0.2-0.8, p = 0.008). ○ Relative hazard of hip fracture while wearing hip protector was 0.2 (95% CI = 0.05-0.5, p = 0.002). ○ Results indicate that among ambulatory elderly adults who are at an increased risk for hip fracture, the risk of fracture can be reduced by 60% by the use of an anatomically designed external hip protector.
Level of Evidence:	II (randomised by unit)

Lauritzen, J., Petersen, M., & Lund, B. (1993). Effect of external hip protectors on hip fractures. *Lancet*, 341, 11-13.	
Design:	Randomised controlled trial
Participants:	665 nursing home residents aged over 69 years. Intervention group: n=247 (167 women, 80 men), Control group: n=418 (277 women, 141 men).
Intervention(s):	Hip protectors – three sets of underpants and one pair of hip protectors.
Results/Conclusion:	○ The use of external hip protectors in the intervention group reduced the risk of hip fracture by 53%. ○ 9 hip fractures were estimated to have been avoided in the intervention group through the use of external hip protectors. ○ Fall register analysese indicate that no hip fracture was sustained by any of the 6 residents who were wearing hip protectors at the time of direct trauma to the hip. ○ None of the 8 residents from the intervention group who had a hip fracture were wearing a hip protector at the time of the fracture.
Level of Evidence:	II (randomisation by nursing home unit)

Meyer, G., Warnke, A., Bender, R., & Muhlhauser, I. (2003). Effect on hip fractures of increased use of hip protectors in nursing homes: cluster randomised controlled trial. *BMJ*, 326(7380), 76.	
Design:	Cluster randomised controlled trial.
Participants:	942 residents from 42 nursing homes (49 clusters - nursing home by itself or an independently working ward of large nursing home), who were 70 years or older, not bedridden and had lived in the nursing home for more than 3 months. Intervention group: 25 clusters, n=459 residents; Control group: 24 clusters, n=486 residents.
Intervention(s):	○ Control group = usual care, nominated study co-ordinator received a brief 10 minute information session about and demonstration of hip protectors, as well as 2 hip protectors for demonstration purposes. ○ Intervention group = staff received structured education sessions (consisting of 60-90 minutes in small groups, covering risk of hip fracture and related morbidity, strategies to prevent falls and fractures, effectiveness of hip protectors, relevant aspects known to interfere with use of protector, and strategies for successful implementation) and then taught residents the about hip protectors. Participants were provided with 3 free hip protectors.
Results/Conclusion:	○ 21 hip fractures in 21 (4.6%) residents in intervention group and 42 hip fractures in 39 (8.1%) residents in control group (relative risk 0.57, absolute risk different –3.5%, 95% CI =7.3% - 0.3%, p=0.072). ○ After adjustment for cluster randomisation hip protectors were used on average by 15% of residents who fell in the control group compared with 68% of residents in the intervention group (40/274 vs 158/237, p=0.0001). ○ More hospital admissions in the control group than in the intervention group (when adjusting for cluster randomisation, p=0.015). ○ Shown that a structured education program and provision of free hip protectors can increase use and may reduce the number of hip fractures.
Level of Evidence:	II (randomisation by nursing home unit)

Parker, M., Gillespie, L., & Gillespie, W. (2001). Hip protectors for preventing hip fractures in the elderly: *Cochrane review*.	
Design:	Systematic review
Participants:	N/A
Intervention(s):	Looked at all randomised or quasi-randomised controlled trials comparing the use of hip protectors with a control group.
Results/Conclusion:	○ Pooling of the data from the 7 trials in which randomisation was by individuals showed no significant reduction in the incidence of hip fracture in those allocated to wearing hip pads (4.9% vs 5.9%, RR = 0.94, 95% CI = 0.67 – 1.31). ○ Pooling of data from 5 individually randomised trials conducted in nursing/residential care settings showed no statistically significant reduction in hip fracture incidence (4.5% vs 6.6%, RR = 0.83, 95% CI = 0.54 – 1.24). ○ Individually each of the studies that used cluster randomisation reported a reduced incidence of hip fractures within the units allocated to receive hip protectors, however pooling of these results was not possible. Reviewer's conclusions: ○ Reported studies which have used individual patient randomisation have provided insufficient evidence for the effectiveness of hip protectors when offered to older people living in institutional care or in their own home. ○ Data from cluster randomised studies provide some evidence of effectiveness of hip protectors in reducing the risk of hip fractures in those living in nursing homes and considered to be a high risk of hip fractures. ○ The only reported adverse effects of hip protectors are skin irritation, abrasion and local discomfort. ○ Compliance with wearing the protectors remains a problem.
Level of Evidence:	I

van Schoor, N. M., Deville, W. L., Bouter, L. M., & Lips, P. (2002). Acceptance and compliance with external hip protectors: a systematic review of the literature. *Osteoporos Int*, 13(12), 917-924.	
Design:	Systematic review
Participants:	N/A
Intervention(s):	Looked at studies that had hip protectors as the intervention, compliance or primary acceptance as the outcome measurements and participants that were aged 65 or over.
Results/Conclusion:	○ Compliance varied from 24% - 92%, with a median compliance of 57% - however compliance was defined in many different ways in different studies (or not defined at all). ○ Factors that may influence compliance negatively include musculoskeletal or cerebral disorders, adverse effects (skin irritation, abrasion, swelling of legs, bowel irritation), hip protector experienced as too hot, uncomfortable in bed, necessitating assistance in toileting, bedridden. ○ Factors that may influence compliance positively include good understanding and sufficient motivation of institution staff or staff commitment, dementia, hip protectors feeling warm, increasing feeling of safety, decreasing fear of falling, positive attitude of staff because patients could be left to walk around more freely. ○ Hip protectors can improve self-confidence and diminish self-restrain of physical activity. ○ When choosing a hip protector you should consider compliance, biomechanical and clinical effectiveness. ○ It has been shown that compliers were younger ($p<0.05$) and had lower grip strength ($p<0.01$) than drop-outs, more drop-outs than compliers experienced hip protectors as uncomfortable ($p<0.001$) and found appearance of the hip protectors unattractive ($p<0.001$), fewer drop-outs found hip protectors useful ($p<0.001$), fallers more compliant than non-fallers ($p<0.01$). ○ Recommend that acceptance should be defined as "the percentage of persons who agree to wear the hip protector".
Level of Evidence:	I

Falls prevention programs

Oliver, D., Hopper, A., & Seed, P. (2000). Do hospital fall prevention programs work? A systematic review. *Journal of the American Geriatrics Society*, 48, 1679-1689.	
Design:	Systematic review
Participants:	N/A
Intervention(s):	Reviewed articles that described fall rates before and during an intervention. Studies were classified according to 7 interventions: risk assessment, education or awareness program, equipment checks, labels or bracelets for high risk patients, use of alarms, restraints or tailored nursing care plan. Not all studies reviewed were randomised controlled trials.
Results/Conclusion:	○ Pooling the 3 randomised controlled trials gave an estimated effect of 1 (ie. Null; 95% = CI 0.60-1.68), while pooling the 7 prospective studies with historical controls gave an estimated effect of 0.76 (95% CI = 0.65-0.88). Pooling all 10 studies provided an estimated effect of 0.79 (95% CI = 0.69-0.89). ○ The restricted maximum likelihood meta-analysis did not suggest that any particular intervention within individual programs was more or less effective. ○ It may be that in frail older patients recovering from acute illness falls are largely unpreventable without adversely affecting rehabilitation and that more emphasis should be placed on interventions that prevent resultant morbidity. ○ In conclusion, it is suggested that in order to implement a successful falls prevention program in a hospital thought needs to be given to the study design.
Level of Evidence:	I

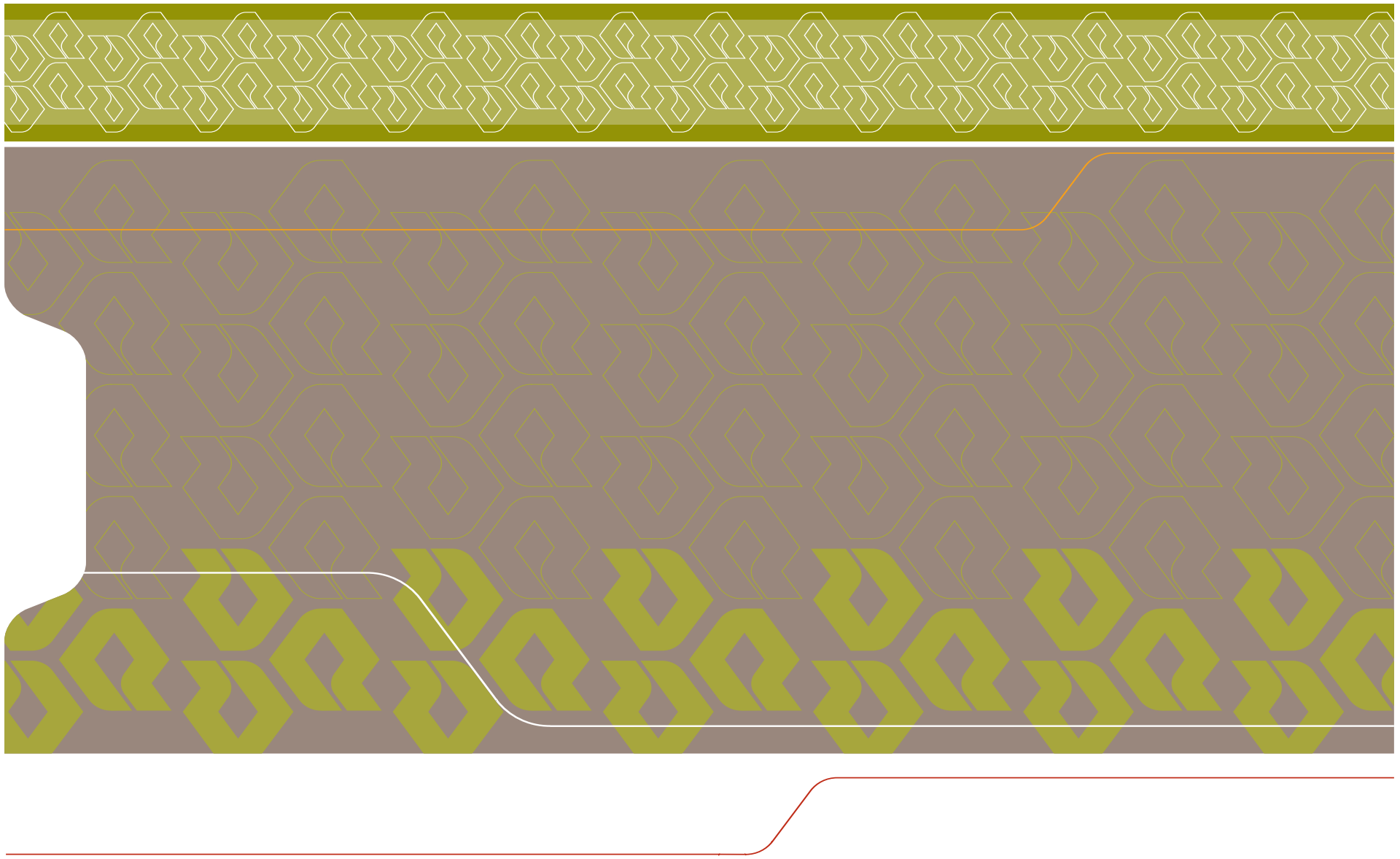
Vitamin D

Bischoff, H. A., Stahelin, H. B., Dick, W., Akos, R., Knecht, M., Salis, C., et al. (2003). Effects of vitamin D and calcium supplementation on falls: a randomized controlled trial. *J Bone Miner Res*, 18(2), 343-351.	
Design:	Randomised double-blind controlled trial.
Participants:	122 female participants, aged 60 or older, from a long-stay geriatric care unit who were awaiting placement in a nursing home and could not live independently. Intervention group (Calcium + vitamin D): n=62, Control group (Calcium only): n=60.
Intervention(s):	Intervention group: ○ 1200mg calcium plus 800 IU cholecalciferol (Vitamin D) per day over a 12 week treatment period. Control group: ○ 1200mg calcium per day over a 12 week treatment period. * tablets for both groups were identical in appearance.
Results/Conclusion:	○ After adjustments there was a 49% reduction in falls for the Calcium + Vitamin D (intervention) group(95% CI = 14-71%; p<0.01). ○ There was no significant difference between groups for the number of fallers, however the direction of the effect was in favour of the Calcium + Vitamin D group with a 30% lower risk of being a faller. ○ The results indicate that Vitamin D and Calcium supplementation decrease falls and improve musculoskeletal function within 3 months of treatment in elderly women with Vitamin D deficiency.
Level of Evidence:	II

Chapuy, M., Arlot, M., Duboeuf, D., Brun, J., Crouzet, B., Arnaud, S., et al. (1992). Vitamin D3 and calcium to prevent hip fractures in elderly women. *New England Journal of Medicine*, 327, 1637-1642.	
Design:	Randomised controlled trial.
Participants:	3270 ambulatory female participants, aged 69 or older, living in nursing homes or apartment houses for elderly people. Intervention group (Calcium + vitamin D): n=1634, Control group (placebo): n=1636.
Intervention(s):	Intervention group: o 1.2g calcium plus 800 IU Vitamin D3 per day over an 18 month treatment period. Control group: o 2 placebo pills per day over an 18 month treatment period.
Results/Conclusion:	o Number of hip fractures was 43% lower (p=0.043) in the intervention group compared with the control group. o There was a marked increase in the incidence of hip fracture over time for the control group, whereas the incidence in the intervention group was stable, indicating that treatment reduced the age-related risk of hip fracture at 18 months (p=0.007). o Bone mineral density of the total proximal femur region increased by 2.7% in the intervention group and decreased by 4.6% in the control group (p<0.001). o The results of this study indicate that Vitamin D3 and calcium supplements reduce the risk of hip fracture and increase the bone mineral density of the proximal femur in elderly women.
Level of Evidence:	II

Chapuy, M. C., Pamphile, R., Paris, E., Kempf, C., Schlichting, M., Arnaud, S., et al. (2002). Combined calcium and vitamin D3 supplementation in elderly women: confirmation of reversal of secondary hyperparathyroidism and hip fracture risk: the Decalyos II study. *Osteoporos Int*, 13(3), 257-264.	
Design:	Randomised controlled trial.
Participants:	583 ambulatory female participants (mean age 85 years), living in apartment houses (defined as institutions) for elderly people. Intervention group 1 (Calcium-Vitamin D3 fixed combination): n=199, Intervention group 2 (Calcium and Vitamin D3 separate supplements): n=190, Control group (placebo): n=194.
Intervention(s):	Intervention group 1: o Fixed combination of 1200mg calcium and 800 IU Vitamin D3 daily for 2 years. Intervention group 2: o 1200mg calcium and 2 pills of 400 IU Vitamin D3 daily for 2 years. Control group: o placebo daily for 2 years.
Results/Conclusion:	o The relative risk of hip fracture in the control group compared with the two intervention groups was 1.69 (95% CI = 0.96 - 3). o The results of this study are similar to the results found in Chapuy et al (1992), although results in this smaller sample did not quite reach statistical significance. These results, in combination with the Chapuy et al (1992) study, support the finding that Vitamin D3 and calcium supplements reduce the risk of hip fracture in elderly women.
Level of Evidence:	II

Latham, N. K., Anderson, C. S., & Reid, I. R. (2003). Effects of vitamin D supplementation on strength, physical performance, and falls in older persons: a systematic review. *J Am Geriatr Soc*, 51(9), 1219-1226.	
Design:	Systematic review
Participants:	N/A
Intervention(s):	Reviewed all randomised controlled clinical trials that investigated the effectiveness of vitamin D supplementation in preventing falls and improving physical function in older people (mean age of 60).
Results/Conclusion:	○ 6 trials met the quality criteria for data pooling but the only outcome that could be pooled across all studies was the number of people who fell and the data could only be obtained for 4 trials. Pooled data showed no evidence of an overall effect (RR = 0.99, 95% CI = 0.89-1.11). ○ No evidence was found to support the hypothesis that vitamin D alone improves strength or physical function or reduces the risk of falls in older people. ○ However there is some evidence that suggests that older people who receive vitamin D combined with calcium supplements may improve their physical function and reduce their risk of falls but this is not definitive because the studies that showed this effect did not have a rigorous methodology. ○ Cross-sectional data suggest an association between vitamin D deficiency and falls and functional limitations in older people. ○ In conclusion, based on current evidence, vitamin D alone does not appear to improve strength or physical function or reduce the risk of falls in older people, however evidence suggests that vitamin D combined with calcium supplementation may have a beneficial effect.
Level of Evidence:	I



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