‘An analysis of research on preventing falls and falls injury in older people: Community, residential care and hospital settings’

(2004 update)

National Falls Prevention for Older People Initiative.
‘An analysis of research on preventing falls and falls injury in older people: Community, residential care and hospital settings’

(2004 update)

Report to the
Australian Government, Department of Health and Ageing, Injury Prevention Section
by the
National Ageing Research Institute

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Executive summary

Australian and overseas studies of community dwelling older people have identified that approximately one in three people aged 65 years and over fall each year, with 10% having multiple falls, and over 30% experiencing injuries requiring medical attention. The rate of falls and associated injuries is even higher for older people in residential care and hospital settings. The effects of falls are costly to the individual in terms of health, function and quality of life. Falls are also costly to the community, with management of injurious falls in Australia estimated in 2001 to cost $AUD 498.2 million. National targets for reducing falls related deaths and hospitalisations for Australians aged 65 years and over have been established as part of the National Health Priority Area (Injury Prevention) program since 1986. Falls Prevention for older people is also a priority under the National Injury Prevention Plan: Priorities for 2001-2003. Most recent figures from the Australian Institute of Health and Welfare indicate no clear upward or downward trend in age standardised falls related mortality or hospitalisation data. However, case numbers are rising because of the increase in the proportion of the population at the ages of greatest risk. Unless a coordinated, effective falls prevention strategy is implemented, the emotional, physical, personal and health resource costs associated with falls among older Australians are likely to continue increasing. Projections estimate overall health costs associated with falls for people aged over 65 in Australia will increase 2.7 times by the year 2051 (Moller, 2003).

This report updates the available research evidence for effective strategies in reducing falls and injurious falls rates among older people, building on a research review published in 2000. The work was conducted for the Injury Prevention Section, Population Health Division, Australian Government, Department of Health and Ageing.

A search of the Australian and international literature was conducted using common electronic health and scientific research databases – spanning from 1980 to the present. Search terms included combinations of:

- fall / injury / fracture;
- setting type, eg community, hospital, aged care, residential care;
- falls risk factors, including polypharmacy, environment, activity, dizziness, vision, and cognition;
- falls prevention program types, including 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 from existing files held by the research team. All papers were reviewed using criteria developed by the National Health and Medical Research Council (as reported in (Robertson & Gardner, 1997)). This four level system was used to classify each paper according to the strength of evidence that can be derived given the specific methodology used in the paper. Broadly speaking, Level I and II evidence relates to randomised controlled trials, Level III evidence comes from non-randomised controlled trials and Level IV evidence relates to descriptive studies and expert consensus or opinion.

There continues to be considerable research activity in falls prevention being undertaken in Australia. We have noted within the review where known studies are nearing completion or have been completed, but for which results have not yet been reported. It is acknowledged that the results of these projects need to be incorporated into the framework of a review such
as this when they become available, and that interpretation and priorities based on the available evidence needs to be sufficiently flexible to adapt as new findings are reported.

A. Community settings
One in three community dwelling older Australians experiences one or more falls in a 12 month period. While the costs associated with the 10% of falls causing serious injury have been reported, the consequences of less injurious falls are often neglected. Factors such as fear of falling and reduced activity level can have a profound impact on the function and quality of life of older people, and over time, may increase an individual’s risk of subsequent falls. As such, falls prevention programs need to address both primary and secondary prevention, and not focus solely on older people with injurious falls.

Evidence of effectiveness in reducing falls rates
There is considerable research evidence from randomised controlled trials among community dwelling older people of the effectiveness of falls prevention programs targeting single falls risk factors. These include:

- targeted home exercise programs incorporating balance and strengthening exercises, developed by a physiotherapist following an assessment;
- group exercise programs incorporating a combination of balance, strength, mobility and fitness exercises;
- group exercise programs using an abbreviated set of forms from the 24 form Tai Chi Quan;
- vitamin D and calcium supplementation (in a mixed community/residential care sample);
- trained volunteers providing in-home health promotion, health screening and falls prevention information;
- psychotropic medication review and graduated withdrawal;
- home visits by an occupational therapist incorporating home modifications and advice regarding behavioural change to minimise falls risk (effective in a subgroup of older people with a recent history of falling); and
- enhanced post-discharge follow-up for older people admitted to a geriatric hospital with functional or mobility decline.

Given that multiple risk factors are often involved in falls, a falls prevention program addressing more than one falls risk factor is more likely to reduce falls rates than a single intervention. Research evidence from several randomised controlled trials has identified the effectiveness of a specialist assessment followed by a targeted management approach, as well as programs where a number of falls prevention strategies are bundled together, in reducing falls rates. These results have been replicated in samples of older people with high risk of recurrent falls and injuries, for example, older people presenting to an Emergency Department after a fall.

Results from several randomised controlled trials of falls prevention programs for older people living in the community are nearing completion in Australia. Areas being investigated include Tai Chi; a multifaceted community based program using a small-group learning environment aiming to improve self-efficacy, and facilitate behaviour change in reducing falls; and a process for falls prevention screening by general practitioners. Results from these studies need to be integrated with the results of this review as they become available.

A number of other commonly applied interventions such as education/information sessions, and environmental modification by itself, have either not been evaluated, or have been
evaluated using methods that have produced level III or IV evidence. Each of these strategies in isolation appear less likely to be able to have a major impact on reducing falls rates among community dwelling older people.

Uptake and ongoing participation by older people in the falls prevention activities being recommended has been shown to be a limitation of most studies. Engaging older people to recognise their individual risk, and adopting strategies to facilitate informed decision making are important factors likely to increase uptake of falls prevention recommendations. There is a need to better understand the factors (perceptions, actions and behaviours) that lead the older person to implement changes to prevent falls. This is an area that warrants further study.

Evidence of effectiveness in reducing falls injury rates
There is a paucity of research addressing the effectiveness of falls prevention programs in reducing serious injuries or fractures resulting from falls in community dwelling older people. A factor contributing to the limited research in this area is the relatively low rate of falls causing serious injuries. There is a need for studies incorporating long term follow-up and large sample sizes to have the statistical power to identify changes between a control and intervention group in terms of fractures or serious injuries. In epidemiological terms, serious injurious falls are a relatively rare event, however in terms of their effect on the individual and the associated health resource costs, they warrant a strong focus in falls prevention programs and research.

Directions for future research
There are a number of areas where there is good justification for further research to investigate the effectiveness of falls prevention interventions which appear to be effective. Research should incorporate the measurement of change in falls or falls related injuries among their outcome measures. Areas warranting further research include:
- methods to improve uptake and ongoing participation by older people in recommended falls prevention actions;
- early identification of falls risk;
- training of health workers, including general practitioners, in falls risk factor screening and management protocols;
- comparative effectiveness of different types and intensity of exercise programs;
- early identification and management of sensory loss, in particular vision, and vestibular dysfunction;
- the effectiveness of different shoe types, appropriate gait aid prescription, and use of personal alarm devices;
- interventions to reduce falls among people with cognitive impairment. Almost all studies which have been effective in reducing falls in the community setting have excluded this high falls risk group;
- analysis of sub-group characteristics such as compliance levels and degree of response to the intervention; and
- cost effectiveness associated with the various interventions.
B. Residential care settings

Falls rates among older people in residential care settings are even higher than those for community dwelling older people, with up to 50% experiencing one or more falls in a 12 month period.

Evidence of effectiveness in reducing falls rates
In contrast to the community setting, there is relatively little level I and II evidence regarding effective falls and falls related injury prevention programs in residential care settings. Randomised controlled trials have reported significant reduction in falls rates in residential care settings using the following interventions:
• a multidisciplinary assessment of high falls risk residents, combined with a multiple risk factor modification program;
• a comprehensive post-fall assessment and targeted multiple risk factor management program;
• a group exercise program;
• a multifactorial falls prevention program; and
• vitamin D and calcium supplementation (in a mixed community/residential care sample). Another randomised controlled trial comparing two models aiming to reduce physical restraint use in residential care settings also identified a reduction in injurious falls rates associated with a combined consultation review process and staff education program, relative to an education program or a control group.

Evidence of effectiveness in reducing falls injury rates
Wearing of hip protectors has been shown to reduce hip fracture rates in residential care settings, although issues of compliance with wearing the hip protectors have been identified as an important factor limiting uptake of this intervention. Strategies to improve compliance with use of hip protectors in at-risk-individuals in residential care settings warrants further investigation.

Directions for future research
The underlying theme in several of the randomised controlled trials reporting successful reduction in falls rates in residential care settings is that they incorporated individual assessment or review, combined with multiple falls risk factor management. Given the high falls and injury rates in residential care settings, it is likely that such an approach, although requiring moderate resource utilisation, may be a cost effective strategy over time. This issue warrants further investigation. There are several important considerations with this type of assessment or review process that have not been addressed by the research literature. These include:
• who undertakes the assessment or review process? In the randomised controlled trials shown to effectively reduce falls rates, one utilised a multidisciplinary assessment, while the other involved referral to the primary care physician. This type of assessment could possibly also be undertaken by nursing or other staff in residential care settings;
• when the assessment or review process should be undertaken? It is likely that falls risk assessment would be important for a new resident, perhaps also at set time intervals, or when there is a clear change in the physical or cognitive status of a resident; and
• which residents should be included in the assessment process - all residents, or only those identified as being at risk of falling, or all residents who have a fall?
There are some clear differences between older people living in residential care settings and those living in the community, including increased number of comorbidities and reduced activity options. However, it is likely that some of the falls prevention programs which have been shown to be effective in community settings may be able to be implemented successfully (perhaps with some modification) in residential care settings. Some examples which warrant investigation regarding their utility in the residential care setting include:

- different types of exercise programs, particularly those incorporating balance retraining; and
- medication review.

Cognitive impairment is an important falls risk factor in residential care settings which can add to the challenge of effective implementation of falls prevention program. Several successful falls and falls injury prevention programs in residential care settings have included residents with cognitive impairment in their sample. However, there is a need for further research utilising innovative approaches to reduce falls and falls injury for residents with cognitive impairment.

Workforce training issues are also likely to be an important component of falls prevention programs in residential care settings. There is increasing evidence that the method of workforce training will be an important determinant in the successful achievement of changes in practice that may reduce risk of falls among residents.

C. Hospital settings

Falls rates among older people in hospital settings are also high, with over 40% of patients with specific clinical problems such as stroke experiencing one or more falls during their hospitalisation.

Evidence of effectiveness in reducing falls rates

Similar to residential care settings, there is very little level I or level II evidence that falls prevention programs in hospital settings are effective in reducing falls rates. This reflects the paucity of randomised controlled trials conducted in hospital settings, rather than indicating that falls prevention programs are not effective in hospital settings. An Australian study is the first randomised controlled trial in the hospital setting to achieve a significant reduction in falls. This study, accepted for publication in early 2004, utilised a falls risk assessment and targeted interventions in the sub-acute hospital setting. A targeted multifactorial intervention program based on falls risk assessment would appear to be an important approach in reducing falls occurrence in the hospital setting, with the necessary components of the intervention in part dependent upon the specific clinical group being considered. No other randomised controlled trials have significantly reduced falls in the hospital setting. One other randomised controlled trial demonstrated a non-significant trend towards reduction in falls rates in the hospital setting with the use of a bed alarm system. Other strategies to show promising results in the literature include:

- proactive nursing interventions (involving the regular review of toileting, mobility and dietary requirements);
- restraint reduction programs targeting reduced use of bed rails; and
- medication review.

A number of factors increase the complexity of conducting and evaluating falls prevention programs in hospital settings:
• the length of stay is often relatively short, resulting in the need for falls risk identification and management programs to be undertaken and implemented quickly;
• the physical and cognitive status of older people in hospital settings can alter quickly - either increasing or decreasing falls risk;
• hospital settings vary considerably and different issues are likely to be important in the different settings of:
  • acute hospitals;
  • sub-acute or rehabilitation hospitals; and
  • other specialist hospitals.

Some of the interventions shown to be successful in reducing falls rates in other settings, particularly those in residential care settings, have the potential to be equally effective in hospital settings. In particular, the use of hip protector garments for high falls risk patients may be an effective strategy in reducing falls related injury rates.

Directions for future research
As with residential care settings, the evidence suggests that workforce training issues are important to optimise processes for early identification of falls risk, maintenance of a falls-safe environment, and incorporation of targeted falls risk factor management strategies. There is a need to explore different workforce training programs to maximise learning and likely changes to practice, in order to effectively reduce falls rates over time.

Hospital settings are the most under-developed in terms of level I and II research activity and evidence of the effectiveness of falls prevention programs. The emphasis of research in this setting should be on evaluating the applicability and translation of those programs that have been shown to be effective in community or residential care settings into hospital settings. Potential areas warranting investigation in this setting include:
• medication review, with particular focus on those medications known to be associated with increased falls risk;
• falls risk screening / assessment, and targeted multiple risk factor management programs.
  It is likely that differing tools and processes may be needed in the acute compared to the sub-acute setting. Issues around timing of screening/assessment, which staff complete the assessment, and frequency of assessment warrant further investigation;
• graduated physical activity and exercise programs; and
• strategies to increase observation of high falls risk patients.

D. Sustainability and cost effectiveness

There has been very little evaluation of factors which optimise sustainability of changes brought about by a specific program, nor of the relative cost effectiveness of the various falls prevention approaches. Moller (2003) has estimated that there is a need to reduce falls incidence by 66% in Australia by the year 2051 in order to maintain cost parity with current figures. In order to inform policy and practice, sustainability and cost effectiveness are critical elements of future program evaluation and research development.

E. Falls prevention among special groups

The Australian community comprises a number of special needs groups for whom established falls and falls related injury prevention programs may be inappropriate. For example, there is a paucity of epidemiological data and falls prevention research that has been reported for Aboriginal and Torres Strait Islander peoples, and people from Culturally and Linguistically
Diverse (CALD) backgrounds. There are likely to be some unique differences in the falls characteristics, as well as individual differences that necessitate novel approaches to falls prevention among these groups within the Australian community. Basic research into the magnitude of the problem of unintentional falls in these groups is required before approaches to interventions are evaluated. Special attention also needs to be given to reducing falls among older people with cognitive impairment in all settings.

Summary

Current data indicates that falls prevention programs in Australia are not changing the trend for increasing falls related hospitalisations during the 1990’s despite the relatively rapid growth in the number and variety of falls prevention programs in Australia. Whilst there is level I and II evidence to underpin some interventions, particularly in community settings, there are many other activities currently being funded and implemented, for which evidence of effectiveness is limited or absent. Whilst it is critical to acknowledge that absence of evidence does not equate to ineffectiveness of a program, there are some important lessons to emerge from the available research literature and consensus opinion. These are that:

- falls prevention approaches for healthy, frail, and cognitively impaired older people will differ;
- falls prevention approaches within community, residential care and hospital settings will differ;
- multifaceted interventions are preferable to single risk factor interventions, in all settings;
- workforce training needs to be addressed:
  - including a range of relevant professional groups;
  - using effective workplace learning and practice change strategies;
- economic evaluation of falls prevention programs are required;
- issues of uptake and compliance need to be addressed; and
- there are major gaps in the falls and falls related injury research literature, particularly in residential care and hospital settings.
1. Framework for review update

This research review update was conducted by the National Ageing Research Institute for the Injury prevention Section, Commonwealth Department of Health and Aged Care (Australia). The aim of this review was to update the 2000 research review (Hill et al., 2000) by:

- identifying and incorporating new evidence where specific falls prevention programs for older people have been shown to be effective in reducing falls or falls related injury rates;
- identifying gaps in the research literature; and
- considering the falls prevention research literature in the community, residential care and hospital settings.

1.1 Search strategies

The primary source of data providing evidence on the effectiveness of falls prevention programs among older people has been in the published, peer reviewed literature. Searches were conducted using the PubMed and Ovid search engines, using Index Medicus and the Cumulative Index of Nursing and Allied Health Literature (CINAHL) from 1980 to the present. Search terms included combinations of:

- fall / injury / fracture;
- setting type, eg community, hospital, aged care, residential care;
- falls risk factors, including 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.

1.2 Levels of evidence classification

All papers were reviewed using criteria developed by the National Health and Medical Research Council {as reported in (Robertson & Gardner, 1997)}. This four point rating system was used to classify each paper according to the strength of evidence that can be derived given the specific methodology used in the paper. The four levels of evidence are:

- **level I** - evidence obtained from a systematic review of all relevant randomised controlled trials (includes Cochrane reviews, and other systematic reviews and meta-analyses);
- **level II** - evidence obtained from at least one properly designed randomised controlled trial;
- **level III** - evidence obtained from well-designed controlled trials without randomisation; or from well designed cohort or case controlled analytic studies preferably from more than one centre or research group; or from multiple time series with or without the intervention; and
- **level IV** - opinion of respected authorities, based on clinical experience, descriptive studies or reports of expert committees.

All research papers were rated independently by two members of the project team.
There are a number of recently completed Australian falls prevention projects that have not yet been published. The project officers for these projects were contacted to determine when results would be available, and whether there were any preliminary results that could be incorporated into this review. Where information has been made available, this has been included within the review.

A brief summary of all publications reviewed reporting falls or falls injury outcomes which used a randomised controlled trial design (level II) has been included in the appendix, to provide the reader with a brief overview of the sample, methodology and results identified.

1.3 Methodological issues

The reviewed studies have used a wide range of study designs. This has resulted in some challenges when classifying information and selecting the most appropriate section of the report for inclusion of results. The study designs include investigation of:

- a single intervention;
- two or more single interventions in parallel;
- two or more single interventions in parallel, and in combination;
- two or more interventions, administered in combination to all subjects; and
- targeted interventions, selected on the basis of a client assessment.

Discussion of the results and evidence from each study appear in the relevant topic based sections of the report.

1.4 Falls prevention guidelines

A number of guidelines for falls prevention have been published in recent years. These provide a useful framework, together with the research evidence from this report, for the development of evidence based falls prevention programs in the community, hospital, and residential care settings. These include:

In addition, Falls Prevention Guidelines and Implementation Tools for Hospital and Residential Care Settings are near completion, and will be available from the Victorian Quality Council around mid 2004 (http://www.health.vic.gov.au/vqc/).

1.5 Table of abbreviations

AIMS      Australian Incident Monitoring System
BMD       bone mineral density
CG        control group
CI        confidence interval
ED        Emergency Department
FICSIT    Frailty and Injuries: Cooperative Studies on Intervention Techniques
FIT       Functional Incidental Training
GCU       Geriatric Care Unit
GP        general practitioner
IG        intervention group
IU        International Units
OR        Odds ratio
MMSE      Mini Mental State Examination
PBS       Pharmaceutical Benefits Scheme
RAI       Resident Assessment Instrument
RCT       randomised controlled trial
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2. Falls among community dwelling older people - Introduction

Falls among older Australians remain a major public health problem. Australian studies in the early to mid 1990’s, utilising a random selection process for recruitment of older people (aged 65 years or older), have highlighted that approximately 30% report one or more falls in the previous 12 months (Dolinis et al., 1997; Kendig et al., 1996; Lord et al., 1993). These studies have all used retrospective falls recall, which has been shown to underestimate true falls rates by 15 to 20% (Cummings et al., 1988; Hill et al., 1999). These falls rates in Australia are comparable to those reported in other countries including the United States of America (Tinetti et al., 1988), the United Kingdom (Prudham & Evans, 1981), and New Zealand (Campbell et al., 1981).

There are a number of indicators of the effectiveness of falls prevention programs both nationally and at a state level. The most commonly cited indicators include falls related mortality data and falls related hospitalisation data. This data are relatively easy to collect, and represent the most obvious impact of major falls. Up until the early 1990’s, falls related deaths in Australia had been steadily decreasing (Hill et al., 1999; Cripps and Carman, 2001). At least in part, this is considered to be due to improved acute hospital management of the older person admitted with a serious falls related injury. This trend for declining falls related death rates is similar to that reported in the United States of America (Hoskin, 1998), although data from Finland indicates no significant change in age adjusted falls related death rates there over the past 25 years (Kannus et al., 1999b). However, most recent figures from the Australian Institute of Health and Welfare indicate no clear upward or downward trend in age standardised falls related mortality data during the mid to late 1990’s (Cripps and Carman, 2001).

Another commonly reported indicator is falls related hospitalisation rates. Australian data from the early 1990’s indicated that falls related hospitalisation rates were increasing (Australian Institute of Health and Welfare, 1997), however recent analyses indicate that rates of falls related hospitalisations have remained relatively stable throughout the 1990’s (Cripps and Carman, 2001). Importantly though, the actual numbers of falls related hospitalisations is continuing to increase, due to the increasing proportion of people aged greater than 65 years (Cripps and Carman, 2001). Data from Finland also reflects a steady increase in falls related hospitalisation rates (Kannus et al., 1999b). Projections for serious injuries in Australia estimate that on current trends, the number of hip fracture patients each year will double by 2026, and increase four-fold by 2051 (Sanders et al, 1999). Other fractures commonly associated with falls (such as wrist, humerus, and pelvic fractures) are predicted to show a similar proportional increase in coming years (Sanders et al., 1999). Moller (2003) has estimated that if falls rates continue at 2001 rates, an additional 886000 hospital bed days (equivalent to an additional 2500 hospital beds) will be required in Australia per year specifically allocated to managing injuries associated with falls.

It is important to acknowledge that less than 10% of all falls cause serious injury (Tinetti et al., 1988). The remaining 90% of older fallers may experience less severe injuries, which warrant attention by a general practitioner or an Accident and Emergency Department, and many falls cause no physical injury at all. However, the effect of falls, both those which do and those which do not cause injury, is often to create a loss of confidence in mobility in the older person (Hill et al., 1996; Tinetti et al., 1994b; Yardley and Smith, 2002). This is commonly referred to as ‘fear of falling’. Over time, this can translate into a conscious reduction in the amount and types of physical activity being performed by the older person (Yardley and Smith, 2002). This in itself can increase an individual’s risk of further falls.
Australian data indicates that approximately 30% of people aged 65 years or older, living in the community, report some degree of fear of falling, and approximately 10% report severe levels of fear of falling (Kendig et al., 1996).

There has been a marked increase in the number and variety of community based falls prevention programs developed in Australia since the late 1990’s (Hill et al., 1999a). Given that there is a considerable time lag between introduction of interventions and impact being observed in a number of the key indicators, any outcomes in terms of reduced falls rates may not be evident until two or three years hence.

In summary, Australian data indicates that currently, falls among community dwelling older people remain a common public health challenge with major repercussions for older people themselves, their family and extended network, and for the wider community and health system generally. The aim of the first section of this report is to review the current research evidence for what works in falls prevention in community settings, and to identify gaps and priorities for future falls prevention activity and research.

### 2.1 Overview of falls risk factors

Numerous studies have reported risk factors for falls among community dwelling older people. Given the limitations of retrospective falls recall (Cummings et al., 1988; Hill et al., 1999b), only prospective studies, which have used multivariate analyses have been included in the following review of risk factors (Campbell et al., 1989; Colon-Emeric et al., 2002; Cwikel et al., 1998; Koski et al., 1998; Lord and Dayhew, 2001; Nevitt et al., 1989; O'Loughlin et al., 1993; Stalenhoeft et al., 2002; Tinetti et al., 1995; Vellas et al., 1998). There is limited comparability between studies due to a focus on different risk factors, and different classification of risk factors being investigated in each of these studies. However, in summarising the results, the major risk factors for one or more falls or injurious falls among community dwelling older people are:

- increased age;
- past history of falls;
- chronic medical conditions such as stroke and Parkinson’s disease;
- multiple medications, and specific medication types such as long acting benzodiazepines, and psychotropic medication;
- impaired balance and mobility;
- reduced muscle strength;
- sensory problems, including impaired visual acuity and depth perception, and peripheral neuropathy;
- dizziness;
- impaired cognition;
- depression;
- low levels of physical activity;
- low body mass index and osteoporosis (predictors of fracture risk);
- fear of falling; and
- female gender.

Each of these risk factors in isolation has been shown to be significantly associated with increased falls or injury risk among older people. However, individuals with multiple falls risk factors have an increased rate of falls compared to individuals with one falls risk factor (Cwikel et al., 1998; Tinetti et al., 1988).
All of the risk factors identified above are *intrinsic* falls risk factors, they relate to the individual’s health and functional status and physical characteristics. In addition to these, *extrinsic* falls risk factors also need to be considered in falls prevention programs. Extrinsic factors relate to an older person’s interaction with the environment. This includes environmental hazards (in the home or in public access areas), such as clutter, poor lighting, uneven flooring/ground levels, inappropriate footwear and clothing, the use of inappropriate or poorly maintained equipment and aids, and risk taking behaviour, such as climbing a ladder or using unsteady furniture for support.

### 2.2 Falls risk factor - intervention matrix

A wide range of falls prevention interventions has been developed and evaluated in community settings. Clearly, different interventions are required to address different risk factors.

A matrix has been developed to provide an overview of the degree of evidence of effectiveness of specific falls prevention program types in reducing falls (Table 1). Programs have been tabulated according to which falls risk factor/s were addressed by the specific intervention type. The highest level of evidence for a particular intervention type and risk factor has been recorded, with relevant references noted. Only studies which have demonstrated significant improvements in falls or falls injury rates have been included in the matrix. A summary of these studies is provided at the end of this report. Other relevant papers are discussed throughout the report.

An overview of single and multiple falls prevention programs for community dwelling older people is shown in Section 2.3.
Table 1. Falls risk factor - intervention matrix (community dwelling older people).

<table>
<thead>
<tr>
<th>Interventions</th>
<th>Falls risk factors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Education</strong></td>
<td></td>
</tr>
<tr>
<td>Exercise</td>
<td></td>
</tr>
<tr>
<td>Strength</td>
<td>B</td>
</tr>
<tr>
<td>Balance</td>
<td>C</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>B</td>
</tr>
<tr>
<td>Multicomponent</td>
<td>K,L,M</td>
</tr>
<tr>
<td>Medical</td>
<td></td>
</tr>
<tr>
<td>Screen</td>
<td>O</td>
</tr>
<tr>
<td>Medication</td>
<td>P</td>
</tr>
<tr>
<td>Specialist management</td>
<td>S</td>
</tr>
<tr>
<td>Environment</td>
<td>T,U*</td>
</tr>
<tr>
<td>Sensory</td>
<td>V</td>
</tr>
<tr>
<td>Injury Minimisation</td>
<td>W,X,Y,Z**</td>
</tr>
<tr>
<td>Improved use of aids</td>
<td>ZA***</td>
</tr>
<tr>
<td>Multiple strategies</td>
<td>ZB,ZC</td>
</tr>
</tbody>
</table>

* A. Hornbrook et al., 1994 B. Buchner et al., 1997b C. Steadman et al., 2003 D. Wolf et al., 1996 E. Campbell et al., 1997
* F. Campbell et al., 1999a G. Robertson et al., 2001a H. Robertson et al., 2001b I. Robertson et al., 2002 J. McMurdo et al., 1997
* P. Campbell et al., 1999b Q. Ettinger et al., 1999 R. Cranney et al., 2002 S. Kenny et al., 2001 T. Cummings et al., 1999
* U. Lyons et al., 2003 V. Nikolaus & Bach, 2003 W. Chapuy et al., 1992 X. Trivedi et al., 2003 Y. Harwood et al., 2004
* Z. Parker et al., 2003 ZA. Cameron et al., 2003 ZB. Close et al., 1999 ZC. Tinetti et al., 1994 ZD. Wagner et al., 1994

*Unless otherwise stated, reported studies are Level II evidence (randomised controlled trials), using NHMRC levels I-IV levels of evidence scale

* Level I – systematic review;
  ** systematic review across settings, insufficient evidence in community setting
  *** Level II, only significant analysis for those wearing hip protectors at the time of the fall
2.3 **Overview of intervention strategies**

A systematic review of the literature in community dwelling older adults has revealed a wide variety of falls prevention intervention strategies aimed at reducing the occurrence of falls, and subsequent injury, based on the modification and reduction of detailed risk factors associated with falls. These include:

<table>
<thead>
<tr>
<th>Education</th>
<th>Health Promotion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Falls Risk Factors</td>
<td></td>
</tr>
<tr>
<td>Health Professional Education</td>
<td></td>
</tr>
<tr>
<td>Exercise</td>
<td>General versus Customised</td>
</tr>
<tr>
<td>Group versus Home -Based</td>
<td></td>
</tr>
<tr>
<td>Balance / Strength / Endurance Training</td>
<td></td>
</tr>
<tr>
<td>Environment</td>
<td>Provision of Aids/Appliances</td>
</tr>
<tr>
<td>Home Assessment / Modification</td>
<td></td>
</tr>
<tr>
<td>Home Support</td>
<td></td>
</tr>
<tr>
<td>Public Areas</td>
<td></td>
</tr>
<tr>
<td>Clinical Assessment and Review</td>
<td></td>
</tr>
<tr>
<td>Medical Screen (including medication)</td>
<td></td>
</tr>
<tr>
<td>Sensory Evaluation</td>
<td></td>
</tr>
<tr>
<td>Multiple Strategy (targeted and untargeted)</td>
<td></td>
</tr>
<tr>
<td>Injury Minimisation</td>
<td>Clothing (hip protector garments / footwear)</td>
</tr>
<tr>
<td>Assistive Devices (walking aids / personal alarm devices)</td>
<td></td>
</tr>
<tr>
<td>Vitamin D and calcium supplementation</td>
<td></td>
</tr>
</tbody>
</table>
3. Falls among community dwelling older people - Research evidence in reducing falls and falls injuries

3.1 Education / health promotion

Education and health promotion programs are used to raise the awareness of older people, and / or health care workers, about risk factors for falls, how they can be identified, and what type of strategies may be implemented to minimise an individual’s falls risk. An underlying assumption of these programs is that increased awareness will translate into behaviour modification. Education needs to be considered in terms of its role as a preventative as well as an intervention tool. Education can also play an important role in the implementation, ongoing maintenance of, and compliance with falls prevention strategies.

There is an important assumption underlying the belief that education programs for older people are effective in reducing falls rates, namely that older people acknowledge that they are personally at some risk of falls. High falls and injury rates have been reported in healthy older people (Hill et al., 1999b; Speechley & Tinetti, 1991) as well as in frailer older people. However, the degree to which older people perceive themselves to be at risk of falling is limited. A survey by Braun (1998) assessed the knowledge and perceptions of falls related risk factors in healthy, community dwelling adults. On average this sample had a low personal perceived likelihood of falling, which may limit their identification with falls prevention messages. An Australian study identified that falls are generally recognised as a problem by older people, although there was limited understanding among older people about strategies to minimise risk of future falls (Managing Innovations, 2000).

3.1.1 Education programs targeting older people

3.1.1.1 Standard education programs

Although community based falls prevention programs have frequently incorporated an education component targeting older people (Hill et al., 1999a), there has been very little quality research published that investigates the effectiveness of this approach. In a review paper, Allen and Simpson (1999) considered education to be a vital component in a multiple intervention falls prevention program. Specific education topics have been cited by various authors as important components of falls prevention programs. These include:

- home safety (Wallace et al., 1998);
- physical activity (Means et al., 1996);
- diet (Bravo et al., 1996);
- social participation (Cwikel et al., 1995);
- personal alarms (Tideiksaar, 1996);
- footwear (Lord et al., 1999); and
- methods of moving up and down off the floor (Allen & Simpson, 1999).

However, there is little evidence to determine the specific benefit of such educational input on falls rates.

Education has been reported as a component of a multiple intervention falls prevention study using a randomised controlled trial (RCT) design. Reinsch et al (1992) used four groups of healthy, community dwelling older adults in their study. They compared the effect of an education / relaxation program, an exercise program, a combined education and exercise program, and a control group. After one year, there was no significant difference between any
of the groups in terms of time to first fall, severity of the fall, or in measures of balance and fear of falling.

Brouwer et al (2003) conducted a randomised study comparing two types of interventions – exercise and education – in a sample of older people aged 67-87 living in the community who reported a fear of falling and activity restriction. The eight week education program engaged participants to discuss their concerns about falling and focused on identifying and reducing falls risk factors. Falls was not an outcome measure of the study but both the education and activity group demonstrated a significant improvement in balance confidence. The majority of participants adopted a higher level of activity although this was greater (though not significantly) in the exercise group. The education group also demonstrated improvement in perceived mental health, whereas the exercise group demonstrated improvement in perceived physical health.

3.1.1.2 Cognitive - behavioural approaches

In addition to providing information to increase the awareness of older people to falls risk factors and falls circumstances, changes in attitudes and behaviours to reduce falls risk may be achieved by using cognitive-behavioural approaches to supplement the education program. These programs may use focus groups, discussions, goal setting, and role-play to reinforce education messages for individuals, and to emphasise self efficacy and self-control. One element of cognitive-behavioural approaches has been to improve individual’s self-efficacy, or their perception of their capabilities within specific situations and activities (Cheal and Clemson, 2001). A small study by Cheal and Clemson (2001) identified improved self-efficacy in performing daily activities in the majority of the sample of older people with balance problems or falls. The group program emphasised mastery experiences and skill development for community mobility tasks.

Hornbrook and colleagues (1994) conducted a RCT to evaluate the effectiveness of a four week intervention program in a group of community dwelling adults in reducing falls. The intervention incorporated education and behaviour modification strategies, home modification, as well as an exercise component. The authors noted a substantial increase in knowledge about falls risk factors, lower reported risk taking behaviour, higher levels of physical activity and greater consumption of calcium-rich foods in the intervention compared with the control group. At 23 month follow-up, the intervention group also had a 16% lower self reported falls rate when follow-up duration was standardised (falls per 1000 person years).

Tennstedt and colleagues (1998) used a randomised controlled study design (n=434) to investigate the use of a cognitive-behavioural approach in the treatment of adults reporting a restriction in activity due to fear of falling. The primary aim of the six week intervention group was to reduce the fear of falling using group discussion, problem solving and an individual home exercise program. Subjects in the intervention group reported increased levels of intended activity and greater mobility compared with the control group, but the effects had decayed by six months. There was no statistical significance between the groups in terms of falls reported. In a follow-up article Tennstedt et al (2001) analysed the baseline and 12 month follow-up data of the 216 participants randomised to the intervention group. The aim of this analysis was to determine who would most likely benefit from this cognitive behavioural intervention aimed to reduce fear of falling. People most likely to benefit were those who reported less physical and social dysfunction, had more concerns about falling and had greater self-efficacy (greater perceived control) in their ability to do something about their concerns. Compliance (those who attended at least 5 out of 8 sessions) was also a predictor of greater attitudinal change. It was concluded that older people who are more disabled, less
active and have less sense of control over their fear of falling or falls may require alternative methods of intervention (eg individually focused intervention or in home intervention). One of the key messages of this study was the need for future research to focus on determining those benefiting most from an intervention, and identifying the characteristics (physical and psychological) that facilitate or hinder participation or compliance.

A randomised controlled trial has been completed by Clemson et al (in press) investigating the effectiveness of a multifaceted community based program using a small group learning environment in reducing falls, improving self efficacy, and encouraging behaviour change. The authors, in a personal communication, reported that the program successfully reduced the risk of falls and improved self efficacy in functional daily living tasks.

3.1.2 Training of health care workers

Older people consider health professionals such as doctors and allied health staff to be trusted sources of health related information (Managing Innovations, 2000). As such, health professionals have a key role in facilitating engagement of older people in falls prevention activities.

Kerse and colleagues (1999) conducted a randomised controlled study to investigate the change in health related behaviours of older people following a series of health promotional lectures attended by general practitioners (GPs). Each GP in the program was asked to incorporate the information learnt over the two to three month period into daily practice and to pass on health promotion advice to patients as appropriate. At one year follow-up, patients in the intervention group had increased both walking time per fortnight and time spent in pleasurable activities, compared with the control group, and reported improved self-rated health. This study did not investigate specific outcomes with respect to falls. Given the regular level of contact that can occur between older people and their GP, the approach utilised in this study has potential as a cost effective model for the transmission of information regarding falls risk factors and subsequent preventative strategies to community dwelling older adults.

Further research is required to investigate the effectiveness of workforce training for GPs and other health professionals working with community dwelling older people in their role as providers of health promotion messages targeting falls prevention, and the effects of these programs on falls rates.

3.1.3 Community level inter-organisational approach

There has been a growing trend towards establishing inter-organisational networks to establish joint program activities and information sharing to promote health and prevent injuries. This includes specific falls prevention networks to share information, through to general injury prevention or health promotion partnerships, such as the Safe Community Programs and Primary Care Partnerships in Victoria and its equivalent bodies in other states. Linquist et al (2001) conducted a population based quasi experimental, pre and post implementation design study to evaluate the effectiveness of an inter-organisational prevention program in reducing injuries among the elderly in a World Health Organisation (WHO) Safe Community. The authors reported a 12% reduction in the total morbidity rate in the study area and a 26% decrease in falls injuries in the 65-79 age group, whereas falls injuries increased in the older age group. There was also a 46% reduction in morbidity in the study area in moderately severe injury, and an increase in minor injuries, while the risk of severe injury remained
constant. Given that falls are a significant cause of morbidity and injury for older people, and that the older person traverses through the various settings - community (home and public), hospital and residential care settings - it is important that a consistent falls prevention message is reinforced across each setting. An integrated cross-sectoral approach/community based population approach to falls prevention is worth further investigation.

Although education programs targeting older people are commonly used in falls prevention programs, and although changes have been reported in knowledge of falls risk factors, there is limited evidence of the effect of these interventions on reducing falls rates. Programs incorporating cognitive-behavioural approaches may have greater likelihood of achieving this goal.

Preliminary evidence of the effectiveness of training general practitioners to convey health promotion messages indicates that this approach may be successful in achieving behavioural change with older people. This approach should be investigated further with respect to falls prevention training of health care workers, including general practitioners.

3.2 Exercise

Exercise programs are a commonly used falls prevention strategy (Hill et al., 1999a). There are a number of models of exercise delivery, including group exercise programs and individualised home exercise programs. There is also a range of exercise types that may be used in isolation or in combination within a specific exercise program, including:

- balance exercises;
- strength training;
- flexibility / muscle and joint stretching techniques; and
- cardiovascular, endurance, or fitness training.

There is a degree of specificity of training with each of these forms of exercise (Judge et al., 1994). There is good evidence that training programs for older people incorporating balance tasks can result in improved balance performance (Johansson & Jarllo, 1991); training muscle strength can improve strength measures (Judge et al., 1994; Skelton et al., 1995), and that fitness or endurance activities (including walking programs) can achieve significant improvements on cardiovascular indicators (Hamdorf & Penhall, 1999). However, there appears to be limited effect of a balance training program on muscle strength (Judge et al., 1994), and vice-versa. This highlights the specificity of exercise programs on outcomes and the need to consider the different types of exercise programs separately.

There are other health benefits associated with exercise programs. These include reduced risk of cardiovascular events such as stroke and heart attack, reduced incidence of diabetes (Cherubini et al., 1998), as well as other general benefits such as improved morale, reduced depression, and improved general health rating (Bravo et al., 1996; Singh et al., 1997, Singh 2001).
Despite the strong evidence that improvements in falls risk factors can be achieved by specific exercise programs, relatively few studies have investigated the effectiveness of these programs on reducing falls rates. Those that have are detailed below.

### 3.2.1 Group exercise (multi-component)

Lord and colleagues (Lord et al., 1995) conducted an RCT of 197 community dwelling older women. The intervention group participated in 10-12 weeks of general exercises, incorporating balance, strength, flexibility and endurance activities. Although the exercise group demonstrated significant improvement in measures of strength and balance, there was no significant difference between the groups in terms of falls incidence over a 12 month period. However there was a trend for fewer “non-accidental falls” in the exercise group, plus a trend for reduced multiple falls (by 50%) in high compliers with the exercise program compared to low compliers.

Building on this, and other related work, Lord and colleagues conducted a clustered RCT to determine whether falls could be prevented in 551 older people living in retirement villages (self-care or intermediate-care) using group exercise designed to improve activities of daily living (Lord et al., 2003). The exercise program, consisting of one hour/twice weekly classes over a 12 month period, was compared to a control group consisting of two groups, one attending a one hour/twice weekly flexibility and relaxation class and one not taking part in any group activity. At one year follow-up, after adjusting for age and gender, there were 22% fewer falls in the exercise group than the combined control groups and 31% fewer falls in the 173 subjects with a history of previous falls. At six month retest the exercise group performed significantly better in simple and choice reaction time tests and the 6 minute walk test, though not in knee extension strength and standing balance.

In a study targeting older frailer people with a history of a recent fall, Means et al (1996) investigated the effect of a six week low to moderate intensity multi-component exercise program on falls occurrence. After adjusting for outliers, there was a strong trend for reduced falls rates in the six months following the intervention compared to prior to the intervention. These results are promising given the short duration of the intervention, and the moderate falls risk of the participants. However, this study was limited to a pre-test / post-test design, with no control group.

Using a randomised controlled trial methodology, 59 ambulatory men aged 70 and over with at least one of the following falls risk factors - leg weakness, impaired gait or balance, or previous falls - participated in a 12 week low to moderate intensity program that included strength, endurance and balance exercises (Rubenstein et al., 2000). The control group were asked to continue their usual activity. The intervention group showed significant improvement in measures of endurance and gait but there were no significant effects for hip or ankle strength, balance, self-reported physical functioning, or in the number of falls reported. Activity level increased within the exercise group and when fall rates were adjusted for activity level, the exercisers had a significantly lower three month fall rate than controls (6 falls/1000 hours of activity vs 16.2 falls/1000 hours).

A randomised control study by Barnett et al (2003) also demonstrated the effectiveness of a weekly group exercise program with ancillary home exercises. The exercise program was designed by a physiotherapist and had an emphasis on functional activities of daily living requiring balance. The program was conducted in a community setting by an accredited instructor trained in the program and targeted people aged 65 and over with one or more physical performance impairment known to increase falls risk that could be addressed by
exercise. The exercise group also received information on practical strategies to avoid falls. The control group only received written information on preventing falls. At six months (not assessed at 12 months) the intervention group performed significantly better than the control group on three of six balance tests but there were no differences in measures of strength, reaction time, walking speed, fear of falling, general health or activity levels. At 12 months the intervention group had a significantly (40%) lower rate of falls than the control group. The intervention group also demonstrated a non-significant trend towards fewer injurious falls (34%) and had a lower proportion of fallers. The program used existing community services and facilities which aids sustainability (76% of the intervention group continued participation in an exercise program after the trial) and transferability.

Day et al (2002) conducted a randomised controlled trial that looked at three interventions and the interaction between them in reducing falls in 1090 people aged 70 and over living at home. The interventions included group exercise, home hazard management and vision improvement, and a factorial design allowed the comparison of the cumulative benefit of different combinations of the three interventions. The exercise program involved weekly one hour sessions over a 15 week period and were supplemented by daily home exercises. The exercise program was designed by a physiotherapist and aimed to improve flexibility, leg strength and balance. Exercise was the only single intervention which achieved a significant reduction in falls rates (6.9%). There was also a significant effect for the combinations of interventions that involved exercise with the strongest effect observed when all three interventions were combined (14%). The reduction in falls among the exercise group seemed to have been associated with an improvement in balance. A kit outlining the successful exercise program (“No Falls Exercise Kit”) has been developed by Monash University Accident Research Centre. A train the trainer program based on this kit has been funded by the Australian Government Department of Health and Ageing’s National Falls Prevention for Older People Initiative. The kit is available from Monash University Accident Research Centre.

Multi-component group exercise programs targeting a combination of balance, strength, and fitness are effective in reducing falls among older people.

3.2.1.1 Group balance training programs

A range of different exercise programs have been incorporated under the umbrella of balance training, including Tai Chi. In a randomised controlled trial of 200 people aged 65 and over, Wolf and colleagues (1996) investigated the comparative benefits of 15 weeks of either individualised balance training on a force platform, Tai Chi Quan (Chinese Martial Art) group sessions, or a social / information control group. This study was part of the FICSIT studies (see Section 3.2.4) which showed an overall 10% reduction in falls for exercise interventions but a much greater effect for specific balance exercises, especially Tai Chi. Adjusting for falls risk, Tai Chi was found to reduce the risk of multiple falls by 48% when compared to control subjects over the four month follow-up period. No significant change was observed in falls rates for the other two groups. These results raise issues regarding the nature of balance training. Tai Chi Quan incorporates a range of movements involving dynamic balance, control, precision and muscle strength, which all may contribute to the effect shown in reducing falls rates. The force platform balance training used in this study did incorporate dynamic tasks, but these were limited in nature, and may have little relevance to the type of circumstances when falls are likely to occur.

It should be noted there are a number of different types of Tai Chi available in Australia, and it is likely that outcomes will differ depending upon the type and number of forms (movements)
included in the program. For example, Tai Chi for Arthritis has become increasingly popular in recent years (Lam., 1998). This modified version of Tai Chi is based on the Sun-style Tai Chi, and has been shown to reduce perceived pain, improve self rated function, and improve balance in a randomised trial of older women with osteoarthritis (Song et al., 2003). However, there have been no randomised controlled trials published investigating this type of Tai Chi, with falls as an outcome measure.

A large randomised trial of community Tai Chi programs in NSW has been accepted, and results are being prepared for publication (Voukelatos, 2003, personal communication).

Steadman et al (2003) conducted a randomised control trial to determine the effectiveness of a six week enhanced balance training program in a sample of 198 people aged 60 and over with balance problems, recruited from a falls clinic. The control group received conventional therapy. Both groups made significant improvements in balance and mobility. There were few between group differences, the exceptions being the Ten Metre Walk Test and Euroquol (quality of life) measures, indicating that irrespective of the type of therapy received an exercise program can improve balance and mobility in a high risk group. Both groups also reported a significant reduction in falls in the previous month (Intervention: 5.0 to 0.6; p=.0001, Conventional: 4.7 to 0.6; p=.0001). A larger sample size may be needed to detect any between group differences in relation to falls outcomes.

**Balance training programs, either targeting general balance activities, or using movement sequences such as Tai Chi Quan, appear to be an effective approach to reducing falls. Tai Chi Quan appears to be an effective, gentle method of training balance abilities in older people. The nature of Tai Chi, with its slow coordinated movements, may also be more acceptable to some older people.**

### 3.2.1.2 Strength training

Randomised controlled trials have demonstrated the effectiveness of strength training programs in community dwelling older people in improving muscle strength, mobility and function. Chandler et al (1998) randomly allocated frail, functionally impaired community dwelling older people to a strength training program supervised by a physiotherapist, three times weekly for 10 weeks, or a control group continuing with normal activities. The exercise group achieved significant improvement in leg muscle strength, with associated improvements in gait, transfers and stair climbing ability, as well as confidence in mobility, compared to the control subjects. Similarly, Skelton and colleagues (1995) conducted a strength training program for community dwelling women aged over 75 years, incorporating one supervised and two home strength training sessions per week for 12 weeks. As well as demonstrating significant strength gains, subjects in the exercise group also achieved significant improvements in rising from kneeling, and in a stepping up onto a block task compared to the control group. A Cochrane review has reinforced the positive outcomes from progressive strength training programs for older people in improving strength and some aspects of function (Latham et al., 2003b).

One randomised controlled trial compared the effectiveness of a strength training program to vitamin D supplementation and a control group who received frequency-matched visits (Latham et al., 2003a). The strength training program incorporated home-based quadriceps resistance exercise in a sample of frail older people after hospital discharge. No effect was found for either the exercise or vitamin D intervention on physical health (at three month follow-up) or falls outcomes (at six month follow-up). The study did not look at the combined effect of vitamin D and exercise. The authors also reported a significant increase in the risk of
musculoskeletal injury in the exercise group and concluded that the routine use of these interventions were not recommended in the rehabilitation of frail older people. Limitations of the strength training component of this project included that it targeted only the quadriceps muscles, instead of all major lower limb muscles, it involved strength training in a non-functional manner, and it appears to have been of too high an intensity for this relatively frail sample. In this type of sample, there is a clear need for close monitoring of performance, graduated increase in intensity, and perhaps consideration of alternative exercise approaches to high intensity strength training.

To date no strength training studies have been conducted, using community dwelling adults, which have achieved significant reduction in falls. However, studies have shown positive benefits of improved muscle strength and functional mobility. Given the strong association between leg muscle weakness and falls, further research in this area is indicated.

3.2.1.3 Cardiovascular fitness training

A range of different forms of exercise have a cardiovascular training effect, including walking programs, bicycle riding (stationary and free wheeling), and aerobic exercise programs. Walking is a particularly important form of cardiovascular training to consider, as it is an easily performed, low cost activity, requiring no specialised equipment or training. Randomised controlled trials have demonstrated significant improvements in cardiovascular measures among older people undertaking walking (Hamdorf & Penhall, 1999), and bicycle ergometry programs (Posner et al., 1992).

The comparative effectiveness of three forms of group-based endurance training techniques (stationary bike, walking, and aerobic movement) was evaluated in an RCT of sedentary, community dwelling older people, assessed as having mild balance deficits (Buchner et al., 1997a). The results of this three month program identified that only the walking program significantly improved at least one outcome measure in each of the areas of muscle strength, endurance, balance, gait and health status.

No studies have evaluated the impact of cardiovascular training on falls rates.

3.2.1.4 Combined strength and endurance training

It is possible that individual exercise types in isolation do not result in reduced falls rates, but that the cumulative effects of several different exercise types may achieve such an outcome. Buchner and colleagues (1997b) performed a randomised controlled study of adults with at least mild deficits in strength and balance. The intervention consisted of supervised exercise (one hour sessions, three times per week, for 24-26 weeks), with post-study planning to promote continued exercise either in existing community classes or unsupervised settings. Three exercise groups received either strength training (using weight machines), endurance training (using stationary bicycles) or combined strength and endurance training. The control group maintained usual activities. At six months follow-up, strength gains were maximal in the strength training group and aerobic capacity had increased in the endurance training and combined training groups. These results reinforce the specificity of training described in Section 3.2. This study also identified no significant improvements on any measures of gait or balance, but exercise (all three groups combined) was found to have a protective effect on the risk of falling (relative hazard = 0.53, 95% CI = 0.3-0.91). Unfortunately, the authors provided no breakdown regarding the specific effect of each type of exercise on falls rates, so further research is still necessary to fully evaluate this.
Exercise may have a beneficial effect on falls risk in older adults with at least mild impairments of balance or strength. Further research is needed to fully evaluate the individual and combined types of exercise that may result in reduced falls and falls injury rates, and the relative effectiveness of each in isolation and combination.

3.2.1.5 Exercise and bone mass

It has been recommended that intervention programs to prevent injurious falls should target both falls-related factors, including strength and balance, as well as maintenance of bone mass (Luukinen et al., 1997). In order to target maintenance of bone mass, an exercise program needs to incorporate a moderate component of weightbearing activities.

Brooke-Wavell et al (1997) performed a randomised controlled trial to evaluate the effect of a 12 month unsupervised brisk walking program on a group of previously sedentary post-menopausal women. On average each participant walked 20.4 +/- 3.8 minutes per day (as recorded using a training diary). There was a significant difference in the change in bone mineral density (BMD) in the calcaneus, with the control group losing BMD, and the walking group maintaining their BMD levels. A similar trend, although not quite reaching significance, was evident in the BMD of the lumbar spine. Bravo and colleagues (1996) conducted another randomised controlled trial, with the exercise group performing weightbearing exercises including walking, stepping on and off blocks, and aerobic dance activities three times weekly for 12 months. Spinal BMD stabilised in the exercisers and decreased significantly in the control group. No change was observed in femoral bone BMD in either group.

Kelley (1998) conducted a meta-analysis of ten studies evaluating the effect of aerobic exercise on lumbar spine bone mineral density. A significant difference was identified between the exercisers compared with controls, again as a result of loss of BMD in the control group relative to the exercise group.

Few studies have, however, evaluated the effectiveness of these programs on falls and falls related injury rates in older people. A randomised controlled study of older female volunteers identified that regular weightbearing exercise, combined with dietary calcium supplementation, had a modestly significant effect on bone mineral density of the forearm, compared to the control group who received calcium supplementation only (McMurdo et al., 1997). The combined exercise and calcium group experienced fewer falls than those only taking calcium, but the difference was significant only between 12 and 18 months into the two year study period. Falls related injury rates were not investigated.

The first year’s results of a current longitudinal non-randomised clinical trial investigating the effect of a vigorous, combined high-impact, strength, and endurance training program for early post-menopausal women have been published by Kemmler and colleagues (2003). These preliminary results indicate the exercise program has achieved significant improvements in strength and fitness, and significant improvements in bone mineral density at the lumbar spine, but not in BMD at the hip or femoral neck. Similar results were obtained in another randomised trial of older subjects (average age 69 years) in which the exercise group used weighted vests for walking and a strength training program (Jessup et al., 2003). Significant improvements in balance, and in bone mineral density at the femoral neck, were observed in the intervention group.

There is strong evidence that strength training, walking and other aerobic exercise programs that incorporate resistance and weightbearing can significantly limit loss of bone
mineral density, which should have an effect on reducing fracture rates following a fall. However, there has been no research to date evaluating the effectiveness of these programs on fracture rates in older people. This area warrants further research.

3.2.2 Customised exercises

Group exercise programs by their nature cannot be tailored specifically to each individual’s specific level and needs. An alternative approach is the tailored exercise program, designed specifically for each individual. These programs are usually prescribed following an assessment, often by a physiotherapist, and the exercises are selected based on assessment findings. This type of program can incorporate balance, strength, cardiovascular and / or flexibility exercises, depending upon the assessment findings.

Campbell et al (1997) conducted a randomised controlled trial in which women aged greater than 80 years were randomly assigned to either a home-based, customised program incorporating a combination of balance and strengthening exercises and a walking program, or a control group receiving usual care, as well as an equal number of social visits. The exercises were established and taught by a physiotherapist (up to four home visits) and the participants were asked to complete the program three times weekly for six months. The therapist was available for contact by phone at any time and a record was kept of exercise and falls frequency. At 12 months, the mean rate of falls per year was significantly lower in the exercise group, compared to the control group. Additionally, after one year, 42% of the intervention group were still doing the exercises, whereas the control subjects had become less active and reported an increased fear of falling.

A follow-up study was performed on almost half of the original sample to identify issues associated with sustainability and long term benefits of this program. Results indicated that the rate of falls remained significantly lower in the exercise group compared with the control group two years later (Campbell et al., 1999a). Interestingly, this benefit was sustained without further home visits from the research physiotherapist beyond the initial 12 month period. In addition, the authors analysed subject characteristics and determined that those who were more frail and may be more at risk of falling, were the ones most difficult to involve and sustain in the home-based program. Alternative strategies to increase compliance in more frail older people, or consideration of alternative intervention types for this group may be indicated, including group activities as described previously. The cost effectiveness of this intervention is reported in Section 3.8 (Robertson et al., 2001a).

To investigate the transferability of this individualised exercise program, the research team investigated different methods of program delivery. In these two additional studies the individualised exercise program (targeting balance and strength) for at risk older people was effective in reducing falls when delivered by nurses trained by physiotherapists in appropriate exercise prescription:

- in an RCT using a trained home health service nurse (Roberston et al, 2001b). At one year follow-up there was a 46% reduction in falls in the intervention group compared to the control group who received usual care. This reduction in falls was detected in those aged 80 and over; there were no differences in falls rates between the intervention and control group for participants aged 75-79. The intervention group had fewer serious injuries (two vs nine) but similar moderate injuries.
- in a controlled trial using trained nurses in 32 general practices (Robertson et al., 2001c). Falls were reduced by 30% in the three exercise centres. There were also fewer injuries (44% for control group and 26% for the intervention) but there were no differences in serious injuries or hospital costs. The compliance rate in the current study was lower.
(43% exercised three or more times each week, 62% at least twice, and 63% walked at least twice a week) than the previous study (43% exercising 3 or more times and 72% at least twice and 71% walking at least twice a week).

It should be noted that there were a small number of falls reported in these two studies while participants were undergoing the exercise programs. Safety is of paramount importance when older people are undertaking exercise programs, particularly those exercises involving balance training. If health professionals who are not well trained in exercise delivery for older people are to be involved in these programs, formal training by experienced staff is necessary to ensure exercises undertaken are appropriate and safe.

**An individualised home exercise program has been shown to be an effective falls prevention strategy for older people living at home. Factors influencing compliance and safety with individualised home exercise programs targeting falls prevention warrant further investigation.**

### 3.2.3 Exercise for ‘at risk’ patients discharged from hospital to the community

Several randomised controlled trials have evaluated the efficacy of exercise interventions following hospital discharge, for patients with high risk of recurrent falls (e.g. following hip fracture).

Hauer et al (2001, 2002) identified significant improvements in strength, balance and function, with a three month, three times weekly, centre based exercise program targeting these parameters, with some of these benefits maintained three months following completion of the program. The intervention group undertook the exercise classes in addition to routine therapy. Falls incidence reduced by 25% in the intervention group, although this difference was not statistically significant as the study was underpowered.

One RCT study using a sample of frail older people after hospital discharge which did not identify a benefit in physical health outcomes or falls with home based quadriceps strengthening exercise was reported by Latham et al (2003a) (see Section 3.2.1.2).

### 3.2.4 Meta-analyses

The FICSIT (Frailty and Injuries: Cooperative Studies on Intervention Techniques) trials were eight collaborative independent randomised studies, conducted at several centres in the USA. They aimed to decrease falls rate and frailty in older subjects (Province et al., 1995). Five of the trials primarily examined the effect of exercise on reducing falls risk factors in community dwelling older adults. Two of the trials were conducted in Nursing Homes and the final project evaluated hip protector garments in reducing hip fracture incidence (Wallace et al., 1993). Unfortunately, the mixed samples (community and residential settings), and the wide range of interventions make it difficult to draw strong conclusions from this work. Despite the diversity in samples used and program type, Province and colleagues (1995) demonstrated significant reduction in risk of falling for those interventions with an exercise component. Programs that specifically targeted balance were found to be most effective in reducing risk of falling.

Robertson et al (2002) conducted a meta-analysis of individual-level data from the four randomised controlled trials from their research group described in Section 3.2.2 (Campbell et al., 1997 & 1999, Robertson et al., 2001b & c) to determine the overall effect of this
individually prescribed muscle strengthening and balance retraining exercise program on the numbers of falls and fall-related injuries and to identify subgroups most likely to benefit from the program. The number of falls and number of falls related injuries were significantly lower (35%) in the exercise group. Those most likely to benefit both in relation to falls injuries (significantly) and falls (non-significant trend) were those aged 80 years and over.

3.2.5 General issues

Issues that warrant further exploration with respect to the effectiveness of exercise among older people in reducing falls rates are:
1. the minimum dosage of exercise required to achieve the benefits of reduced falls rates, and whether higher frequency or intensity of exercise results in greater improvements in falls rates;
2. the comparative benefits of the various forms of exercise in reducing falls rates. For example, is a specific dosage of Tai Chi twice as effective in reducing falls rates as a walking program;
3. identifying individual and environmental factors which facilitate uptake and sustained engagement in exercise interventions;
4. the relative cost effectiveness of different exercise approaches; and
5. whether exercise can also reduce serious injury rates.

There is strong evidence that exercise incorporating some degree of balance training is effective in reducing falls rates among community dwelling older people. Multi-component group and customised home exercise programs, balance programs and Tai Chi Quan have been shown to reduce falls rates, in samples of relatively frail, through to relatively well older people. Walking, aerobic, and resistance training programs have also been shown to reduce loss of bone mineral density, which has the potential to reduce risk of fracture in older people.
3.3 Environmental safety

Environmental hazards are any objects or circumstances in the environment that increase an individual’s risk of falling. These may be within the home and grounds (commonly termed home falls hazards), or away from the home (commonly termed public falls hazards). Examples of home falls hazards include cords on the floor, loose mats, poor lighting, and poorly marked steps (Clemson, 1997). Examples of public falls hazards include uneven footpaths, slippery floors in supermarkets, and dimly lit walking areas.

3.3.1 Home falls hazards

Home assessment and modification are frequently advocated as methods of falls prevention and reduction. However, Clemson and colleagues (1996) performed a case-control study of community dwelling adults referred for home assessment, and found that the homes of fallers were no more hazardous than the homes of non-fallers. Only cognitively impaired fallers had significantly more hazards than cognitively impaired non-fallers. Likewise Sattin et al (1998) studied subjects following an injurious fall and found that environmental hazards were not associated with an increased risk of fall injury events in this group of community dwelling adults. It has also been found that, in a sample of 911 older people with a confirmed hip fracture, 96% were as a result of a fall, 80% of these falls occurred indoors, but only 25% were associated with an environmental hazard (Norton et al., 1997). The authors hypothesised that intrinsic factors appear to play a greater role than extrinsic factors in the cause of falls in frail older people.

In a pre-post study design, Thompson (1996) reviewed falls occurrence before and after home modifications in 305 community dwelling adults. The inspections were free of charge and subsidised prices were offered for adaptive equipment provided, thus facilitating compliance. The results indicated that in the previous 12 months, 23% of participants had one or more falls, compared with 10% in the 12 month follow-up period. This translated to a reduction of 58% of people reporting a fall following the intervention. Using a similar study design, Plautz and colleagues found a 60% reduction in falls following the provision of minor home safety modifications (Plautz et al., 1996).

To date there is no evidence from randomised controlled studies that the provision of a safer environment, by itself, is of benefit in preventing falls and falls injury. Indeed, there are several randomised controlled trials using this approach in isolation which have not achieved a significant reduction in falls. Stevens et al (2001a) used research nurses, who were trained to conduct home assessments, to assess and make recommendations to minimise falls hazards within and around the home. The target group were people aged 70 or over living independently in the community. The intervention group received a home hazard assessment, installation of free safety devices and education about home hazard removal and modification. At one year follow-up, two thirds of the falls that occurred involved an environmental hazard. However there were no significant group differences in the rate of falls or falls injuries, the proportion of fallers or the frequency of falls involving an environmental hazard. Subject attrition may have impacted on outcomes. Of the 122 participants who did not complete follow-up, baseline falls were significantly greater (twice as high), and the rate of falls were higher (though not significantly) in the intervention group. Some methodological issues described in a follow-up paper (Stevens et al., 2001b) may have contributed to the non-significant results from this study. These include low inter-rater reliability for almost half of
the items on the home assessment form used, and that only a small sample of homes were formally re-assessed for modifications, with the remainder being evaluated by a self completion questionnaire. In addition, although a higher proportion of subjects in the intervention group reported taking action to reduce falls risk and enhance safe behaviour, 74% of the control group reported taking more care to avoid falls and 16% reported taking action to reduce falls risk in their homes.

A randomised factorial design study investigated home hazard assessment and management as one of three interventions provided either in isolation or in combination (the others being group exercise and a vision assessment and referral intervention) (Day et al., 2002). In the home hazard intervention participants removed or modified hazards themselves or through the council’s home maintenance program. Hazards were identified by the home maintenance staff who visited participant’s homes, provided quotations for work required and provided free labour and material for work up to the value of $AUD100. Home hazard assessment and management did not result in a significant reduction in falls when conducted in isolation. There was a significant reduction in falls when the home hazard assessment and management program was combined with the exercise program, or with both the exercise and vision interventions, however the effect appeared to be largely related to the effect of the group exercise intervention. The authors suggested that the intensity of the home hazard intervention program or the type of modifications implemented may not have been sufficient to have an impact on outcomes.

In a RCT study by Cumming et al (1999) home visits undertaken by an occupational therapist for assessment and modification of environmental hazards achieved a significantly reduced risk of one or more falls for a subgroup who were at increased risk of falls at the commencement of the study. It is important to note that the occupational therapy intervention in this study included not only recommendations for home modifications, but also considerations to the general safety within the home environment, and advice on strategies to minimise individual risk. However, despite this approach, there was still a non-compliance rate on most recommendations of between 30% and 50% at 12-month follow-up. Furthermore, the effectiveness of the program in reducing risk of falls among those identified as being at risk at commencement was similar for falls within the home and away from the home. This reduces the likelihood that the home hazard modifications themselves were responsible for the observed results. In an interesting commentary on this paper, Gill (1999) reviews the options for targeting of limited falls prevention resources, and recommends that greater benefit is likely to be achieved with programs addressing intrinsic falls risk factors with targeted interventions.

In a follow-up study, Cumming et al (2001) further investigated issues influencing adherence to home hazard modification recommendations. Of the 121 homes revisited at 12 month follow-up, 419 recommendations were made, however, only 52% (216) of the recommendations were partially / completely adhered to. This figure is similar to that reported in other studies. Only two significant predictors of adherence were identified - the belief that home modifications can prevent falls, and having received help at home from relatives. These factors may indicate an acceptance of the need for assistance. Of the 264 who were invited to participate in the home visit, 27% refused to participate and the two most common reasons for non adherence were that participants did not see a reason for the change (49%) or felt their homes were already safe (34%). These results highlight the need to establish relevance for the recommended home modifications to the older person.
In a sub-analysis of a multiple intervention study (Steinberg et al., 2000, see Section 3.5.2), Peel et al (2000) evaluated the effectiveness and sustainability of the home assessment and modification component within a multi-component intervention. There was no control group per se, the comparison group consisted of two groups, those who received education only or education and exercise. The intervention group consisted of two additional groups, those who received education, exercise and home assessment / modification, and those who received education, exercise, home assessment / modification and clinical assessment. Home assessments were conducted by an occupational therapist. In both groups there was a non-significant reduction in falls and falls injury at one year follow-up. Limited adherence to recommended home modifications, potential interactions with other components of the intervention, and potential cross over between groups are factors that may have impacted on outcomes. For example, 59% of the intervention group made at least one home modification compared to 32% in the comparison group. The authors pointed out that structural modifications were more likely to be made in the intervention group and that the financial and practical assistance provided may have been a motivating factor.

A number of important issues need to be considered in future research investigating home assessment and modification studies for community dwelling older people. How is adherence measured? What are the reasons for non-adherence and how can the level of adherence be improved? Is it the belief that home modifications do not help, are costly, devalue the home aesthetically / financially, or are not relevant to the individual? What are the minimum changes needed or type of changes needed to improve outcomes? The training and expertise of the assessor is likely to be an influencing factor. For example, intervention by an appropriate health professional who can consider and address both the intrinsic factors and the environmental/extrinsic factors is important. It seems clear that home assessment needs to include more than a simple checklist of items but should also closely look at how the individual interacts with the environment. Use of environmental home assessments that consider both the physical environment and the individual’s interaction with the environment, such as the HomeFAST tool (Mackenzie et al., 2000; 2002) may improve falls prevention outcomes.

3.3.2 Home assessments for ‘at risk’ patients discharged from hospital to the community

Pardessus et al (2002) conducted a study to investigate whether home visits by an occupational therapist reduce the risk of falling and improve discharge and autonomy of older patients hospitalised for falling. Sixty participants aged 65 and older, who were hospitalised for falling and were returning home after hospitalisation, were randomised to a control group, receiving usual care, or an intervention group, receiving usual care plus a home visit by an occupational therapist and an ergotherapist. It was unclear from the article what role each health professional undertook in the assessment. However, causes and risk factors for falling were determined for each participant, physical therapy started and any therapeutic modifications made during hospitalisation. Patients (and families) were also provided with information on home safety and possible social assistance. For the intervention group, homes were assessed for environmental hazards, modifications were recommended, advice was provided on how to live more safely with the unmodifiable hazards, and contact was also made with people likely to provide social assistance to the participant. At 12 month follow-up there were no statistical differences between groups in relation to the rate of falls, hospitalisation for falls, institutionalisation, or death. Although both groups had a loss of functional autonomy at follow-up, this was only significant in the control group.

Nikolaus and Bach (2003) conducted a randomised controlled trial to determine the
effectiveness of a home intervention team that provided an environmental hazards assessment and advice, modification and training in the use of technical and mobility aids provided. Three hundred and sixty community dwelling older people (mean age 81.5) showing functional decline, especially with regard to mobility, were recruited while they were in-patients in a geriatric hospital. Both groups received a comprehensive geriatric assessment, with the intervention group receiving a home visit while the control group received usual care. There was a three month follow-up visit to check compliance and to address any additional problems. At one year follow-up there was a significant reduction in the number of falls in the intervention group. Sub group analysis looking at participants with a history of falls found that in the intervention group both the proportion of frequent fallers, and the rate of falls were significantly reduced. In relation to compliance, 222 home modifications were recommended in 137 homes (75%) and at the 12 month follow-up at least one of the recommendations had been implemented in 105 homes (75%). Compliance with the various recommendations varied from 33 to 83%, with most recommendations having a 50% compliance rate and half having over 67% compliance. There was a significant reduction in the rate of falls for participants in the intervention group who implemented at least one recommended change. There were no significant differences in the intervention group participants who did not make any recommended changes. Those with two or more previous falls also had a higher compliance rate. These results suggest that environmental hazard reduction programs may be more relevant / acceptable and therefore more effective for older people with a high risk for falls.

3.3.3 Meta-analyses

A Cochrane review of home hazard assessments concluded that of the 15 studies that targeted older people none demonstrated a reduction in injuries, although two resulted in a reduction in falls, possibly as a result of a hazard modification program (Lyons et al., 2003). The review recommends further randomised trials investigating home hazard assessment and modification that have adequate sample size to identify effect of the intervention, and to incorporate strategies to increase compliance with recommended interventions.

3.3.4 Public falls hazards

Falls occur more commonly away from the home for more well, active older people and falls in this group can be associated with higher injury rates (Hill, 1999b). As such, public falls hazards need to be minimised. Gallagher and Scott (1997) reviewed the location and nature of falls in public places and made recommendations for the management of public safety falls hazards. However, there are considerable methodological challenges in formally evaluating the effectiveness of falls prevention programs targeting public falls hazards and no such studies have been identified.
There is growing evidence that home hazard assessment and modification programs may be effective in reducing falls, particularly when undertaken by trained health professionals such as occupational therapists, and when targeting those at increased risk of falls. These approaches are more likely to be effective when combined with strategies to modify risky behaviours, and maximise adherence with recommended hazard modifications. To date there is no strong evidence that modifications to reduce environmental falls hazards within the home or public areas in isolation are effective in reducing falls rates.

3.4 Clinical assessment

Clinical assessment involves the systematic evaluation of older people for their individual risk of falling based on the presence of one or more of the main falls risk factors. The evaluation may be by a general practitioner, by an allied health professional, a nurse, or other trained individual. The outcome of this form of clinical evaluation is generally a management program addressing one or more of the falls risk factors identified.

3.4.1 Medical screen (including medication)

3.4.1.1 Comprehensive medical assessment

Coleman and colleagues (1999) investigated the effect of an intervention comprising an extended consultation with a physician, nurse and pharmacist every three to four months, plus a patient self-management group between consultations, compared to “usual care”. Although the study identified significantly greater levels of patient satisfaction among those in the intervention group, there were no significant differences between those randomly allocated to management at the Chronic Care Clinic and the “usual care” intervention, in terms of reported falls and total costs. Interpretation of the findings is hampered by the small sample size and the relatively low uptake of the intervention. Only 53% of the intervention group attended two or more clinics, and 29% attended none of the clinics. Furthermore, the intervention was generic, targeting a range of common health problems for older people, and not specifically falls prevention. It is also not clear whether the health professionals involved received any supplementary training.

Reuben et al (1999) performed a randomised controlled study to determine the effectiveness of a single geriatric consultation, compared with a “usual care” group in an “at risk” group of older people living in the community. Following assessment, recommendations were made to the primary care physician and the patient given a list outlining these. After 18 months, physical functional status scores and frequency of restricted activity days had not changed in the intervention group, but had worsened significantly in the control group. There was also a significant improvement in scores for physical health, energy / fatigue levels and social function for the intervention group compared to the control group. Unfortunately the follow-up assessment did not incorporate documentation of falls events.
Newbury et al (2001) conducted a randomised controlled trial investigating the outcome of the ‘over 75 years health assessments’ for 100 older people living independently in the community. The health assessments were conducted by a nurse in a home visit and findings were reported to the participants’ general practitioner. There were no interval reminders or follow-up of problems for 12 months. At 12 month follow-up there were no significant differences between the intervention and control groups in relation to primary outcomes (number of problems, number of participants with problems and mortality) or secondary outcomes related to physical function, psychological function, falls and admission to institutions. However there were significant improvements reported in self-rated health, depression, and number of participants reporting falls in the intervention group when comparing results from their first visit in 1998 and the follow-up visit in 1999. Given the wide spread availability of the ‘over 75 years health assessments’, further investigation of outcomes is warranted.

People aged 50 years and over presenting to an Emergency Department with non-accidental falls were comprehensively assessed medically to investigate whether there may be a treatable cardiac cause of the falls (Kenny et al., 2001). Suitable patients were assessed for cardioinhibitory carotid sinus hypersensitivity (CSH), and those identified (mean age 73) were randomised to the intervention group who received a dual-chamber pacemaker implant (paced patients) or the control group who received standard treatment. At one year follow-up the control group reported 669 falls, and the paced patients reported 216 falls. The intervention group were significantly less likely to fall than the control group, and injurious events were also reduced by 70% relative to the control group. Syncopal events at follow-up were also reduced though not significantly. The authors report that patients with non-accidental falls are not usually assessed for cardioinhibitory carotid sinus hypersensitivity (CSH) even though there is a strong association. This study provides impetus for the consideration of cardiovascular assessments for older adults presenting to Emergency Departments with non-accidental falls.

Comprehensive medical assessment of older people at risk of falling is a potentially important component of a falls prevention strategy. However, there is little research using a randomised controlled trial design with falls as an outcome measure. This area warrants further research evaluation. Training for health professionals in falls risk assessment and prevention prior to implementation of this type of assessment may result in improved outcomes: this also remains to be tested.

3.4.1.2 Health Visitor Intervention

Home intervention by health visitors or community nurses described in this section refers to interventions involving an assessment of intrinsic risk factors and may also incorporate a home environment assessment component.

A randomised controlled design was used by Vetter and colleagues (1992) to assess whether home intervention by a health visitor (one or more visits per year, as required) resulted in a reduction in the number of fractures in older individuals over a four year period. Assessment and treatment concentrated on: nutrition, medical conditions (including medication review), environment and fitness / exercise. There was a tendency for more falls in the intervention group than in the control group, especially for patients with less severe disability, and no significant difference in the incidence of fractures. Falls rate was based on self-recall which may have been influenced in the intervention group by the health visitor’s repeated visits. The authors argued that the increased rate of falls in the intervention group might also have been attributed to increased confidence in mobility and exercise in this group, resulting in
increased activity and therefore increased exposure to risk. However, no measures of activity level or falls risk exposure were used to support this hypothesis.

Wagner et al (1994) performed a RCT to evaluate the effectiveness of a multifactorial intervention program on falls reduction in community dwelling older adults. The intervention group received an assessment by a trained nurse / educator with subsequent risk factor modification, encouragement to begin a brisk walking program, home safety advice, recommendations to the primary care physician regarding medication review, audiological testing and the provision of information regarding resources in the community for visually impaired individuals. The second group received general health promotion information without stressing the importance of physical activity and the control group received usual care. In the first year post-intervention, there were significantly fewer reported falls in the intervention group compared with the control, but this was no longer significant two years later. The second group receiving the information only had intermediate outcomes for falls and injurious falls at 12 months, relative to the intervention and control groups.

Regular home visits by a community nurse were investigated by Van Haastregt et al (2000). These visits aimed to reduce falls and mobility impairment among people aged 70 and over with moderate falls or mobility problems. Participants were recruited from 6 general practices in Hoesnbroek, the Netherlands. Participants were randomised to receive usual care, or five home visits by a community nurse over a one year period, in which they were screened for medical, environmental and behavioural factors that impacted on falls and mobility. The intervention group were then provided with advice, referrals and other action to address the identified risks. There were no significant differences with respect to falls, mobility measures, mental health, social functioning, perceived health, perceived gait problems or loneliness. However at 12 month follow-up (but not 18 month follow-up) there was significantly less decline in daily activity in the intervention group, and significantly less fear of falling both at 12 months and 18 month follow-up. A limitation of the study was a low rate of compliance (46%) to the specific advice provided, and a moderate proportion of participants lost to follow-up. The positive outcomes in terms of activities of daily living and fear of falling indicate that this approach might warrant further investigation, with a stronger focus on the screening process, and enhancing long term engagement with the recommended actions.

A similar approach was utilised by Hogan et al (2001). One hundred and sixty three people aged 65 and over who had fallen in the previous 3 months were recruited. Participants were randomised to usual care or the intervention group. Those in the intervention group received a multifaceted in-home assessment (individual and environmental risk factors) and specific care plan. The assessments were performed by one of a group of volunteer health professionals. Written recommendations were provided to the participant and their local doctor. Assessors did not implement any of the recommendations, other than a referral to an exercise class conducted at a geriatric day hospital for relevant participants. Results indicated no significant difference between groups in the number of falls, the proportion of single or multiple fallers or percentage of falls resulting in an Emergency Department or hospital visit. Two major limitations of this study were that adherence was only measured at six months (reported to be 81%) and not at the one year follow-up, and that only 48% of falls data calendars were returned. In the intervention group, sub group analysis found that those with an 80% adherence had fewer falls (though not-significantly) than lower adherers, and those with two or more falls at baseline had significantly lower falls and significantly longer time between falls.

Kingston et al (2001) conducted a RCT of a health visitor intervention involving 109 women aged 65-79 who presented with a fall to an Emergency Department. The intervention group
received advice on pain control, medication, diet, exercise, education about falls risk factors and how to get up after a fall, and other advice and referral as required. This advice was received within five days of returning home from the Emergency Department. The intervention group was also care-managed for 12 months after the fall on an individual basis. The control group received standard post-fall management from the Emergency Department staff. At 12 week follow-up there were no group differences in seven of eight domains of the SF-36 (these included physical function, role-physical, role-emotional, bodily pain, vitality, social functioning and mental health) or in the proportion of patients experiencing further falls. The authors concluded that a more specific screening tool is needed to target this intervention to individuals at risk of poor recovery after a fall rather than to implement it to all who present with a fall.

Other studies have incorporated visits to the homes of at-risk older people by trained volunteers. Fabacher and colleagues (1994) evaluated the effectiveness of a brief in-home geriatric screening assessment by a physician’s assistant or a nurse, but included follow-up visits incorporating encouragement to comply with initial recommendations, in conjunction with health education information delivered by a trained volunteer every four months for one year. Self-reported falls rates were not significantly different between the intervention and control groups, although the falls rate in the intervention group was less than two-thirds that of the control group. The intervention group also demonstrated significant improvement on a number of other variables, including medication usage, functional status and immunisation rates.

Another randomised controlled trial in the United Kingdom identified that regular visits by non-professional volunteers to the homes of community dwelling older adults resulted in fewer falls over the three year study period for the intervention group compared with the control group (Carpenter & Demopoulos, 1990). Indeed, the number of falls in the control group doubled and in the intervention group remained unchanged. The volunteers received a one hour training session, with regular four monthly meetings, and were educated in the use of an activities of daily living questionnaire, which highlighted subjects needing referral to their general practitioner or other support services. This program appears to require a relatively low level of resource usage in screening older people in the community and providing them with information about appropriate services and aids to daily living. The authors proposed that a similar program could be run in conjunction with a general practice.

Trained health visitors or volunteers may be used effectively to screen community dwelling older people for their falls risk and to identify appropriate actions to minimise future risk of falling. Strategies to maximise uptake and longer term adherence with recommendations warrant further investigation.

3.4.1.3 Medication

A range of medication types, and drug interactions may increase the likelihood of an older person having a fall (Cumming, 1998). Furthermore, taking three or more medications has been shown to increase risk for recurrent falls (Campbell et al., 1990; Leipzig et al., 1999b). Regular review of the need for and the dosage of specific medications has the potential to reduce this risk.

In systematic reviews and meta-analyses of the effect of medications on falls, Leipzig and colleagues (1999a; 1999b) identified a significant association between certain types of
psychotropic, cardiovascular and analgesic medications and an increased risk of one or more falls in older adults. It should be noted that no randomised controlled trials were identified in this systematic review, and that results are based on the pooling of data from cohort, case control and cross section studies, in community, acute and residential settings. Specific psychotropic medications which were significantly associated with falls in community settings included:

- neuroleptics;
- sedatives / hypnotics;
- antidepressants (especially tricyclic antidepressants); and
- benzodiazepines (Leipzig et al., 1999a).

A prospective cohort study by Ensrud et al. (2002) confirmed that the use of benzodiazepines, antidepressants and anticonvulsant medication were associated with an increased risk of frequent falls in a large sample (8127) of community dwelling older women. The implications of these results are highlighted in a paper by Cumming and Klineberg (1993) which identified that 20% of community dwelling older people were taking one or more psychotropic medications.

Similar analyses were conducted for cardiac and analgesic medications (Leipzig et al., 1999b), with the following medication groups significantly associated with falls in community samples of older people:

- diuretic use (when all diuretics were considered together); and
- digoxin.

It remains unclear, however, whether these associations are caused by the side effects of the drug (i.e. sedation, cognitive dysfunction, psychomotor impairment or orthostatic hypotension) or by the indications for drug use.

Although often described as an important component of a falls prevention program (Allen & Simpson, 1999), few studies have evaluated the effect of medication review and modification on falls rates, using a randomised controlled design. Tinetti et al. (1994a) used a multifactorial approach, including medication reduction and use of non-pharmacological strategies, as one of three interventions given to all participants in a randomised controlled trial. Results indicated the proportion of subjects with four or more medications had reduced by 23% relative to the control group at 12 months follow-up. This multiple intervention program also produced a significant reduction in time to first fall, and in the proportion of subjects who fell during the one year follow-up period, compared to the control group. However, the contribution of the medication review and modification as an isolated intervention was not investigated.

Using a randomised controlled trial methodology, Campbell et al. (1999b) investigated two interventions. One intervention was withdrawal of psychotropic medication, the other was a home-based exercise program, on older people currently taking psychotropic medication. Patients were randomly allocated to one of four groups: gradual withdrawal of medication versus continuing to take medication; and a home-based exercise program versus no exercise. The medication withdrawal group had the active component of their capsules gradually reduced to zero over 14 weeks. After 44 weeks, there was a 66% reduction in falls risk in the medication withdrawal group. The risk of falling for the exercise group compared with those not exercising was not significantly reduced. Unfortunately, 47% of participants who had successfully ceased psychotropic use during the study had restarted taking their medication one month after completion of the study. The authors stressed that further work needs to consider support services, including counselling, relaxation therapy and sleep promotion.
resources, for patients attempting to come off psychotropic medication. Foy (1993) recommended that admission to hospital might be necessary in this group, particularly since older people appear to be at the greatest risk of a severe withdrawal reaction. Guidelines outlining support strategies and alternatives to these medications have been reported for weaning patients from these medications (National Prescribing Service Ltd., 1999).

*General practitioners and pharmacists have a key role in considering implications for new medications prescribed, including consideration of non-pharmacological alternatives and potential for interactions. If medications are required, implementation of regular review of the long term need for the medication is important. There is increasing evidence that medication review and reduction can result in reduced rates of falls among older people. Further research is warranted, particularly on strategies to improve compliance and sustainability of outcomes.*

3.4.1.4 **Nutrition**

It has been estimated that 30% of people over the age of 60, living independently in the community, are suffering from malnutrition (Lipski, 1996). Furthermore, low body mass has been cited in the literature as a risk factor for serious falls-related injuries (Tinetti et al., 1995). Adequate nutrition is also important for optimising physical gains from an exercise or physical activity program for older people (Dontas et al., 1999). The changing nutritional needs of exercising older people also need to be considered, particularly with respect to vitamin B6, vitamin B12, calcium, and vitamin D (Sacheck & Roubenoff, 1999). To date no studies have investigated the effect of nutritional assessment, advice and supplementation alone, or in combination with exercise, on falls incidence in community dwelling adults.

Refer to Section 3.7.2 for details of a RCT that identified reduced risk of hip and other non-vertebral fractures in a group of older women living in apartment blocks and nursing home settings, receiving vitamin D and calcium supplements, relative to a control group (Chapuy et al., 1992). The benefits for those living in apartment blocks independently and those in nursing homes were not investigated separately.

3.4.2 **Sensory impairment**

3.4.2.1 **Vision**

Vision is one of the three sensory systems that play a critical role in the maintenance of balance under challenging circumstances. Effective vision incorporates a number of functions, including visual acuity, contrast sensitivity, depth perception, and visual field integrity (Lord and Menz, 2000; Lord and Dayhew, 2001). There are age-related declines in each of these functions, but performance is most significantly compromised by the development of ocular disease, commonly cataract, glaucoma, diabetic retinopathy and macular degeneration (Butler et al., 1997). Impairment in the visual system has been well described as a risk factor for falls (Nevitt et al., 1991), and multiple falls (Ivers et al., 1998). It has been suggested that, in the USA, general practitioners may lack the training to do appropriate eye examinations, or they may be unaware of community resources available for referral and visual rehabilitation (Butler et al., 1997). Use of bi-focal and multi-focal glasses has also been shown to impair depth perception and edge-contrast sensitivity at critical distances, impairing judgement of environmental obstacles, and potentially increasing risk of falling (Lord et al., 2002).

A population based study in Victoria – The Melbourne Vision Impairment Project – identified that the most common cause of bilateral vision impairment was uncorrected refractive error,
affecting almost 25/1000 people aged over 40 (vanNewkirk et al., 2001). Uncorrected refractive error can contribute to potential falls by limiting the clarity of visual images of environmental obstacles. These results highlight the need for regular vision reviews for older people, and the importance of using corrective lenses if recommended.

Cataracts are another prevalent, progressive vision problem which have been shown to be associated with risk of multiple falls (Ivers et al., 1998). The relative number of cataracts in Australia is projected to double over the next 50 years (McCarty et al., 2002). Using pre-post design methodology, Brannan et al (2003) identified a significant reduction in falls following cataract surgery.

Only one randomised controlled trial has included an evaluation of a vision intervention on falls. The study by Day et al (2002) (described in Section 3.2.1) incorporated a factorial design, where participants were randomised to none, one, two, or all three of the following interventions:

- vision assessment and management recommendations;
- group exercise; and
- home hazard assessment and modification.

The vision intervention involved vision assessment, and if treatment was not already being received for any identified problems, a referral to an eye care provider (general practitioner or local optometrist) was given. Control group participants were provided with a brochure from the Australian Optometrist Association on eye care. Visual acuity (high contrast) improved marginally in the non-intervention group but remained unchanged in the intervention group. There were no differences in any other vision measure found between groups, nor did the vision intervention reduce falls. When combined with exercise alone, or exercise and home hazard assessment, the combined interventions resulted in a significant reduction in falls, although this was largely related to the effect of the exercise intervention, which was the only intervention in isolation that reduced falls. The authors suggested that the intensity of the vision intervention may not have been sufficient to have an independent impact on outcomes, especially given that only 48% of participants in the intervention group required a referral for vision treatment. The provision of an eye care brochure may also have prompted action by the control group.

3.4.2.2 Dizziness

Dizziness is a common problem for older people, with approximately one in four people aged greater than 65 years experiencing dizziness each year (Sloane et al., 1989). Balance performance is often impaired in people presenting with dizziness. In addition, dizziness has been cited by a number of authors as being associated with functional decline and falls risk (Colledge et al., 1996, Sixt and Landahl, 1987). Although there are a number of medical causes of dizziness in older people, abnormalities of the vestibular (inner ear) system have been reported as contributing to dizziness in up to 50% of older individuals (Slone et al., 1989). However, the relationship between dizziness, vestibular dysfunction and falls remains unclear.

The importance of identifying vestibular contributions to falls risk lies in its apparent response to rehabilitation. Vestibular rehabilitation therapy is a comparatively new exercise-based approach to the treatment of people with vestibular system disease. Several prospective, controlled studies have been conducted which report significant improvements in balance, disability, handicap and patient reported symptoms as a result of the interventions (Horak et
al., 1992; Krebs et al., 1993; Strupp et al., 1998). Customised exercise programs have been found to be more beneficial than a generic therapy approach (Shepard & Telian, 1995).

One of the most common causes of dizziness in older people is benign paroxysmal positional vertigo (BPPV) (Sloane et al., 1989) which is a disorder involving the inner ear structure. This condition can be extremely disabling, and is associated with reduced activity levels, depression and falls in older people (Oghalai et al., 2000). BPPV has received considerable attention in the recent literature due to the ease with which it can be diagnosed (Hallpike manoeuvre) and the apparent effectiveness of repositioning techniques in improving symptoms of dizziness and impaired balance (Epley, 1992; Lynn et al., 1995; Blatt et al., 2000). This manoeuvre can be performed by a general practitioner, physiotherapist, or other health practitioner with training in vestibular assessment and management. However currently, knowledge and skill in assessment, diagnosis and management of vestibular dysfunction by community practitioners appears to be limited.

No studies to date have used falls occurrence, or injury, as an outcome measure in subjects with vestibular dysfunction.

3.4.2.3 Reduced peripheral sensation

Sensation from the limbs provides information about the body’s alignment with the support surface, and between the body segments. Reduced sensation in the lower parts of the legs has been called peripheral neuropathy, and has been shown to be a risk factor for falls (Richardson et al., 1992; Lord et al., 2001). Very little research has focused on reduced peripheral sensation and falls prevention.

The area of sensory impairment remains one of the poorly investigated areas of falls risk, despite the high importance of the sensory systems in safe and effective interaction with the environment. There have been no randomised trials which have demonstrated the effectiveness of falls prevention programs targeting sensory impairment to date. Further research is warranted investigating early identification of sensory impairment, and targeted intervention programs aiming to minimise risk of falls.

3.5 Multiple intervention strategies

3.5.1 Multiple strategy (targeted)

Given the multifactorial nature of falls, it is likely that falls prevention programs that target several risk factors concurrently are likely to have a greater impact in reducing falls or injurious falls than programs that target only one risk factor. The goal of these approaches is to modify several risk factors concurrently. Multiple interventions may be administered in two ways - firstly by selecting the most appropriate interventions based on an assessment process (targeted multiple interventions), or secondly by the blanket administration of two or more interventions irrespective of identification of specific risk factors (untargeted multiple interventions). Targeted multiple interventions will be discussed in this section. Untargeted multiple interventions are discussed in Section 3.5.2.

One of the challenges of effective multiple strategy falls prevention programs in the community setting is the need for effective communication and coordination between health professionals. Brandis and Tuite (2001) reported a program linking general practitioners and
occupational therapists. Some of the difficulties associated with successful engagement of general practitioners in falls prevention programs were highlighted, including the number of other programs and activities general practitioners are expected to be involved in. Positive outcomes were reported, including improved interaction between general practitioners and occupational therapists, increased referrals, and a reduction in falls after the program was implemented.

3.5.1.1 Mono-disciplinary assessment and targeted management programs

Lightbody et al (2002) conducted a randomised controlled trial evaluating the effectiveness of a nurse assessment and management plan and care pathway development for older people discharged home from Emergency Departments after a fall. Three hundred and forty eight patients aged 65 and older were recruited and assigned to usual care or a falls risk assessment in the home to address modifiable risk factors (medication, ECG, blood pressure, cognition, visual acuity, hearing, vestibular dysfunction, balance, mobility, feet and footwear). Advice and education was also provided about general safety in the home. Identified risk factors were addressed using referral to existing services. At six month follow-up there was a non significant trend towards lower falls (89 in the intervention group, and 145 falls in the control group), and fewer fall-related admissions and bed days (8 and 69 respectively) than the control group (10 and 233 respectively). The intervention group were significantly more independent in function and mobility within the community compared to the control group at follow-up.

3.5.1.2 Specialist multidisciplinary assessment and management programs

This type of program has often been described under the broad heading of Falls Clinics. These consist of a comprehensive multidisciplinary assessment of older people at risk of falling, with the development of an individualised falls risk management plan. The assessment process has often been reported to involve medical specialists (commonly geriatricians and neurologists), physiotherapists, occupational therapists and nurses (Close et al., 1999; Hill et al., 1994; Tiderksaar, 1996; Hill et al., 2001; Puisieux et al., 2002). Although a relatively resource intensive intervention, this type of approach targets those who continue to have a high risk of falling despite undertaking routine assessment and management for their falls problem (for example by the general practitioner or other community based management options). With a focus on those identified as being at risk, these services differ from the more general assessments discussed in Section 3.4.1.

In a meta-analysis of randomised controlled trials for the Cochrane Collaboration, Gillespie and colleagues (2003) identified from a small number of studies which met the inclusion criteria, that “multidisciplinary, multifactorial, health / environmental risk factor screening / intervention programs” significantly reduced the number of participants falling and falls among community dwelling older people. Similar findings were reported by Hill-Westmoreland et al., (2002), and Shekelle et al., (2003).

This meta-analysis included the very successful randomised controlled trial by Tinetti and colleagues (1994a), which involved a multiple risk factor intervention strategy. Subjects included had at least one risk factor for falling. Those in the intervention group were assessed and subsequently given a combination of: adjustments to their medication, home hazard review, behavioural recommendations (such as advice regarding postural hypotension) and a home exercise program (balance and strength training). Control subjects received “usual care” plus social visits. During one year of follow-up, there was a significant reduction in time to first fall and proportion of fallers in the intervention group compared to the control
group, as well as reduced fear of falling. The authors hypothesised that risk factor modification may partially explain the promising positive results.

Another randomised controlled trial by Close et al (1999) focused on older people presenting to an accident and emergency department because of a fall. The study utilised a core assessment by medical and occupational therapy staff, with referral to other specialist services if required. A range of targeted interventions were incorporated, including referrals to hospital out-patient departments and day hospitals (often for exercise programs), medication review, and vision review. Significantly fewer falls and multiple falls were reported in the intervention group relative to a control group receiving “usual care”.

In one of the few falls prevention studies to focus on people with cognitive impairment, Shaw et al (2003) conducted a similar randomised controlled trial. Participants were older people with cognitive impairment presenting to an Emergency Department after a fall. The intervention group had a multidisciplinary assessment (including medical, physiotherapy and occupational therapy) and were referred for interventions based on assessment findings, while the control group received usual care. This study has been reported in more detail in Section 5.5, as 80% of the participants were from residential care. Although this study did not identify significant reductions in falls, it highlights the need for further research in falls prevention for people with cognitive impairment. Despite cognitive impairment being an independent risk factor for falls, people with cognitive impairment have been excluded from most of the successful falls prevention randomised controlled trials in the community setting.

3.5.1.3 Other targeted multiple interventions

Falls rates also feature as an outcome measure in studies that aim to promote older people’s general health. Here they are often part of a multifaceted strategy to improve common geriatric symptoms. These have been reviewed in Section 3.4.1 (eg Coleman et al., 1999; Reuben et al., 1999). In addition, the study reported by Wagner and colleagues (1994) and Newbury et al (2001) in Section 3.4.1, which incorporated home visits by trained staff with subsequent targeted risk factor modification also identified a significant reduction in falls / fallers.
Targeted multiple interventions strategies, based on comprehensive assessment, appear to be an effective approach to reduce falls rates among older people with moderate risk of falling. However, to date, few research studies using this strategy have assessed the contribution of each individual component. Further research is warranted to determine the relative contribution of individual components of multiple intervention strategies, the optimal combination and intensity of multiple intervention strategies, whether there is a cumulative benefit of various combinations of interventions on reducing falls rates, and whether these interventions are cost effective.

3.5.2 Multiple strategy (untargeted)

A large randomised controlled trial involving 3,182 independently living HMO members aged 65 and over incorporated home safety, exercise and behavioural risk elements. The intervention decreased the odds of falling, but did not have a significant impact upon actual falls rates (Hornbrook et al., 1994). The home safety component was tailored via a home visit, but other aspects were implemented using a group approach. The researchers recommended a more intensive maintenance phase for sustained effect and suggested focusing upon those at highest risk.

A health promotion program conducted by Wallace et al (1998) was largely untargeted, with all participants receiving an exercise intervention, nutrition counselling and a home safety assessment. However, at-risk subjects also received smoking and alcohol intervention. This study confirms the feasibility of a multiple approach, but does not offer evidence on the relative impact of the various components. After six months, the intervention group had significantly better scores on self-rated health, and fewer depressive symptoms than controls. The prevalence of risk factors other than physical activity was so low that the main impact probably came from the exercise intervention. However, effectiveness of the program was not evaluated in terms of falls.

Steinberg et al (2000) conducted a study looking at the effectiveness of a multi-component intervention targeting major falls risk factors in reducing slips, trips and falls among older people living in the community. Volunteers were recruited from 10 branches of a senior’s association representing a community group of active Australians aged 50 and over. Branches were divided into four groups and randomised to receive one of four interventions. Group 1 received an education program - an oral presentation, video on home safety and a pamphlet on falls risk factors and prevention strategies - and was considered the control group. Group 2 received the education program given to Group 1 and an exercise program - a one hour exercise class once a month, handouts and a gentle exercise video for use between classes. In addition to the education and exercise, Group 3 were offered a home safety assessment and financial and practical home modification assistance. Group 4 received education, exercise, home assessment / modification and a clinical assessment and advice on medical falls risk factors. At one year follow-up there was a statistically significant reduction in the risk of slips and trips (episodes where balance was regained without landing on a lower surface) and a
trend towards a reduction in the risk of falling in the intervention groups compared to the control group. Except for trips, there was no evidence that the reduction in risk declines with the number of strategies used.

3.6 Other interventions

3.6.1 Footwear and foot care

Footwear provides the interaction between an individual and the support surface in situations when a fall may occur. Until recently most of the information regarding suitable footwear for older people was anecdotal, with several authors reporting its importance in falls prevention (Tideiksaar, 1998; Menz and Lord., 1999). Fortunately, there are now a small number of studies that provide scientific data regarding the effects of footwear on balance in older adults.

One study reported that wearing shoes resulted in impaired foot position sense in both younger and older adults (Robbins et al., 1995). Another study using a randomised controlled design (Lord & Bashford, 1996) determined that bare feet and walking shoes maximise balance in older women, whereas high-heeled shoes were an unnecessary hazard. Lord et al (1999) also investigated the effects of shoe collar height and sole hardness on balance in a group of older women. The findings indicated that subjects were more balanced when wearing shoes with a high collar than when wearing those with a low collar, or when barefoot. Sole hardness was not related to balance.

Sherrington and Menz (2003) investigated the footwear worn by people at the time they fell and suffered a hip fracture. Three quarters of the subjects wore footwear with at least one sub-optimal feature such as absent fixation (63%), excessively flexible soles (43%), and 22% wore slippers. The slip resistance qualities of a number of types of footwear were examined by Menz and colleagues (2001). None of the shoes examined were considered safe under wet conditions, from the perspective of the soles’ coefficient of friction.

This is certainly an area where appropriate advice can help modify a commonly reported, potential risk factor for falls. There have been no randomised controlled trials investigating the effect of shoe type on falls rates.

Foot problems, such as pain in the feet from corns, callouses and bunions, foot deformities such as hammer toes, poor nail condition, and sensory loss in the feet, can be associated with increased falls risk (Menz and Lord., 1999). Many of these foot conditions can be effectively treated with podiatry and the use of appropriate orthotics. However, there are no RCT studies investigating footcare treatments and falls outcomes. Menz and Sherrington (2000) developed a foot assessment tool to help identify foot problems and deformities. This tool not only aids research in the area of foot care and falls, but more importantly, ensures older people with foot problems and foot deformities receive appropriate treatment and care.
3.6.2 Assistive Devices

3.6.2.1 Appropriate walking aids

Little research has been done investigating the specific role of walking aids in the maintenance of balance and the prevention of falls. Dean and Ross (1993) studied the relationship between using a walking stick and falls occurrence. The majority of participants reported that the greatest benefit of using a gait aid was improved confidence for performing physical activities and 20% reported less falls when using their walking stick. This study also highlighted that in many cases, walking aids were fitted by non-health care workers, and this commonly resulted in a gait aid being the incorrect height. Another study by Nandapalan and colleagues (1995) determined that a walking stick was able to significantly reduce lateral body sway in patients with balance deficits. The authors hypothesised that the use of a walking stick was able to provide additional proprioceptive input and so reduce the fear of instability.

Administration of a walking aid is a commonly used intervention for older people at risk of falling. People for whom a walking aid is considered appropriate should undergo a falls risk assessment to identify contributing factors for their impaired balance or mobility, some of which may be amenable to other forms of falls prevention intervention. Consideration should also be given to appropriate prescription and instruction regarding use and maintenance of the gait aid.

No randomised controlled trials have been conducted to evaluate the effectiveness of walking aid prescription on falls rates.

3.6.2.2 Personal alarm device

Personal alarm devices are worn by a person at risk of a medical emergency, including falls, where it is important for medical assistance to be obtained quickly. Various types are available, usually triggered by the wearer in the case of an emergency to activate an emergency contact system. Personal alarms have been advocated for older people at risk of falling, particularly those with limited social contact, in an attempt to reduce the likelihood of lying on the floor for a long period before assistance is obtained (termed a “long lie”). Studies have shown increased self-reported health and reduced anxiety and depression for both carers and older people who are using personal alarm devices (Bruce, 1994). Wild et al (1981a) identified that 16% of falls resulted in a period greater than one hour before assistance was obtained (none of these falls caused a fracture). The presence of a “long lie” has been shown to be significantly associated with mortality within a year of the fall, relative to fallers who did not have a “long lie” (Wild et al., 1981b).

There have been no randomised controlled trials evaluating the effectiveness of personal alarm devices in reducing the incidence of “long lies”, morbidity or mortality in older community dwellers after a fall.
3.7  *Injury minimisation*

3.7.1  Hip protector garments

Hip protectors are special shields worn over the hip that can absorb the impact of a fall, or divert the impact of the fall away from the greater trochanter of the hip, aiming to minimise the risk of a hip fracture. They may be most appropriate when other falls prevention strategies have been implemented but the individual’s risk of falling remains high. Various forms of hip protectors and undergarments have been developed. The hip protector pad is usually fitted within the underwear, although there have been recent developments with adhesive hip protector shields which can be worn with the older person’s own underwear. Until recently, the majority of research using hip protectors had been conducted in residential care facilities.

Cameron et al (2003) conducted a two year randomised control trial investigating the effectiveness of hip protectors in a community sample. The sample included 600 females aged 74 years and over (average age 83 years) who had two or more falls, or one fall requiring hospital admission in the previous year. Adherence by participants with use of the hip protector was limited and approximately 53%. On an intention to treat basis there were no differences in fracture rates between the control group and hip protector group. However, the risk of a hip fracture when falling while wearing a hip protector, compared with a fall while not wearing a hip protector, was significantly reduced (relative risk (RR) 0.23, 95% CI 0.08 to 0.67). A previous study by Cameron and colleagues (2000) identified significant improvements in fear of falling when wearing hip protectors in a randomised controlled trial of older community dwelling women at risk of falling.

In another community sample, Birks et al (2003) looked at the effectiveness of hip protectors among older people who had sustained a hip fracture. There were 366 participants, although only 46 were male. Participants were recruited through the media (general population) and from orthopaedic wards where patients were recovering from a hip fracture. After a median follow-up of 14 months, there were 43 fractures sustained by 39 participants. Self reported fractures were followed up at six monthly intervals and all fractures were confirmed by contact with GPs at the end of the study. Fractures not confirmed by GPs were not included in the analysis. There were only 8 hip fractures reported, a much lower rate than expected, 6 in the hip protector group and 2 in the control group. Adjusting for age and volunteer status (volunteers vs hospital ward recruits) the odds ratios were similar. Hip protectors also had no effect on the risk of other fractures or falls. However compliance was very low (34%) and only one participant in the hip protector group reported wearing a hip protector at the time of fracture. More surprisingly, compliance was lower in the hospital ward recruits (23%) than the volunteer group (39%). Reasons for non-compliance were not ascertained in this study but given that this was a study sample of older people who have had a previous hip injury or were recovering from a recent hip fracture, the reasons for non adherence need to be further investigated.

A Cochrane review of the evidence supporting the use of hip protectors has been reported (Parker et al., 2003). The sub-analysis for the community setting indicates that there is insufficient evidence that hip protectors provide a benefit in reducing hip or pelvic fractures, in contrast to the results from studies in residential care settings, particularly those in which randomisation was by unit or facility. A number of methodological factors are cited in the Cochrane review as potential reasons for the community studies not identifying an effect of hip protectors, including relatively small sample sizes (for detection of impact on fracture rates), problems with adherence to use of the hip protectors in the intervention groups, and the
possible need to target hip protectors primarily to those with a high risk of falls.

Two major limitations of hip protector studies in the community setting are low adherence rates, and also how adherence is measured. Patel et al (2003) investigated factors that may contribute to the acceptability of and compliance with hip protectors specifically in the community setting. The study involved 85 women aged 70 and over referred for open access bone densitometry who had femoral neck osteoporosis and one or more risk factors for falls. Only 38% of participants found hip protectors acceptable and agreed to participate. Reasons for non-acceptance included: they were uncomfortable (34%), they disliked their personal appearance with the hip protectors on, or felt they would even without trying them on (25%), they disagreed with the assessment of increased risk of hip fracture (13%), they were unable to independently put the hip protectors on (5%) and various other reasons. The only statistical difference between those agreeing to participate and non-participants was that non-participants were slightly older. There was also a non-significant trend for those who wore hip protectors to have had a family history of osteoporosis (47% vs 26%), and they were twice as likely to have had a hip fracture (16% vs 8%). At 12 months follow-up about half of those recommended to wear hip protectors were wearing them daily, with the majority of these reporting 8-10 hours of hip protector use in 14-16 waking hours per day. The authors concluded that “whether individuals will find an intervention such as drug treatment or a hip protector acceptable and comply with use will depend on the complex interaction between personal perception of risk, side-effects of the intervention and the ability to administer the intervention” (p 772).

Van Schoor et al (2002) conducted a systematic review of the acceptance and adherence to use of hip protectors, although the majority of the studies reviewed were in the residential care setting. Primary acceptance of hip protectors varied from 37% to 72% (median 68%) and compliance varied between 20% and 92% (median 56%). The most frequent reasons for non-compliance included - not being comfortable (too tight/poor fit); the extra effort (and time) needed to wear the device; urinary incontinence; and physical difficulties / illnesses. The authors concluded that compliance is a complex but important issue in hip protector research and implementation. The results of this review, together with those described by Patel et al (2003) highlight areas where modifications could be considered to the design of the protectors and underwear, while maintaining the force attenuation capacity needed to reduce fractures. The review also highlights the need to develop and test methods to improve compliance.

3.7.2 Maintenance / improvement in bone strength

Vitamin D and calcium supplements have been recommended as management options for older people with osteoporosis and osteomalacia, although this approach has been the focus of relatively little research in terms of reducing falls or fracture rates.

One randomised controlled trial by Chapuy and colleagues (1992), found a significant reduction in risk of hip and other non-vertebral fractures, as well as an increase in the bone mineral density (BMD) of the proximal femur, of older women in an intervention group compared to a control group. The intervention consisted of vitamin D and calcium supplementation, with the control group receiving a placebo. The sample in this study was mixed, including older women living in apartment buildings, as well as those in nursing homes. The study does not differentiate outcomes for those living in the community from those living in nursing homes.

A study by Latham et al (2003a), reported in Section 3.2.1.2, found no effect on falls for the vitamin D supplementation group at six month follow-up.
Trivedi et al (2003) studied the effect of vitamin D supplementation in isolation in a community dwelling population of men and women aged 65 and over. This double blinded randomised control pilot study recruited participants (n=2686) from a doctor’s registry and patient register from general practice. Participants in the study received a 100,000 International Units (IU) capsule of vitamin D or placebo by post every 4 months for 5 years. At the end of the 5 year follow-up the intervention group had a significantly lower rate of first fracture at any site (22%) and a significantly lower rate of first fracture in the hip, wrist, forearm, or vertebrae site (33%) than the control group. These differences were observed one year into the study.

Another recent RCT study by Harwood et al (2004) also confirmed the benefits of vitamin D in 150 older women recruited after hip fracture surgery. The authors compared the effects of various calcium and vitamin D regimes (single injection of 300,000 units of vitamin D$_2$, injected vitamin D$_2$ plus 1 g/day oral calcium, 800 units/day oral vitamin D$_3$), or no treatment on bone biochemical markers, bone mineral density and falls rates. At one year follow-up the authors found that vitamin D treated groups, whether injected or taken orally, showed an increase in bone mineral density, a suppression of parathyroid hormone and reduced falls. Although the number of fractures were insufficient to determine between group significance, the treated groups had lower fracture rates (0, 3 and 3 fractures respectively) than the control group (8 fractures). The effect was more apparent in the group also receiving calcium co-supplementation. The authors also concluded that the 300,000 units of injected vitamin D may not last a whole year (20% were deficient in 25-hydroxyvitamin D a year later).

Latham et al (2003b) conducted a systematic review of the effect of vitamin D supplementation on physical outcomes such as strength and function, as well as falls. They concluded that although there is insufficient evidence that vitamin D supplementation alone improves physical performance or reduces falls in older people, several studies did identify improved physical performance and reduced falls with vitamin D supplementation combined with calcium.

For older people who have had a “minimal trauma fracture”, with bone mineral density or radiological evidence of osteoporosis, some medications are available through the Pharmaceutical Benefits Scheme (PBS) that have an effect on maintaining or improving bone strength (O’Neill et al., 2002). Bisphosphonate medications which act to inhibit bone resorption, have been shown to reduce risk of vertebral, and in some cases, peripheral fractures such as hip fractures (Cranney et al., 2003; Cranney et al., 2002). Risk reduction is often seen in the first six to 12 months of taking the medications (O’Neill et al., 2002). Other medications which reduce bone resorption are the Selective Oestrogen Receptor Modulators (SERMs). Studies have shown that use of SERMs reduces the risk of vertebral fractures, but not peripheral fractures (Ettinger et al., 1999; Cosman et al., 2003). Each of these medications is associated with some side-effects, so prescription needs to be considered in the context of the individual’s previous medical history, previous “minimal trauma” fracture/s, level of osteoporosis, other medications, and side effects experienced.
Vitamin D (used in isolation, or in combination with calcium) has been shown to significantly reduce risk of fracture from a fall in older people living in the community and residential care. For people who have experienced minimal trauma fractures and who have evidence of osteoporosis, use of bisphosphonate medications or SERMs have also been shown to reduce subsequent fracture rates.

3.8 Cost effectiveness

Reviewing the cost effectiveness of a healthcare service is a difficult and lengthy process, requiring hypothetical estimates of costs incurred in terms of the intervention itself and the supposed benefits achieved. Indeed, the majority of literature in this area describes costs related to European and US healthcare models and may have limited direct application in the systems of other countries (Nicholl et al., 1994). In the area of falls prevention, there is certainly a paucity of information regarding the cost effectiveness of community-based intervention programs.

Rizzo et al (1996) conducted an important study using information gained as part of the Yale FICSIT trial (Tinetti et al., 1994a), to assess the cost effectiveness of a multifactorial falls intervention program in community dwelling older adults. The authors concluded that overall health care costs were $US 2000 less in the intervention, compared with the control group. Among participants with four or more targeted risk factors, there were lower hospitalisation, nursing home and home health care costs due to risk factor modification and a reduction in falls occurrence. Indeed, for participants in the high risk group receiving intervention, incidence of falls was decreased by almost 50%, with substantially fewer serious falls. It would appear that the strongest effect in terms of costs was for those individuals at high risk of falling (four or more risk factors) and perhaps highlights a need to concentrate resources on this specific patient population.

Buchner and colleagues (1997b) used a randomised controlled study design to evaluate the effect of an intervention strategy on gait, balance, falls risk and health service-use in a group of mildly balance impaired community dwelling adults. Although hospital usage over an 18 month period was similar between groups, the hospitalised controls were significantly more likely to spend more than three days in hospital and to have more out-patient clinic visits. This would indicate that this type of intervention program could reduce health care costs in a less disabled population of older adults.

Smith and Widiatmoko (1998) used an analytic model to determine the cost effectiveness of a home assessment and modification approach. The authors hypothesised that this type of intervention could effectively reduce the probability of a fall by 25%, and reduce the severity of the injury sustained. Over a one year period, the incremental cost per fall prevented was calculated to be $1721, and the cost per injury prevented was $17,208. Over a ten year period, the intervention was estimated to result in a cost saving of $92 per person. The assumptions made by the authors, particularly with regard to the effectiveness of home modifications program in isolation, indicate that caution should be used in the generalisation of these figures until stronger research evidence of the effectiveness of this approach has been established.
Salkeld et al (2000) also estimated the cost effectiveness of home assessment and modification as part of the Cumming et al (1999) (Section 3.3.2) study that found a reduction in falls as a result of home modifications conducted by an occupational therapist. Effectiveness was based on all 530 participants in the study, but costs were determined using a sub sample (n=212), the last to be recruited. The incremental cost per fall prevented was $4986, although with the removal of 12 outliers, the incremental cost per fall prevented was $1912 for all subjects and actual cost savings for those with a history of previous falls. The authors did however find higher use of home and community services, levels of informal care and hospital costs in the intervention group but no significant difference in median costs between groups. However the authors calculation of costs were broad and included non-falls related costs (eg most hospitalisations were non-falls related).

Robertson et al (2001a) conducted a cost effectiveness evaluation of the individual home exercise program conducted by Campbell et al (1997) (Section 3.2.2). The cost of implementing the program was calculated at $314 for 1 year and $265 for 2 years (NZS) per fall prevented and $457 and $426 respectively per fall resulting in a moderate or serious injury. There were no significant differences in the number of serious injuries sustained in the two groups; the difference related to moderate injuries, and therefore although there was a significant reduction in falls there were no significant differences in healthcare costs, which included hospital costs substantiated by hospital records and self reported other costs, between the intervention group and control group. However the sample size was based on effectiveness of the intervention and not costs. A larger study would be required to better determine cost effectiveness of the program.

The data from the small number of studies investigating cost effectiveness suggests potential for longer term cost savings, particularly for interventions targeting those with increased risk of falls. More research needs to be done in Australia to further investigate this issue with regard to population sample (healthy versus frail), nature of fall event (fracture versus soft tissue injury) and likelihood of hospitalisation. It has been suggested that intervention strategies need to concentrate primarily on injurious falls (Vellas et al., 1997) since these are more costly to the community in terms of hospitalisation, health services usage (rehabilitation and nursing home stays) and change in functional status (Knusly et al., 1997). Since serious falls constitute only 12% of total falls (Tinetti et al., 1995), and in view of the long term implications of reduced activity, increased falls risk and resource usage of older people who experience mild injuries but moderate fear of falling as a result of their fall, this is a difficult argument to uphold.

3.9 Compliance and sustainability

Two key issues which need to be considered if falls prevention programs are to achieve long term effectiveness are those of compliance and sustainability. Compliance refers to the uptake of a specific program among the target group. Factors such as how the program is promoted, whether the target group identifies with the health problem being targeted by the program, venue, ease of access, and cost will influence whether or not an older person participates in a particular falls prevention program. Sustainability refers to the likelihood of continued participation with a program or its message in the longer term. Factors influencing compliance and sustainability may include perceived benefit of the program (and therefore the need for review and reflection), enjoyment in participating in the program, social and other benefits of the program, and the ability of the program to respond to changing needs. Problems with compliance and sustainability have been reported in a number of papers in the falls prevention literature.
The effectiveness of an exercise program in reducing falls rates has been shown to be greater for those who were high compliers with the program (Lord et al., 1995). Campbell (1999a) reported that 42% of those performing a home-based program of strength and balance exercises, were compliant with the program after one year. The authors hypothesised that the individual nature of the program may have assisted compliance and suggested six monthly reviews to maintain enthusiasm. Those participants who were more physically active at baseline, those with a previous fall and those who remained confident about not falling were more likely to continue exercising. Another study by Williams and Lord (1995) identified that impaired balance and strength, and using psychoactive medications were associated with reduced compliance in a group program for older women.

Interestingly, the proportion of older people who comply with recommendations for home hazard modifications after a formal review is low. Cumming and colleagues (1999; 2001) identified that between 30% and 50% of older people who were recommended by an occupational therapist to undertake home modifications to reduce falls risk had not complied with the most of the recommendations at 12 month follow-up.

In their study of the effectiveness of a Comprehensive Geriatric Assessment, Shah and colleagues (1997) identified that physician implementation of recommendations was 70% and that this was highest for the falls component of the program. Patient adherence to physician implemented recommendations was 85%, but only 46% for self-care recommendations, such as the use of assistive devices, incontinence aids, home environment modifications or psychological counselling services. In a study to promote physical activity, GPs were taught different modes of recommending behaviour change. Where GPs gave both verbal and written personalised information (including goals), there was a significantly greater increase in patients’ recreational activity levels after six weeks, compared to a group that received verbal information alone (Swinburn et al., 1998). These studies highlight issues regarding workforce training in the targeted area, and the difference in effectiveness of different methods used to convey health promotion information.

Hip protector use by community dwelling older people appears to be one of the most problematic interventions with respect to compliance. Van Schoor et al (2002) and Patel et al (2003) have reviewed the key factors related to the uptake and sustained use of hip protectors in community dwelling older people. Comfort, appearance, ease of putting on and taking off, other heath problems, such as incontinence, and family history of osteoporosis or personal history of hip fracture, were all identified as important factors influencing compliance.

Several studies have highlighted the limited sustainability of what were otherwise effective programs. Tennstedt and colleagues (1998) incorporated cognitive restructuring and strength training in a group based program to reduce fear of falling. The positive outcomes diminished over time, and the authors recommended inclusion of booster sessions. Similarly, the effective reduction in use of psychotropic medications in the study by Campbell and colleagues (1999b) had reverted in almost half of the participants within a month of stopping the study. A customised exercise approach was also found to be effective in reducing falls, with subsequent maintenance of gains over a two year period (Campbell et al., 1999a).

Uptake of and adherence to recommended interventions has continued to be highlighted as a moderate limiting factor in many of the recent studies which have achieved successful reductions in falls or falls related injuries. Some of the specific adherence issues raised in these studies have been highlighted in the sections of this review where the specific intervention has been reviewed. In all areas, further research into strategies to maximise
uptake and sustained engagement with appropriate falls prevention activities is warranted. In order to identify appropriate compliance strategies there is a need to better understand the factors (perceptions, actions and behaviours) that lead the older person to implement changes to prevent falls, that is both key motivators and barriers. Understanding individual motivators and behaviours is also important. A recent study by Clemson et al (2003) describes the development of an assessment tool to evaluate the behavioural factors associated with falling. Ten behavioural dimensions were identified – cognitive adaptations, protective mobility, avoidance, awareness, pace, practical strategies, displacing activities, being observant, changes in level and getting to the phone. The authors concluded that the tool, designed to rely on the older person’s perception of his or her own behaviour, could be used as an assessment and goal setting tool. This warrants further investigation.

Issues associated with increasing participation in falls prevention programs that are shown to be effective, and factors associated with sustainability of the positive health benefits longer term are key factors which need to be further explored.

3.10 Cultural issues

It is apparent from a review of the literature that the majority of studies investigating falls intervention in community dwelling older adults involve English speaking participants. Indeed, an inability to comprehend or speak English is frequently cited as an exclusion variable for admission into the study (Buchner et al., 1997b; Close et al., 1999). A study by Reinsch et al (1992) in the United States evaluated a population inclusive of Spanish and English speaking elders and focused predominantly on those in low socio-economic areas. The authors made no statement as to the influence these factors made on the intervention process.

3.10.1 Aboriginal and Torres Strait Islander people

Census counts of Aboriginal and Torres Strait Islander people are acknowledged to be incomplete, and although the quality of the count has improved over the past two decades (McLennan & Madden, 1999), considerable variations in estimates still exist between different states and territories. Although there has been a significant improvement in many aspects of health in Aboriginal and Torres Strait Islander people, rates of hospitalisation, adult death rates and reports of disability indicate that the burden of disease is far greater in this group within Australia (Donovan, 1995). Disabling conditions have included loss of sight and hearing and diseases of the musculoskeletal system, factors frequently associated with a higher risk of falling in older adults (Nevitt et al., 1989). Lower life expectancy rates, environmental factors, and reduced access to medical services for these people makes comparison with other older populations difficult. Figures from the Australian Bureau of Statistics (McLennan & Madden, 1999) have indicated that in a number of Aboriginal communities, initial presentations to the health care clinic were because of injury, but that about half (51%) of these were associated with alcohol. Although excessive alcohol consumption could be considered a risk factor for falls, community falls prevention studies
have not found this to be a common problem. There is no data available on falls occurrence in Aboriginal and Torres Strait Islander people, and no intervention strategies reported.

### 3.10.2 Australians from Culturally and Linguistically Diverse backgrounds

Issues relating to the utility of the many falls prevention approaches in Culturally and Linguistically Diverse populations have rarely been reported in the English research literature. In a review of falls prevention programs in Australia, several have identified the specific needs of people from Culturally and Linguistically Diverse backgrounds (Hill et al., 1999a). One project used a focus group approach to identify issues related to falls prevention, and perceived barriers to physical activity in older people from the Macedonian community in Sydney (I. Gaha, South Western Sydney Area Health Service, unpublished). A number of important findings were reported, including cultural differences in the understanding of the term physical activity. Such differences would have the potential to limit effectiveness of a program targeting physical activity in this group, unless the program is suitably modified. While a number of programs have been introduced which have incorporated some elements to address these cultural issues, none have been published, and none have utilised a randomised controlled trial design to evaluate effectiveness.

### 3.10.3 Rural and regional Australia

About 36% of Australians live outside capital cities: half in major regional centres and the remainder in rural and remote areas (Donovan, 1995). Recognised poorer health and significant access problems make data collection and intervention programs more difficult in rural areas.

One population based study in Geelong, Victoria, has identified significantly lower rates of hip fractures and of all fractures, among rural residents than urban residents (Sanders et al., 2002. The authors conclude that the lower fracture rates may be associated with lower levels of osteoporosis in rural residents, likely to be associated with environmental / lifestyle factors.

There has been little else published comparing falls / falls injury incidence, or falls prevention programs between metropolitan and rural/regional Australia. This part of the Australian community requires further consideration in terms of falls prevention.
There is a need for epidemiological data to better understand the incidence of falls and falls injury in Aboriginal and Torres Strait Islander communities, with subsequent implementation and evaluation of relevant falls prevention approaches. The needs of rural and regional Australians and of those from Culturally and Linguistically Diverse backgrounds also require further investigation. It is likely that some modifications will be necessary for successful translation of evidence-based falls prevention programs for these groups. It is important that effective evaluation and dissemination of results be facilitated to enable wider application of programs targeting these groups.

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4. Falls among older people in residential care settings - Introduction

Reported falls rates among older people in residential care settings vary widely, ranging from 13% (Lipsitz et al., 1994) to over 60% of residents falling in a 12 month period (Tinetti, 1987; Jensen et al., 2002a). Most studies report rates in the 30-50% range (Aronow & Ahn, 1997; Kiely et al., 1998; Nygaard, 1998). Falls among community dwelling older people have also been shown to be a strong predictor of admission to residential care settings (Tinetti & Williams, 1997). Despite the association with admission to residential care, and the very high rates of falls which have been reported in these settings, comparatively little research has been conducted in this area.

A high proportion of falls in the nursing home setting are associated with injuries (Thapa et al., 1996; Nurmi and Luthje, 2002). A New Zealand study reported the risk of hip fracture to be 10.5 times higher for women living in institutions compared with those in private homes, although this figure decreases with increasing age, so that beyond 90 years it is no longer statistically significant (Butler et al., 1996). This New Zealand data translates to one in every 25 older people in residential care settings sustaining a hip fracture annually (Butler et al., 1996). Furthermore, less than 15% of older people in residential care settings who fracture their hip regain their pre-injury ambulatory status (Folman et al., 1994). The substantial human suffering and the large financial costs associated with falls and their related injuries highlights the importance of developing and implementing intervention strategies aimed at preventing falls and falls related injuries in this population (Butler et al., 1998b). Falls in residential care settings may also lead to caregiver stress and fear of litigation for staff and administration (McHutchion & Morse, 1989). Costs associated with falls in residential care facilities in Finland have been estimated as 944EURO / fall (Nurmi and Luthji, 2002). This amount is equivalent to approximately $AUD 1,560. Moller (2003) has estimated that if falls rates continue at 2001 rates, an additional 3320 nursing home places will be required in Australia by 2051 as a result of falls related injuries.

Residential care in Australia is provided in a range of settings. In ‘low care’ facilities, such as Supported Residential Services and Hostels, residents may have a large degree of independence in personal activities of daily living, and also independence in some instrumental activities of daily living. In ‘high care’ facilities, some residents require full assistance with all activities and a significant proportion are cognitively impaired. The international falls literature often uses the term “nursing home” to include both high and low care settings.

A number of factors may contribute to the high rate of falls among older people in residential care settings (see Section 4.1). The generally advanced age, physical and / or cognitive impairment and functional dependency of this population are all important issues to be considered with respect to falls prevention programs in these settings. Some of the differences between risk factors and demographics of older people living in the community and in residential settings, such as cognitive status, may indicate that falls prevention strategies identified as being successful in one setting may not translate readily to the other setting. Furthermore, some of the unique aspects of residential care may warrant novel approaches to falls prevention rather than a direct application of strategies used in community settings. These issues will be discussed throughout this section of the report.
4.1 **Overview of falls risk factors**

Falls recall has been identified as a factor limiting studies that utilise falls as an outcome measure in community dwelling older people. This problem is overcome to some degree in residential care settings by the use of incident reporting systems, including documentation of falls events. However, even with the use of incident reporting systems, there remains considerable variability in the data. For example, Kanten and colleagues (1993) reported that chart review reflected a greater number of fall events among residents than the traditionally counted incident reports. In analysing the data for falls risk factors, studies using any of the three reporting methods (review of incidents reports, review of charts and structured interview of subjects) described by Kanten (1993) were included.

*Given the magnitude of the problem of falls in residential care settings, there is merit in working towards standardisation of falls incident and injury reporting systems, similar to the Australian Incident Monitoring Service (AIMS) or RiskMan® Medical Incident Reporting Database for reporting of incidents in hospital settings.*

Numerous studies have reported risk factors for falls among older people in residential care settings. Unfortunately, there is limited comparability between studies due to a focus on different risk factors, and different classification of risk factors being investigated. However, in summarising the results, the major risk factors for one or more falls or injurious falls among older people in residential care settings have been identified as:

**a/ intrinsic factors:**
- increased age (Bueno-Cavanillas et al., 2000);
- acute health status (Kuehn & Sendelweck, 1995; Jensen et al., 2002a; Kallin et al., 2002);
- history of previous falls (Kiely et al., 1998; Bueno-Cavanillas et al., 2000; Krueger et al., 2001);
- wandering behaviour (Kiely et al., 1998);
- cognitive impairment (Nygaard, 1998; Bueno-Cavanillas et al., 2000);
- maximal drop in post-prandial systolic blood pressure (Aronow & Ahn, 1997; Le Couteur et al., 2003);
- deterioration in Activities of Daily Living performance (Kiely et al., 1998);
- reduced lower extremity strength or balance (Lipsitz et al., 1994);
- unsteady gait / use of a gait aid (Kiely et al., 1998; Bueno-Cavanillas et al., 2000);
- independent transfers / wheelchair mobility (Kiely et al., 1998);
- use of antidepressant medication / polypharmacy (Lipsitz et al., 1991; Thapa et al., 1998; Bueno-Cavanillas et al., 2000; Kallin et al., 2002), or drug side-effects (Kallin et al., 2002);
- impaired vision (Kallin et al., 2002); and
- diabetes mellitus (Bueno-Cavanillas et al., 2000).

**b/ extrinsic factors:**
- relocation between settings (Friedman et al., 1995); and
- environmental hazards.

Information about circumstances of falls within a particular residential care setting can provide a basis for targeting falls prevention activities. In one residential care facility, the following information about falls circumstances was considered important to inform planned falls prevention activities (Jensen et al., 2002a):
- time when falls occur. In this setting 27% of falls occurred at night, indicating a need to investigate factors contributing to the falls during this period;
location of falls. Two thirds of falls were identified as occurring in the resident’s room; and
activity at the time of the fall. Nearly a third of all falls were related to toileting (Jensen et al., 2002a)

There are a number of common risk factors for falling among older people in residential care settings, with the risk of falling increasing as the number of risk factors accumulates (Kuehn & Sendelweck, 1995). However, the contribution of facility-specific factors to falls risk, independent of resident-specific factors, needs further investigation (Kiely et al., 1998).

4.2 Falls risk factor - intervention matrix

Compared to the number of intervention studies evaluating falls prevention in community settings, relatively little work has been carried out investigating the effectiveness of falls prevention programs in residential care settings. The remainder of this section focuses on an analysis of this literature. Different interventions have been established to address different risk factors.

A matrix has been developed to provide an overview of the degree of evidence of effectiveness of specific falls prevention program types in reducing falls (Table 2). Programs have been tabulated according to which falls risk factor/s were addressed by the specific intervention type. The highest level of evidence for a particular intervention type and risk factor has been recorded, with relevant references noted. Studies which have demonstrated significant improvements in falls or falls injury rates have been included in the matrix, although given the very small number of these, several additional studies have been added which identified a strong trend towards reducing falls rates (and in one case, falls injury). A summary of these studies is provided at the end of this report. Other relevant papers are discussed throughout the report.

An overview of single and multiple intervention falls prevention programs for older people in residential care settings is shown in Section 4.3.
Table 2. Falls risk factor - intervention matrix (older people in residential care settings).

<table>
<thead>
<tr>
<th>Interventions</th>
<th>Falls risk factors</th>
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<tbody>
<tr>
<td>Education</td>
<td>A, B***</td>
</tr>
<tr>
<td>Exercise</td>
<td>C**</td>
</tr>
<tr>
<td>Group</td>
<td>E**</td>
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<tr>
<td>Individual Walking</td>
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<tr>
<td>Medical</td>
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<td>Screen</td>
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<tr>
<td>Medication</td>
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<tr>
<td>Nutrition</td>
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<tr>
<td>Environment</td>
<td>F***</td>
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<tr>
<td>Sensory</td>
<td></td>
</tr>
<tr>
<td>Injury Minimisation</td>
<td></td>
</tr>
<tr>
<td>Multiple strategies</td>
<td>O</td>
</tr>
</tbody>
</table>

A. Evans et al., 1997  B. Evans et al., 2003  C. Toulette et al., 2003  D. Lord et al., 2003  E. Mulrow et al., 1994  
K. Kannus et al., 2000  L. Harada et al., 2001  M. Meyer et al., 2003  N. Parker et al., 2003  O. Ray et al., 1997b  
P. Rubenstein et al., 1990  Q. Shaw et al., 2003  R. Jensen et al., 2003  S. Jensen et al., 2002b  T. Becker et al., 2003

Unless otherwise stated, reported studies are Level II evidence (randomised controlled trials)

* Level I – systematic review;  ** non-significant trend in RCT for reduced falls or falls injuries
*** Level III - significant reduction in falls (non randomised study)
**** subanalyses for those with cognitive impairment resulted in significant reduction in fractures
### 4.3 Overview of intervention strategies

A systematic review of the literature in the residential setting has revealed a wide variety of intervention strategies aimed at reducing the occurrence of falls, and subsequent injury, based on the modification and reduction of detailed risk factors associated with falls. These include:

<table>
<thead>
<tr>
<th>Education</th>
<th>Health Professional Education</th>
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<tr>
<td>Falls Risk Factors</td>
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<td>Health Promotion</td>
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<table>
<thead>
<tr>
<th>Exercise</th>
<th>Generalised versus Customised</th>
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<tr>
<td>Group versus Individualised</td>
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<tr>
<td>Balance / Strength / Endurance Training</td>
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<th>Environment</th>
<th>Assessment / Modification</th>
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| Clinical Assessment and Review | |
| Medical Screen (including medication) | |
| Sensory Evaluation | |
| Multiple Strategy (targeted and untargeted) | |

| Injury Minimisation | |
| Clothing (hip protector garments / footwear) | |
| Assistive Devices (walking aids / physical restraints) | |
| Vitamin D and calcium supplementation | |
5. **Research evidence in reducing falls and falls injuries: Residential care settings**

5.1 **Education / health promotion**

The role of education in the prevention of falls among older people in residential care settings has been frequently described as an important component of falls prevention strategies, but has not been investigated as a single intervention in these settings. Education programs may target:

- staff / care providers in residential care settings;
- residents; and
- other interested groups, such as family and friends of residents.

5.1.1 **Education programs targeting staff / care providers**

Education programs for staff of residential care settings aim to inform staff about the magnitude of the problem of falling in these settings, risk factors for falls, and strategies which may reduce falls rates in this population. The underlying theme for these education sessions is that staff have a key role in terms of their attitudes, knowledge, and work practice in reducing falls rates among older people in residential care settings. Most often, information is provided in a didactic manner. Although commonly used, to date there have been no randomised controlled trials of this approach in identifying its effectiveness in reducing falls rates in residential care settings, and there is increasing evidence that this approach is ineffective in other areas of medical workforce training. For example, Davis and colleagues (1995) published a systematic review of 166 educational interventions aimed at changing doctors’ behaviour (not related to falls prevention). They found that the usual didactic continuing professional education is relatively ineffective.

A survey of falls prevention activities in residential settings in New Zealand, reported that falls were perceived to be a problem by over 75% of nurses responding to a questionnaire (Butler et al., 1998b). The authors noted that strategies being employed for falls prevention were not consistent with the evidence about effectiveness. Despite this, support for initiatives to prevent falls and fall-related injuries was evident, with two thirds of respondents willing to participate in subsequent projects. A follow-up study aimed at increasing use of hip protector garments using education and group discussion, achieved promising results with increased receptivity reported by staff and residents (Butler et al., 1998a). A number of key issues emerge from the results of these two studies which are likely to influence the success of education programs in residential care settings:

- staff need to perceive that falls among residents is a major problem;
- staff need to perceive that there is potential benefit of specific interventions aimed at reducing falls and fall-related injuries among residents; and
- staff should have an active involvement in the development and implementation of falls prevention programs.

5.1.1.1 **The method of workforce training**

There is increasing focus in the education literature to indicate that different approaches to learning may need to be considered in specific settings. Complex behaviour change in individuals and system change in institutions may be required to achieve reduced falls and
injuries in aged care facilities. In some regards the situation is similar to education in other health care areas. A simple in-service program, utilising a didactic approach of provision of information, with some opportunity for questions, may not be the best approach for achieving long term behaviour change in both staff and residents in residential settings. A study conducted in an Australian low care residential setting found that staff knowledge increased following a staff education program, offered as a traditional didactic presentation, but that the incidence of falls had not decreased (Taylor and Morris, 1999). Instead, training initiatives which incorporate active interaction between all key players, investigating key issues within the specific setting, and identifying barriers and motivators for change within these settings, may result in improved change in behaviour (Lindeman et al., 2000; Lindeman et al., 2002). These issues are discussed further in the Workforce Training section of this report (Chapter 8).

5.1.2 Education programs targeting residents

Education programs for older people in residential care settings aim to facilitate behaviour change in the older person that will achieve safer mobility and minimise falls risk. A limiting factor of this approach among older people in residential care is the prevalence of impaired cognition, and reduced learning of some residents. Nonetheless, for residents without learning difficulties, this approach may be indicated. Issues raised in the review of this type of program among community dwelling older people are likely to be important to consider. These include that the older person needs to perceive that they are at risk of falling, and to consider that there is potential for reducing their individual risk of falling.

One randomised controlled trial using a multifactorial intervention approach that included resident education (written information on falls prevention; and a personal consultation on falls prevention offered to all non-chair/bed bound residents) demonstrated significant reduction in falls (Becker et al., 2003). See Section 5.5 for details of the multifactorial intervention.

Again, however, there is no evidence that this approach in isolation is effective in reducing falls rates in residential care settings.

5.1.3 Education programs as part of multifactorial falls prevention programs

Although never formally investigated as an isolated strategy in a falls prevention program, education of staff, patients and family has been described as an important component of a multidisciplinary approach to reduce falls in nursing home residents (Ray et al., 1997b). The authors described inservice training of staff regarding falls risk, as well as practical safety suggestions in four safety domains: a quick environmental and wheelchair check, a checklist for adverse effects of psychotropic drugs, and more extensive training in appropriate transfer techniques (Ray et al., 1997b). This randomised controlled trial, which included the staff training described above, in conjunction with individual patient assessment and recommendations, resulted in 19% fewer fallers and 31% fewer injurious falls among residents in facilities receiving the intervention compared to the control group settings. Two other randomised controlled trials using multifactorial interventions that included staff education programs have demonstrated significant reduction in falls (Becker et al., 2003; Jensen et al., 2002b).
5.1.4 Education packages

Several falls prevention packages have been developed for use in residential settings that have incorporated an education component as part of the whole program. None of these have been subjected to formal evaluation of their effect on falls rates in the published literature. However, they do provide a standard format for a falls prevention education program. The packages include:

- *The essentials of falls prevention: A falls prevention manual for residential institutions.* (New Zealand, contact Meg Butler, 0011 09 5202788). This program describes a comprehensive assessment and management plan for older people in residential settings; and
- *Falls Prevention Resource Kit:* Peninsula Health Falls Prevention Service (contact ph 03 97881200, email fallskit@phcn.vic.gov.au). Information and training resource (interactive CD-ROM).

*Further research is necessary to determine the effectiveness of different approaches to workforce training, as well as resident and family education, in preventing falls in the residential care setting.*

5.2 Exercise

Exercise programs are a commonly described method of falls prevention for older people living in residential settings. A survey of senior living facilities in the USA identified that 94% of those returning the questionnaires offered some type of exercise program (not specifically targeting falls reduction) (Wasner & Rimmer, 1997). There was wide variation between settings, incorporating activities as diverse as bowling to formal exercise classes (Wasner & Rimmer, 1997). The most common form of group exercise was chair-based exercises (89% of facilities), followed by stretching (46%) and supervised walking (44%). Only a small proportion offered classes for residents with Alzheimer’s disease. More than half employed full-time exercise instructors, and volunteers were used in 25% of facilities. In contrast, Ruuskanen and Parkatti (1994) examined the level of physical activity amongst nursing home residents in Finland and found that more than one third reported decreased exercise since coming to the institution. The main factor described by residents as limiting participation in exercise was poor health and functional status (38-60%), rather than lack of interest (6-12%).

Several studies have shown that structured exercise can reduce the level of assistance required by nursing home residents to perform activities of daily living, by increasing muscle strength and endurance, flexibility, balance and respiratory efficiency (Fisher et al., 1991; Naso et al., 1990; Sauvage et al., 1992). In many cases however, it is only those residents who have suffered a recent acute event (hip fracture, stroke, chest infection) who may receive formal physiotherapy. Long-stay residents, whose reduced function is at least partly due to deconditioning and multiple chronic conditions rather than an acute event, frequently do not (Mulrow et al., 1994).
5.2.1 Group exercise

Two randomised controlled trials have been conducted in the residential care setting, using a group exercise program and evaluating its effectiveness in reducing falls rates (Nowalk et al., 2001; Toulotte et al., 2003). The study by Nowalk and colleagues compared two exercise interventions – one utilised a Tai Chi group exercise program, and the other consisted of individualised strength training and fitness exercises, including walking and bicycling. The control group received an education program targeting enhancement of quality of life. There were no significant differences between the three groups after 24 months follow-up. However, adherence to the exercise programs was poor, with an average of 55% of sessions attended for the individualised program, and only 24% for the Tai Chi group. The low attendance rates would have lowered the power of the study to identify significant differences in falls rates. The study by Toullette et al (2003) utilised a small sample of 20 ambulant, frail, cognitively impaired fallers in a residential care unit. The group exercise (two groups of five participants) was conducted twice weekly for 16 weeks, and included strengthening, standing balance and flexibility exercises. The exercise group achieved significant improvements in balance, gait and flexibility relative to the control group, whose performance deteriorated. Although under-powered to detect statistically significant differences in falls, the intervention group did not experience any falls during the intervention period, while the control group had 6 falls.

An RCT by Lord et al (2003) involving 551 older people living in retirement villages (self-care and intermediate-care) also confirmed the benefit of a group exercise program, designed to improve activities of daily living, in reducing falls and maintaining physical function. At one year follow-up, after adjusting for age and sex, the exercise group had 22% fewer falls than the combined control groups (consisting of flexibility and relaxation classes or no group activity) and 31% fewer falls in the 173 subjects with a history of previous falls. Improvements were also noted at six month retest in three physical measures – simple reaction time, choice reaction time, and the six minute walk tests - but not in knee extension strength or standing balance.

There are, however, a number of RCTs, case control, and time series studies that have identified positive health benefits of group exercise in residential settings, although falls rates were not measured. A randomised controlled trial of strength training and cardiovascular fitness exercises resulted in significant improvements in muscle strength for the intervention group in a sample of frail older residents, and significant improvements in function for the sub-group with the lowest functional abilities at baseline (Meuleman et al., 2000). Lazowski and colleagues (1999) used a Functional Fitness for Long-Term Care program (a group program targeting strength, balance, flexibility, mobility and function). They demonstrated significant improvements in mobility, balance, flexibility and strength over a 4 month period. Naso and colleagues (1990) determined that a 12 month low intensity conditioning program had a small but significant training effect in the arms but not in the legs. It may be that a more intensive program is necessary to achieve change (Chiodo et al., 1992). A similar program of shorter duration involving residents with chronic dementia and mobility problems found a significant improvement in measures of balance, but not in other scores of physical performance (Binder, 1995). Issues raised in Binder’s study included difficulties with compliance and attention among those residents with dementia, as well as limited dedicated resources (staff and equipment) available for the group program. Morris and colleagues (1999) identified maintenance of functional abilities using a pre-post design study incorporating both strength training and walking programs, compared to control subjects.
whose performance deteriorated over the same period. Falls were not analysed in these studies.

Connelly and Vandervoort (1995) concentrated solely on group-based strength training of independent ambulatory nursing home residents. They demonstrated a moderate increase in quadriceps strength as an outcome from this program. Following cessation of the program due to lack of funding, most of the gains achieved in strength and mobility were lost within 12 months (Connelly & Vandervoort, 1997). Sauvage and colleagues (1992) reported similar improvements for the intervention group in a randomised controlled study of a group of more debilitated subjects (lower limb weakness and gait and balance problems). The intervention included progressive strength training and aerobic conditioning for three months.

Group exercise targeting balance and resistance training formed part of a multifactorial falls prevention program which achieved a significant reduction in falls (Becker et al., 2003). Those participating in the exercise program achieved significant improvement in balance, strength and mobility measures. However, the project methodology did not allow the effect of the exercise program alone on falls to be identified. Another randomised trial in which the intervention group received a falls risk factor assessment and modification program, together with a group seated balance exercise program did not achieve a significant reduction in falls (McMurdo et al., 2000). A high drop-out rate limited the potential to identify a significant reduction in falls in this study. The authors considered that the intensity of the exercise program may have been too low, or that perhaps greater benefit would have occurred if the exercise program was conducted in standing, where the individual’s functional ability could tolerate this.

Seated group exercise programs have been reported widely in residential settings, especially for more frail older people. McMurdo and Rennie (1993) identified significant functional improvements (grip strength, spinal flexion, chair to stand time, activities of daily living and self-rated depression) in an intervention group of frail residents receiving twice weekly seated exercise sessions to music.

A number of the group exercise programs described above included some people with cognitive impairment within their sample (e.g. Lazowski et al., 1999; Meulemann et al., 2000; Toulotte et al., 2003). However, simple to follow activities or instructions may need to be identified and included in exercise programs targeting cognitively impaired older people.

Reduced muscle strength, balance and deterioration in functional performance have been cited in the literature as significant risk factors for falls in residential care settings (Lipsitz et al., 1991; Wolfson et al., 1995), however there have been no randomised controlled trials in residential care settings using group exercise in isolation, that have identified significant reductions in falls. Studies have identified significant benefits on secondary indicators, including improved strength, balance and function. Further research is necessary using a randomised trial design, and sufficiently large sample size, to determine the effectiveness of group-based exercise in reducing falls rates in residential care settings. The appropriate intensity and duration necessary to achieve change, and the modifications required dependent upon the functional status and medical history of the participating individuals, are important factors to investigate more thoroughly.
5.2.2 Customised exercise

An alternative approach to group exercise programs is the provision of an individualised exercise program by a trained therapist (often a physiotherapist or occupational therapist) on a one to one basis. Exercises are usually tailored to the specific strength, balance, flexibility, and fitness aspects of the individual, identified in an assessment process. In the Australian residential care system resource issues can impact on the capacity of facilities to provide substantial individual intervention. Mulrow and colleagues (1994) conducted a randomised controlled study with long-stay residents who were dependent in at least two activities of daily living. The four month intervention included strengthening, flexibility, balance, endurance, transfer and gait / wheelchair training, targeted to impairments identified on assessment, with the control group receiving a similar number of social visits. No significant difference was found between the groups in terms of falls rates at follow-up one year later, although a trend was evident for the intervention group to fall less. A similar intervention strategy studied by Harada and colleagues (1995) achieved significant improvements in balance, but falls occurrence was not recorded.

The study by Mulrow and colleagues (1994) also investigated comparative cost, and associated resource utilisation between the intervention and control group. No significant difference was identified in the health care charges (primarily nursing home and hospitalisation charges) between the groups.

Pooling of the results of the study by Mulrow and colleagues (1994) with those from three similar community-based studies gave an odds ratio of close to one for the number of participants sustaining a fall (OR 1.05; CI 0.74 - 1.48) (Gillespie et al., 1998a). However, given the diversity of functional ability between older people living in the community and residential care, the diversity of exercise programs, and the small number of studies, these results are considered inconclusive.

In another randomised controlled trial, Fiatarone and colleagues (1994) investigated the effectiveness of interventions targeted specifically at deficits in skeletal muscle. They compared progressive strength training (supervised on an individual basis by an exercise trainer), multinutrient supplementation, both interventions, and neither intervention in 100 frail nursing home residents over a ten week period. Unfortunately, falls rates were not recorded, but muscle strength increased significantly by 113% +/- 8% in residents receiving training, with associated improvements in walking speed, stair climbing and spontaneous physical activity. The exclusion of subjects with severe cognitive impairment in the subject sample may limit the generalisability of these results to some high care residential care settings.

Wolf et al (2001) conducted a randomised controlled trial in which the intervention group received 12 sessions of individualised physiotherapy targeting balance, strength, mobility and confidence. The control group received similar frequency of attentional activities. Significant improvements were evident for the intervention group relative to the control group for measures of balance and mobility, and the mobility improvement was maintained one month after the program ceased. Analyses were also undertaken on a number of predictor variables to attempt to identify characteristics of those who might benefit most from this type of intervention, however results were inconclusive. Falls rates were not assessed as an outcome in this study.
Further research is necessary to determine the comparative effectiveness (in terms of falls, injury and cost effectiveness) of exercise programs conducted using a group or a one-to-one structure in residential care settings. This includes the identification of sub-groups most likely to benefit from either a group or one to one structure.

5.2.3 Walking programs

Walking programs have frequently been reported in residential care settings, although less than 50% of facilities surveyed in the USA offered supervised walking as an exercise intervention (Wasner & Rimmer, 1997). Importantly, these programs would appear to be suitable for older people of varying frailty and levels of cognitive impairment. Considering the high incidence of falls and related injuries reported in this population (Shaw & Kenny, 1998), it is vital that this group be considered in terms of appropriate falls prevention strategies.

Koroknay and colleagues (1995) reported encouraging results from a similar walking program, initiated by nursing staff, aimed at promoting functional mobility in a frail group of nursing home residents, who required some assistance with ambulation. Individualised, functional goals were set for each participant (eg walk to dining room for dinner) and education sessions provided to encourage staff compliance with the program. The authors reported that after four months the proportion of residents who fell had decreased significantly from 25% to 5% after initiation of the program. Cognitive and functional status did not influence outcome. In fact, studies have determined that a walking program can significantly improve ambulatory status and communication performance (Friedman & Tappen, 1991) and decrease incidence of urinary incontinence (Jirovec, 1991) in cognitively impaired nursing home residents.

MacRae and colleagues (1996) investigated the effectiveness of an individualised walking program with a sample of deconditioned, cognitively impaired, but ambulatory, residents aged > 80 years. The intervention group participated in a walking program (approximately five days per week for a maximum of 30 minutes) which was supervised by the research assistant. Walk goal times were set each week based on individual performance and increased weekly by 10%. The control group received social visits only. While gains were achieved in endurance, there was no difference found in falls rates between the groups at 12 or 22 weeks. The authors hypothesised from this that the program was safe and had no side effects in terms of increased numbers of falls. The study is interesting in terms of the population used and the gains made in endurance capacity. However, extensive staff time was required to supervise residents (eight hours per day) and no significant changes were found in physical activity (as measured over an eight hour period), mobility and quality of life measures, during the 22 week testing period.

Schoenfelder (2000) conducted a randomised controlled trial of a three times weekly exercise program incorporating ankle strengthening exercises as well as a walking program, in two residential care facilities. Participants were matched on level of falls risk prior to randomisation. After 3 months, the intervention group had achieved small, non significant improvements in muscle strength, walking speed and confidence in mobility. The sample size was too small to analyse falls statistically. Although falls in the intervention group increased relative to the controls, this was considered by the authors to be primarily related to two participants in the intervention group who suffered an acute illness during the intervention period, resulting in clusters of falls for these two individuals.
Some controversy exists in the literature regarding the effectiveness of walking programs in reducing falls rates in frail residents. The functional nature of the programs and the apparent suitability for more cognitively impaired individuals makes more research in this area of prime importance. Intensity and frequency of activity, including clear assessment of the level of staff supervision required, are important research questions.

5.2.4 Functional Incidence Training

A different approach to exercise and physical activity was proposed by Schnelle and colleagues (1995), called Functional Incidence Training (FIT). The basis for this program was that the exercise intervention was designed to be performed during, or incidental to, daily nursing care routines such as toileting. Residents were included in the study if they were able to pass a simple cognitive screening test, and were incontinent of urine. The FIT was performed every two hours when prompted voiding was undertaken to reduce the levels of incontinence. Weekly goals were set including walking / wheelchair endurance times and sit to stand performance. Eight weeks after implementation of the program, the FIT intervention, which required six minutes more nurses’ aide time, increased both physical activity and mobility endurance in this extremely frail group of deconditioned residents. Although fall rates were not recorded, this study provides some interesting ideas regarding the implementation of strategies to maintain or improve physical activity levels and mobility in frail older people in residential care settings. Further research using this approach and evaluating the effect on falls rates appears warranted. Despite the positive functional gains, and a 10% (non-significant) reduction in incidence of acute health conditions associated with a subsequent 8 month period of FIT, there was no reduction in healthcare costs associated with the program (Schnelle et al., 2003).

5.2.5 Meta-analyses

The FICSIT (Frailty and Injuries: Cooperative Studies on Intervention Techniques) trials were eight collaborative independent randomised studies, conducted at a number of centres in the United States. They aimed to decrease falls rate and frailty in older subjects (Province et al., 1995). Five of the trials primarily examined the effect of exercise on reducing falls risk factors in community dwelling older adults. Two of the trials were conducted in nursing homes and the final project evaluated hip protector garments in reducing hip fracture incidence (Wallace et al., 1993). Unfortunately, the mixed samples (community and residential settings), and the wide range of interventions make it difficult to draw strong conclusions from this work. Despite the diversity in samples used and program type, Province and colleagues (1995) demonstrated significant reduction in risk of falling for those interventions with an exercise component. Programs that specifically targeted balance were found to be most effective in reducing risk of falling.

The most recent Cochrane review of falls prevention programs has sub-analysed studies by setting, grouping hospital and residential care together under the heading of “institutional care” (Gillespie et al., 2003). This meta-analysis sub-analysis only included three randomised trials, two in a residential care setting, and did not identify a reduction in falls associated with exercise.
Formal exercise is commonly offered in residential care facilities. However, despite good evidence regarding the positive health benefits of such an approach, few randomised controlled studies have been performed to determine its effectiveness in reducing falls and injury rates in this setting. The potential benefits of the “incidental” approach to exercise in reducing falls rates requires further investigation as a practical method for working with a residential care population.

5.3 Environmental safety

Falls among older people can typically be considered the result of a complex interaction of personal (intrinsic) and environmental factors (Gross et al., 1990). Environmental causes in the residential care setting may include poor lighting, wet or slippery floors, obstructed or cluttered pathways, bed or wheelchair with brakes not locked, unsafe footwear and incorrect use of a walking aid (Ginter & Mion, 1992). Tinetti and colleagues (1987) considered that environmental factors had less of a role in the structured residential care setting compared with the community setting, and that this was probably a result of the greater control staff have over environmental factors in the institutional setting. However, Kiely and colleagues (1998) reviewed the risk factors for falling among residents and determined that residents in facilities with the highest falls rates were more than twice as likely to fall compared with those in facilities with low falls rates. This may indicate that factors specific to the residential care environment (physical environment, in addition to staffing and service provision) contribute to falls risk, independent of resident-specific factors.

A survey of residential care settings in New Zealand identified that assessments of footwear, medication use and environmental audits were the most common falls prevention strategies, employed by over 80% of the institutions questioned (Butler et al., 1998b). The authors hypothesised that this may reflect the nature of the criteria necessary to fulfill licensing requirements, and that implementation of other strategies such as exercise classes, dietary supplements and use of hip protectors may require revision of these criteria, as well as the provision of additional resources, to maximise compliance.

5.3.1 Environmental modification

Various strategies have been reported in the literature to decrease environmental hazards and optimise observation in skilled-nursing facilities (Ginter & Mion, 1992). Increased lighting, lowered bed heights, carpeting in high traffic areas, non-skid floor surfaces, individual seating, wheelchair safety, bed stabilisers, bedside commodes at night, increased proximity to the nurses station and the use of electronic warning devices have all been recommended as strategies, but none have been investigated individually with regard to implementation and subsequent effect on falls occurrence (Ray et al., 1997b). The need to address public falls hazards amongst nursing home residents is limited since it has been reported that few (7.5%) participate in activities outside the institution, with these mainly involving associations for retired people and organised religious activities (Ruuskanen & Parkatti, 1994).

Importantly, environmental modifications need to be implemented with respect to the population being considered. A study by Thapa and colleagues (1996) determined that the incidence of injurious falls in ambulatory residents was more than twice that in non-ambulatory residents. The circumstances of injurious falls between the groups differed, in that those occurring in non-ambulatory subjects were more likely to involve equipment (87% versus 45%), to occur while seated or during transferring (82% versus 21%), and to be from a
chair or bed level (54% versus 6%). For this high risk group, environmental considerations should include transfer and equipment safety. The cause of falls in special care units for individuals with probable dementia, are different again. Meddaugh and colleagues (1996) monitored falls for approximately three months in a skilled nursing facility and reported that 38% were due to the resident slipping on urine, 24% were related to gait disturbances, and 35% were associated with some degree of agitation. Subsequently all residents were provided with treader slipper socks and falls rates were recorded for a further three months. Although there was only a 9% decrease in overall falls rates, the proportion associated with slipping on urine reduced from 38% to 5% in the three month follow-up. This is a simple method for providing residents in special care facilities with a safer environment and possibly minimising the risk of falls and related injuries.

These examples highlight the need for falls intervention strategies targeting the environment to address the varying needs of residents living in residential care facilities.

Two randomised controlled trials incorporating multifactorial interventions and achieving significant reductions in falls both incorporated environmental assessment and modifications as one of the intervention components. The study by Becker et al (2003) reported using a 76 item checklist, with most common modifications being implemented including changes to lighting, chair and bed heights, reducing clutter in resident’s rooms, installation of extra rails in toilets and bathrooms, and maintenance of walking aids. Similarly, Jensen et al (2002b) undertook modifications such as removing loose carpets, changes to bedding, provision of rails and improved lighting. Neither of these studies was able to provide sub- analyses on the effectiveness of the environmental modifications in isolation.

*Environmental and facility-specific factors appear to play a role in the high falls risk reported among older people in residential care settings. To date few studies have investigated the effectiveness of environmental modifications alone in reducing falls and related injuries in this elderly population. However, environmental modifications have been shown to be effective as part of two multiple intervention randomised trials which have resulted in reduction in falls rates.*

### 5.4 Clinical Assessment

Clinical assessment may involve use of a brief, simple, screening tool to identify at risk individuals, or a detailed assessment identifying specific risk factors. Although the brief screening tool would enable the application of generic or untargeted falls prevention interventions, the detailed assessment tool enables staff to identify which risk factors apply to the resident enabling targeted intervention to reduce individual falls risk. A brief screening tool may also be used to identify residents who require a more detailed assessment. Clinical assessment may also include detailed assessment of specific risk factors, eg – medication, vision etc. An important consideration for any assessment or screening process is how often, or at what intervals, to reassess.

#### 5.4.1 Medical screen

A medical screen or review at regular intervals, or following specific incidents such as a fall, may result in identification of previously undetected or new falls risk factors that require management in the residential care population. Medical screening procedures usually form
part of a targeted multifactorial falls prevention program, with management strategies implemented based on the results of the screen. Two approaches have been utilised:

- an assessment or screening process for all residents on admission to a facility, and / or at regular time intervals; and
- a review following an acute event which may increase falls risk, eg - a fall, stroke, or chest infection.

Several randomised controlled trials have demonstrated the effectiveness of an assessment and targeted management program in reducing falls rates as part of a multiple strategy falls prevention program (Ray et al., 1997a; Rubenstein et al., 1990; Jensen et al., 2002b). These are described in greater detail in Section 5.5.

### 5.4.1.1 National Resident Assessment Instrument

The National Resident Assessment Instrument (RAI) was developed in the United States of America in response to the federal nursing home reform laws (1987), established to improve the quality of care in the residential care setting (Morris et al., 1990). The RAI is a multidimensional assessment tool, which includes 18 domains representing major problem areas in the nursing home population. These include: medical history and status, functional level, nutritional status and requirements, cognitive loss, psychosocial well-being, incontinence, pressure ulcers, and medication use. Guidelines for care planning were provided, with possible approaches outlined to assist in the prevention or resolution of problems identified. Using a pre / post study design, the effect of implementation of this assessment process has been investigated (Fries et al., 1997; Phillips et al., 1997). Over a six month period, fewer residents declined in nutrition and visual status, but the percentage of fallers actually increased (although not significantly). It is possible that falls prevention needs to be addressed more specifically in care planning guidelines. As in the hospital setting, a clinical risk assessment tool, tailored to meet the needs of a specific clinical population, may assist in identifying residents at high risk of falling, and with the implementation of appropriate interventions to minimise these risks.

Education of staff in the use of the RAI would also appear to be of prime importance. In contrast to the USA, where the new reforms required that a registered nurse co-ordinate the process, other countries to voluntarily implement this same tool (Japan, the Netherlands, Switzerland) have trained a multidisciplinary health care team in its use (Bernabei et al., 1997). Training programs in the USA tended to be of shorter duration compared with other countries and may reflect the mandate for fast implementation of the RAI by thousands of users.

A current pilot project in Australia involves trialling of a recommended framework for assessment in residential care settings. As part of this trial, a falls risk assessment tool is recommended as one of a range of assessments. Results from the pilot trial may inform changes in recommended assessment on admission and during a resident’s time in residential care, and provide a basis for targeting of falls prevention actions (http://www.ageing.health.gov.au/rcspage/rcsreserv/rcsrpp.htm).

*The National Resident Assessment Instrument is an interesting tool for the comprehensive evaluation of people in residential care that has been implemented in America, Japan, the Netherlands and Switzerland. Further research, using an RCT design, is necessary to establish its effectiveness in reducing falls rates in this high risk population. Development of more specific risk assessment tools for residential care may be warranted. No studies have evaluated whether the assessment and management processes associated with*
the Resident Classification Scale in Australia, an assessment instrument with some similarities to the RAI, have the potential to be further developed to contribute to minimising falls risk among residents.

5.4.1.2 Medication

There is a high prevalence of medication use among older people in residential care settings, with 98% taking at least one form of medication and 63% taking four or more (Yip & Cumming, 1994). Indeed, there appears to be a significant association between the number of drugs taken and the rate of falling (Nygård, 1998). A study of older people in Australian residential care settings revealed that users of antipsychotic medication had a much greater risk of falling than non-users (Yip & Cumming, 1994). Another large study of residential care facilities in the United States identified an increase in falls rates related to increased doses of benzodiazepines (Ray et al., 2000). Both short and long acting benzodiazepines were shown to increase the risk of falling (Ray et al., 2000). In addition, a five year study of 120 residential care settings in Canada determined that antipsychotic agents and sedatives were associated with an elevated risk of injurious falls (Mustard & Mayer, 1997). A meta-analysis to critically evaluate the evidence linking medication use with falls occurrence in older people, included studies in community, long-term care and hospital settings (Leipzig et al., 1999a). Psychotropic medications were found to be associated with an increased risk of falls, with this further increasing in patients taking more than one psychotropic drug. The use of cardiac and diuretic medication was also weakly associated with falls in older adults (Leipzig et al., 1999b). Unfortunately, the risk for each medication type was not broken down to reflect risk in residential care settings.

There are conflicting results regarding the association between antidepressant medication use and falls among older people in residential care settings. Nygaard (1998) determined that users of antidepressant medication had a lower tendency to fall and hypothesised that these drugs may have a beneficial influence on anxiety and depressive states, thereby also improving walking performance. In contrast, Thapa and colleagues (1998) found a higher rate of falls among antidepressant users, and argued that this may be related to the increased activity that occurs as the depression resolves (Slaughter et al., 1999). Both hypotheses may be correct to some degree. Another study determined that residents using the newer serotonin-reuptake-inhibitor antidepressants, which are largely free of the side-effects thought to cause falls, continued to have a higher rate of falls (80% higher than non-users) (Thapa et al., 1998). This rate was, however, lower than that recorded for users of tricyclic antidepressants and suggests that both medication use and the presence of depression may influence falls risk. Interestingly, the baseline characteristics of the group varied with the use or non-use of antidepressants, so that although the users had a greater history of falls, they presented with better mobility than those not using the medication.

A recent study in a long term care facility in the United States used a retrospective observational (pre-post) analysis to investigate the effect of a fall-focused pharmacist review and recommendation process. The facility was described as a rehabilitation centre, although the sample only included subjects with at least a one year length of stay (Haumschild et al., 2003). Two hundred cases were randomly selected from the year prior to introduction of the pharmacist medication review, and 200 from the year following introduction of the review. There were no other specific falls prevention initiatives occurring at the same time as this study. The intervention included a review of all medications by a consultant pharmacist, with recommended changes to medications discussed with the physician and nurse prior to implementation of changes. Results showed a 47% reduction in falls in the period following implementation of the medication review program. Reductions in medication use included
18% reduction in use of psychotropic medications, 14% reduction in sedatives and hypnotic medications, and 11% reduction in cardiovascular medications.

Strategies to reduce medication use in older people in residential care settings have been described as common falls prevention strategies in New Zealand (Butler et al., 1998b). Gilbert and colleagues (1993) performed a randomised controlled trial (by institution) to determine the effectiveness of an intervention aimed at reducing medication use among residents. This involved group education and relaxation training for residents, as well as education for prescribers and caregivers in, for example, alternative strategies for managing sleep disturbance. After 12 weeks, the proportion of participants in the intervention group who used benzodiazepines had declined significantly (from 70% to 53%) and no adverse consequences were reported. Unfortunately, falls occurrence was not measured before or after the intervention, but the results were positive with respect to minimal withdrawal response in an elderly population.

**Considering the extensive use of medications by residential care residents and the strong association between medication, falls and related injuries, additional research is necessary to formally evaluate medication reduction strategies in terms of falls rates, staff training and cost effectiveness.**

5.4.1.3 Nutrition

Reduced body mass and bone mineral density have been cited as risk factors for falls and subsequent injury in older people (Dargent-Molina et al., 1996; Hayes et al., 1993). In the pathogenesis of hip fracture, the falling mechanism, the impact energy created by the fall, the energy absorption capacity of the trochanteric soft tissue, and bone strength have been suggested to be the main determinants of fracture (Kannus et al., 1999a). Trochanteric soft tissue thickness is correlated with the body mass index and this may explain the reduced risk of hip fracture in older women who are overweight (Hayes et al., 1993). In addition, malnutrition has been associated with muscle weakness, an important risk factor for falls. Fiatarone and colleagues (1994) conducted a randomised controlled trial to compare resistance training and multinutrient supplementation in frail nursing home residents over a ten week period. The nutritional supplement was a liquid in the form of carbohydrate, fat and soy-based protein, and was given once a day. It was designed to augment caloric intake by about 20% and provide one third of the recommended daily allowances of vitamins and minerals. The study found, however, that the nutritional supplement alone had no significant effect on muscle weakness or physical frailty. The relatively short nature of the trial and the lack of information regarding falls or fracture occurrence makes it difficult to determine from these results the role of nutrition in a falls or fracture prevention program.

Reduced bone mass has been indicated as a factor predictive of hip fracture in older women (Dargent-Molina et al., 1996). Over 50% of older people in Australian residential care settings have been identified as having at least marginal vitamin D deficiency (Nowson and Margerison, 2002; Sambrook et al., 2002). Stein and colleagues (1999) determined that ambulant nursing home and hostel residents who fell had lower vitamin D and higher parathyroid hormone levels than non-fallers. A hormonal disorder may lead to reduced bone mass and place this population at a higher risk for hip fracture. Vitamin D supplementation has been associated with functional improvement in a group of community-dwelling and nursing home residents (Gloth et al., 1995).

A recent randomised controlled trial of older women in a long-stay geriatric care unit awaiting placement in nursing home evaluated the effectiveness of vitamin D and calcium
supplementation, compared to calcium supplementation in isolation (Bischoff et al., 2003). Vitamin D deficiency was common among participants of both groups at baseline. Over a 12 week follow-up period, adjusted falls rates were significantly 49% (p=0.01) lower in the vitamin D and calcium supplementation group, compared to the calcium only group. A subset of participants had a range of other secondary outcome measures assessed. The vitamin D and calcium group had significant improvements in musculoskeletal functional measures, and significant improvement in vitamin D status. Fracture rates were not assessed in this study. Another randomised controlled trial in a mixed sample of older people living in apartments and residential care settings identified that the use of Vitamin D₃ and calcium supplementation caused significant increases in proximal femoral bone mineral density, and significantly reduced the risk of hip and other non-vertebral fractures (Chapuy et al., 1992). The effectiveness of the supplementation was not analysed for those living in residential care in isolation.

Another potential source of vitamin D for older people in residential care settings is ultraviolet light, for example, sitting outdoors for short periods each day with some skin exposed to the sunlight (e.g. short sleeves). Improvements in vitamin D status have been reported in residential care populations using exposure to ultraviolet light as an intervention (Lips, 2001). No studies have investigated the effect of this intervention on falls rates.

Nutritional augmentation, in particular the use of calcium and vitamin D supplements is a simple, low-cost intervention which appears to be effective in reducing falls and fracture risk among older people in residential care settings. Important issues for further investigation include necessary time frames and dosages required to achieve and sustain change, staff and resident compliance and efficacy in conjunction with an exercise intervention.

5.4.1.4 Vision

Visual impairment is common among older people in residential care (Tielsch et al., 1995; vanNewkirk et al., 2000). Studies in both Australia and the United States of America have suggested that in many cases this loss of vision could be treated or prevented with appropriate ophthalmologic care (Mitchell et al., 1997; Tielsch et al., 1995) and that increased surveillance of older people in residential care settings is needed. Indeed, visual assessments were only reported by approximately half of the facilities surveyed in New Zealand (Butler et al., 1998b). In addition, visual impairment has been significantly related to functional disability (Marx et al., 1992) and disruptive behaviours among nursing home residents (Horowitz, 1997). These factors, in conjunction with the associated increase in falls risk, highlight the need for improved visual assessment and management in residential care settings.

No randomised controlled trials have evaluated the effectiveness of a vision assessment and correction program in residential care settings.
5.5 **Multiple Strategy (targeted)**

Utilising a multi-pronged approach to falls prevention has been one of the more extensively researched areas in falls prevention in residential care settings. These programs are based on the understanding that most falls are multifactorial, and that programs addressing more than one risk factor are more likely to be effective than single intervention studies.

Rubenstein and colleagues (1990) investigated the effectiveness of a post-falls assessment (within seven days of the fall) and implementation of a targeted range of actions following assessment in the residential care setting. The management actions included:

- review of risk factors associated with falling;
- medical laboratory tests (such as complete blood count, urinalysis, creatinine, electrolytes, standard 12 lead electrocardiogram, 24 hours ambulatory cardiac monitoring); and
- an environmental assessment.

A primary cause for the fall was determined and recommendations made to the primary care physician. The control group received usual care. After two years, the intervention group had 26% fewer hospitalisations, a 52% reduction in hospital days and 9% fewer falls (although this latter result was not statistically significant).

Neufeld et al (1991) described a falls consultation service involving a medical director, assistant administrator, gerontologist, physician, rehabilitation nurse and activities specialist. This multidisciplinary team evaluated patients who had fallen and made recommendations regarding falls prevention. The management options included a range of medical, environmental, exercise, mobility and staff education factors. Other multidisciplinary falls prevention programs have included a post-fall medical screening component, with the subsequent development of recommendations. These have achieved promising results in terms of falls rates and hospital admissions, but have not been investigated using a randomised controlled study design.

Another study by Ray and colleagues (1997b) used a randomised controlled study design (randomisation of residential care setting) to evaluate the effectiveness of a consultation service on reducing falls among high risk residents in these facilities. The intervention involved a multidisciplinary individual assessment targeting four safety domains:

- environmental and personal safety;
- wheelchairs (as assessed by an occupational therapist);
- psychotropic medications; and
- transfers and ambulation (with possible referral to physical therapy for balance and gait training).

An individual treatment plan was then developed and reviewed by the facility staff. Each nursing home appointed a falls co-ordinator, who implemented the recommendations, with regular meetings to reinforce motivation and exchange ideas. In addition, inservice training sessions were organised for all residential care staff, providing a general discussion of the causes and consequences of falls and practical safety suggestions. Those facilities participating in the intervention strategy reported fewer recurrent falls (43.8%), than the control facilities (54%). A non-significant trend was also noted towards less injurious falls in the intervention facilities. The greatest benefits were for those residents for whom the recommendations were fully carried out or who had three or more falls in the preceding year.

A cluster randomised trial of nine residential care facilities was conducted by Jensen et al (2002b). In part, the range of interventions selected was based on a falls risk screening tool.
(the Mobility Interaction Fall Chart). Components of the intervention included staff education, environmental modification, strength, balance and mobility exercises, supply and repair of walking aids and wheelchairs, changes in medication, provision of hip protectors, and a post fall problem solving conference between the physician, nurse and physiotherapist. There was a significant reduction in the adjusted rates for falls and multiple falls in the intervention group compared to the control group, although there was no significant difference in injuries associated with falls. A sub-analysis of this study demonstrated that the reduction in falls was strongest for residents with higher levels of cognition, however there was a significant reduction in fractures for the group with cognitive impairment (Jensen et al., 2003).

Becker and colleagues (2003) used a cluster randomised trial methodology involving 6 residential care facilities. Three facilities were randomly allocated to the intervention group, and three to the control (usual care) group. A range of falls prevention interventions were offered to residents in the intervention group, including staff training, monthly feedback on falls data, information and education programs for residents, environmental assessment and modification, group exercise targeting strengthening and balance exercises, and provision of hip protectors (together with a protocol for use of the hip protectors). The intervention group had significantly fewer falls, fallers and multiple fallers compared to the control group. Uptake and sustained participation in the range of interventions was low to intermediate.

Shaw et al (2003) conducted a randomised controlled trial investigating the effectiveness of a multifactorial assessment and interventions for people aged 65 and over with cognitive impairment who presented at an Emergency Department with a fall but were not hospitalised. Eighty percent of the study participants were from residential care units, with the remainder living at home. The control group received usual care, while the intervention group received medical, physiotherapy and occupational therapy assessments, and referrals for interventions based on these comprehensive assessments. Seventy three percent of participants co-operated with the assessments. At one year follow-up there were reductions in the proportion of participants who fell, and less falls related injuries, although these differences were not statistically significant. This study highlights the complexity of falls prevention for people with cognitive impairment. The multidisciplinary approach of this study may need to be supplemented with some specific strategies for people with cognitive impairment in order to have a positive impact on falls.

**There are clear benefits of a multiple strategy approach to falls reduction for older people in residential care settings (both as an intervention and prevention strategy). In most instances these relate to targeted interventions being developed based on a falls risk screen or assessment. Further research is necessary to validate falls risk screening and assessment tools in the residential care setting, and to determine the most important components and processes, such as the timing of assessments and who performs the assessments, and cost effectiveness of this intervention approach.**

### 5.6 Other interventions

#### 5.6.1 Footwear

As in the community, the role of footwear in the prevention of falls among older people living in residential care settings has been predominantly anecdotal. An audit by Butler and colleagues (1998b) determined that over 80% of institutions in New Zealand employed footwear assessment as a common falls prevention strategy in their facilities. In one dementia-specific setting, the introduction of treded socks for all residents resulted in a
reduction in falls rates using a pre-post research design (Meddaugh et al., 1996) (see Section 5.3.1).

The effect of specially designed “seniors” shoes were assessed among female residents in residential care facilities, who were used to wearing shoes with raised heels (Lindemann et al., 2003). The special shoes had an outward flare in the mid-sole region to increase the base of support, Velcro straps for fastening, and a firm extended heel support. Heels were also broad. Participants were randomised to trial the new shoes with a one centimetre high heel, or a two centimetre high heel, or to continue use of their usual shoes. Participants with the new shoes were asked to wear them for at least two hours / day for 5 weeks. The new shoes were well accepted by participants, with the most important features considered to be low weight, soft upper material, and a firm heel hold. Interestingly, there were no significant differences in balance and mobility measures between the different shoe types. The authors consider that heel heights up to 3-4 cm might be within a threshold where balance and mobility are not significantly compromised.

One multiple intervention randomised controlled trial which included fitting of appropriate footwear under the broad classification of “supply or repair of aids”, resulted in a significant reduction in falls (Jensen et al., 2002b). The independent effect of the fitting of appropriate footwear component of the intervention was not analysed.

5.6.2 Assistive Devices (appropriate walking aids)

The introduction or change in use of a walking aid is a frequent action for older people who appear unsteady, or who have falls in residential care settings. However, there is often not a systematic review of what has precipitated the need for the walking aid change (medical or physiotherapy review), nor of the selection of the appropriate walking aid and training of the older person in the correct use of the aid. Anecdotal evidence suggests that in some cases, poor use of a walking aid may actually increase an individual’s risk of falls and injury. Education of both staff and residents appears vital to encourage correct usage, maintenance and compliance.

No research has been performed investigating the specific role of walking aids or wheelchairs in the prevention of falls among older people in residential care settings. In one study to determine the factors affecting wheelchair mobility in non-ambulatory residents, it was identified that problems with the chair itself (poor function or inappropriately fitted to the resident) were the major barriers to frequent or easy wheelchair propulsion (46%) (Simmons et al., 1995).

One multiple intervention randomised controlled trial which included supply or repair of aids such as walking aids and wheelchairs, resulted in a significant reduction in falls (Jensen et al., 2002b). However, the independent effect of the supply and repair of aids component of the intervention was not analysed.

*Targeted intervention programs involving the training of staff, potential prescribers and users in the correct use and maintenance of appropriate aids warrant investigation in terms of effect on falls rates and ability to improve resident independence and quality of life.*
5.7 Injury Minimisation

5.7.1 Hip protector garments

The use of hip protector pads to reduce injury following a fall was first reported in 1993. Wallace and colleagues (1993) reported on issues associated with feasibility of hip protectors as an intervention to reduce fracture risk, as part of the Iowa FICSIT trial (Frailty and Injuries: Cooperative Studies on Intervention Techniques). Lauritzen and colleagues (1993) conducted a randomised controlled trial to investigate the effect of external hip protectors on hip fractures in older people in residential care settings. The results showed a 50% reduction in hip fractures in the intervention group. In addition, of those residents in the intervention group who had a hip fracture, none were wearing their hip protectors at the time of the injury. These findings have since been replicated in a nursing home in Sweden (Ekman et al., 1997), where low compliance (44%) with wearing the protector was determined to be a major limiting factor.

Kannus et al (2000) conducted a randomised trial investigating the effectiveness of hip protectors, with a mixed sample from community based health care centres, including geriatric long stay facilities and outpatient care units for supported living at home. In a ratio of 1:2, treatment units (not individuals) were randomised as either a hip protector unit or a control unit. Of the 1801 participants 721 (40%) lived in supported home living. Although the study may have been affected by selection bias (as there were marked differences in the rates of refusal to participate between groups) the authors reported a significant reduction in hip fracture in the intervention group and a non-significant trend towards lower rates for pelvic fractures at follow-up (18 months). The rate of hip fracture was 21.3 for the intervention group and 46.0 for the control group per 1000 person years. The rate of pelvic fracture was 3.3 for the intervention group and 8.2 for the control group per 1000 person years. There was also a significant difference within the intervention group, with a lower risk of hip fracture while wearing the hip protector. Although the study demonstrated a reduction in hip fractures, the high refusal rate and average compliance (48%) raise further questions about the acceptability of hip protectors to older people.

Harada et al (2001) and Meyer et al (2003) also conducted randomised controlled trials evaluating the effectiveness of hip protectors, using the same unit of randomisation as Kannus et al (2000) and Lauritzen et al (1993) – that is, by unit, ward or facility. Both of these studies reinforce the positive findings of earlier studies, – with more than 40% fewer hip fractures in the intervention group than the control group. Follow-up period for both studies were 1-2 years and 18 months respectively. Each program incorporated staff training programs about the use of hip protectors, and residents who agreed to participate and were randomised to the intervention arm were provided with three pairs of hip protectors.

In contrast to the positive results in randomised trials where randomisation occurred by unit, ward or facility, a small number of randomised trials have attempted to reproduce these results randomising by individual resident, mostly achieving non-significant results. Cameron and colleagues (2001) conducted a study of a sample of female residents who had experienced two or more falls, or one fall requiring hospitalisation in the preceding three months. Participants were visited by a research nurse for initial fitting of the hip protectors, then approximately 2 weeks, 2 months, and 10 months later, to encourage ongoing use of the hip protectors. There was no significant difference in hip fracture rates between the intervention and control groups. However, only one of the eight hip fractures in the intervention group occurred while the hip protectors were being worn, and in that case, it was considered that the hip protectors were
being worn inappropriately (Cameron et al., 2001). Similar results were reported by Hubacher et al (2001) and van Schoor et al (2003).

A Cochrane review of randomised trials using hip protectors and evaluating fracture rates concluded that there is a significant reduction in hip fractures in studies where the randomisation has been performed by unit, ward or facility, but that there is no significant effect in those studies where randomisation by individual has occurred (Parker et al., 2003). The review indicates that the studies using randomisation by individual appear to have had sample sizes that were underpowered to detect significant differences in fractures.

Despite these promising results, an audit of New Zealand nursing homes identified that none of the institutions responding to a questionnaire about current falls prevention practice actually used hip protectors (Butler et al., 1998b). Subsequently, a sample from the same group of institutions was randomly selected to participate in a discussion session about hip protector underwear, perceived acceptability, identification of suitable wearers, barriers to use and strategies to enhance compliance (Butler et al., 1998a). The results indicated that nursing staff were receptive to the use of hip protective underwear as a strategy to prevent fractures. Future efforts need to be directed at educating policy makers and staff in residential care settings about the latest advances in falls prevention and to ensure that the necessary resources are available and accessible to older people living in these settings.

Compliance with use of hip protectors among those identified as at high risk for injurious falls has been raised as a major issue. Australian data have shown that a high proportion of women at high risk of hip fracture stated they would not wear the hip protector garments shown to them (Cameron & Quine, 1994). Cryer and colleagues (2002) reported on a range of factors influencing compliance with use of hip protectors in a study of 17 nursing homes in which residents were offered three pairs of hip protectors. Only 51% of residents who were offered hip protectors agreed to wear them. Of those who agreed to wear hip protectors, the overall 24 hour compliance rate was 24%, and the compliance rate for wearing hip protectors during the day was 37%. Compliance rates reduced steadily over the first six months of use. The authors considered the level of support and encouragement by staff within the participating facilities for residents to wear the hip protectors was an important factor influencing compliance.

Van Schoor et al (2002) conducted a systematic review of the acceptance and adherence to use of hip protectors, with the majority of the studies reviewed being in the residential care setting. Primary acceptance of hip protectors varied from 37% to 72% (median 68%) and compliance varied between 20% and 92% (median 56%). The most frequent reasons for non compliance included:

- not being comfortable (too tight/poor fit);
- the extra effort (and time) needed to wear the device;
- urinary incontinence; and
- physical difficulties / illnesses.

The authors concluded that compliance is a complex but important issue and that future research needs to develop and test methods of improving compliance as well as continuing to improve the design of the protector and underwear.

There have been some recent modifications in the design of the main hip protector types available in Australia including use of different materials and design in the undergarments, removable protector shields (so that one pair of shields can be used with several pair of undergarments), development of a hip protector undergarment with the capacity to be used with continence pads, and development of a “stick on” hip protector, which can be worn with
the resident’s own underwear. Evaluation of the impact of these modifications on compliance has not been reported to date.

5.7.2 Physical and chemical restraints

The use of physical restraints among residents of residential care facilities has been investigated extensively in the literature, with less emphasis given to chemical restraint usage. Typically physical restraints may include chest, wrist or ankle ties, mitts, belts, crutch or pelvic devices, suit or harnesses, sheet ties, bed-rails, and “geriatric” or recliner chairs with fixed tray tables. The misuse of psychoactive medication has been reported in the literature and can be considered a form of chemical restraint (Tideiksaar, 1998). Tideiksaar considered that inappropriate use included: prescription in excessive doses, use as the sole treatment without investigation into alternative interventions, and administration for purposes of discipline or convenience of the staff.

Figures for restraint usage vary, but in a prospective study of independently mobile people in residential care settings in the United States of America, Tinetti and colleagues (1992) determined that 31% were restrained in a one year follow-up period. Reasons for restraint included: unsteadiness, concerns regarding falls and maintenance of position. Similar figures and reasons for usage have been reported in Australian residential care settings (Retsas, 1997; Retsas & Crabbe, 1997).

Whilst restraints are meant to prevent injury, the evidence suggests that they may have the opposite effect. The interaction between the number of falls and restraint use has been shown to be positive and statistically significant, in terms of rates of serious injury (Tinetti et al., 1992). Indeed, confused ambulatory individuals have been found to have both a high falls rate and high restraint use, with more falls occurring while the restraints were in place (OR = 1.65, 95% CI = 0.69-3.98) (Capezuti et al., 1996). Another study by Capezuti and colleagues (2002) highlighted relatively high and increasing use of bed-rails as restraints for residents. They also identified that there was no significant difference in the likelihood of falls, serious injuries or recurrent falls between residents with bed-rails and those without.

5.7.2.1 Restraint reduction

Various studies have described physical restraint reduction as an intervention strategy in residential care facilities to reduce falls occurrence (Rader et al., 1992). Ejaz and colleagues (1994) used a group comparison design to evaluate a formal program of staff education and training and a multidisciplinary implementation process designed to reduce restraint use in seven residential care facilities across the United States of America. The intervention group consisted of all those subjects being restrained initially, and the control group those subjects who were not being restrained. Common alternatives to physical restraint included:

- bed and chair alarms;
- “wanderguards” for those who wandered;
- wedge cushions; and
- increased referral to physiotherapy and occupational therapy.

Following the program, 85% of those in the intervention group were totally unrestrained. However, there was a significant increase in the number of non-serious falls in this group, but not in serious falls, with no significant change in the control group. A longer follow-up period (>25 weeks) would be necessary to monitor this change and to determine staff adherence to
the program. It would also be useful to evaluate the effectiveness of this type of intervention targeting restraint reduction, in conjunction with a falls prevention program.

Evans and colleagues (1997) performed a randomised controlled trial in which 3 residential care facilities were randomly assigned to three interventions:

- a restraint education program;
- an education program with a consultation component; or
- a control group.

The consultation component used in one of the facilities involved 12 hours per week of nursing consultation to facilitate restraint reduction in residents with more complex conditions. Over a 12 month period, the more intensive intervention produced a significantly greater reduction in restraint use compared with the education only and control groups. Falls related serious injuries were lower in the combined education/consultation group (p=0.026), relative to the restraint education group only, (although the sample size was very small for the analysis of injurious falls).

Another study investigated a restraint reduction program, with a two year follow-up (Neufeld et al., 1999). The results included a 90% reduction in restraint use and significantly less serious injury over the two year follow-up period. However, there was no control group in this study, and no systematic record keeping across settings.

Schnelle and colleagues (1996) investigated the effectiveness of an exercise protocol designed to increase strength and mobility and to decrease injury risk factors, in physically restrained nursing home residents. The residents were frail, with over half non-ambulatory, and a high proportion were cognitively impaired. Following randomisation, the intervention group received:

- supervised mobility exercises (designed to improve walking or wheelchair endurance);
- safety practice (incorporating behavioural training principles, with verbal reminders of safety issues); and
- rowing endurance and strength training exercises.

The results indicated a significant improvement in upper body rowing performance, handgrip strength, and wheelchair endurance, as well as a decrease in injury risk factors (including transfers, walking, and judgement of safety), for those residents who completed the intervention protocol. In particular, the behavioural changes (improvement in total safety score and scores relating to transfers, walking and judgement) were an interesting result of the study. Unfortunately, falls rates were not recorded as an outcome of the study, and there was moderate subject attrition resulting in a restricted sub-population in the final sample. The opportunities for generalisation of results from this study are therefore limited.

Much of the work done in this area appeared following the introduction in the United States of America of the Nursing Home Reconciliation Act (1987), which stated that “residents have the right to be free from any physical or chemical restraint imposed for purposes of discipline or convenience ……” (Castle et al., 1997).

Castle and colleagues (1997) investigated restraint usage pre and post implementation of the reforms and found a 30% reduction in restraint use three years later. The results suggested, however, that there was no significant change in the types of residents who were restrained. The authors discussed the importance of resident (use of psychotic medication, history of falls and mobility problems) and facility risk factors when considering restraint usage. High registered nurse / resident ratios were found to significantly decrease the likelihood of use, whereas greater numbers of nursing aides in a facility significantly increased use. These are
issues that require further investigation in terms of restraint use, falls and related injury rates, and staff ratios and education.

A systematic review of physical restraint use and injuries has been recently published (Evans et al., 2003). This review incorporated studies from both residential care and hospital settings. Studies reviewed suggest that physical restraint use “may increase the risk of death, falls, serious injury …”. The review highlights the limited data available in this area, and the need for further research.

Queensland Health have recently published guidelines for restraint reduction in health care settings (Queensland Health, 2003). These provide a useful framework for implementing practice change in the area of restraint use reduction, including a strong emphasis on observation and evaluation, and staff education.

*Promising results have been reported in the residential care setting, in terms of a reduction in injurious falls, following a program aimed at decreasing restraint usage. Further research, investigating the necessary components of such a program (for example: education, consultation, an exercise protocol) would be beneficial, particularly if performed in conjunction with a falls prevention program.*

5.7.3 Bed alarm and other monitoring systems

Many falls in institutional settings are unwitnessed, and strategies need to be explored to facilitate increased observation capacity and response time by staff when a resident who requires supervision or assistance with mobility is starting to get up. A small device has been trialled in the residential care setting to provide an alarm sound when an “at risk” resident begins to stand up (Kelly et al., 2002). The device is called the NOCwatch®. It is a small credit card sized device attached to a resident’s thigh with an adhesive patch. The NOCwatch® is a wireless device, that emits an audible alarm when a resident’s leg approaches vertical. It is waterproof, shock-proof, and reported to be unobtrusive. The audible alarm is thought to be potentially useful in two ways. Firstly to alert staff about the resident starting to stand, and secondly, to possibly sound as a warning to the resident, so that they sit down again when the sound is emitted. The NOCwatch® is also disposable (to be thrown away after about 10 days if attached directly to the patient or up to a month if incorporated into clothing) and was reported as costing $2 a day if directly attached to the resident. The NOCwatch® was trialled in a residential care facility with a sample of high risk residents. In a short evaluation period of one week, falls were reduced by 90% compared to the week prior to use of the NOCwatch® (Kelly et al., 2002). Consideration of skin integrity is necessary prior to application of the device.

A range of other alert devices are available, including bed, chair or floor pads that sound an alarm as the person moves on to or off the pad.

*As yet, there have been no randomised controlled trials evaluating the effectiveness of bed, chair or other alarm / monitoring systems in the residential care setting.*
5.8 Cost effectiveness

There is little data available investigating the cost effectiveness of falls prevention programs in residential care facilities.

Residential care residents use Emergency Departments at rates higher than community-dwelling older people (Ackerman et al., 1998), with most common causes of Emergency Department presentation including:

- respiratory symptoms (14.4%);
- altered mental status (10.1%);
- gastrointestinal symptoms (9.9%); and
- falls (8.2%).

Over 40% of these visits will lead to hospital admission, with an average charge per visit of $US1239. The authors suggested that increasing the reimbursement of physicians working in residential care facilities, encouraging the recruitment of medical staff on site and implementing falls prevention programs may reduce costly resident transfer to local emergency departments. Likewise, Butler and colleagues (1998b) encouraged the use of evidence-based falls intervention strategies such as: vitamin D and nutrition supplements, hip protector garments and lower extremity resistance training, but stressed that resources must be made available for satisfactory implementation and training of staff.

Kumar and Parker (2000) reported an analysis investigating the cost effectiveness of hip protectors in preventing hip fractures. Their estimates suggest that provision of hip protectors for people aged 80 years and older, and for all older people in residential care would result in overall cost savings in terms of reduced costs associated with the prevention of hip fractures. This analysis was undertaken before several of the less successful hip protector studies were published, so results would need to be reviewed in the light of these results.

Few studies have been reported which investigate the efficacy of falls prevention strategies in the residential care setting, with an additional economic evaluation. This is an important area for future research.

5.9 Compliance and sustainability

Both resident and facility factors influence compliance with falls prevention strategies in the institutional setting. Rubenstein and colleagues (1990) found that physicians and care-givers complied with over 60% of falls prevention recommendations made but that environmental changes had the lowest compliance rate. Butler and colleagues (1998) determined that, despite promising evidence-based literature and reports of reduced physical activity among nursing home residents (Ruuskanen & Parkatti, 1994), only 40-50% of surveyed facilities provided gait, balance, and strengthening exercises. Participation in facility-organised activities appears to be strongly related to the characteristics of the facility itself (Lemke & Moos, 1989). More functionally dependent individuals may tend to be less active in the institutional setting due to factors such as staff resources and environmental constraints (eg location of room, need for assistance or transport to therapy). The authors recommended that a possible solution may be to divide subjects into smaller subgroups based on functional or cognitive status to ensure greater participation, compliance and an appropriate level of activity. These strategies would not appear to be commonly implemented, with Wasner and Rimmer (1997) reporting specific classes for
residents with Alzheimer’s Disease in less than 15% of surveyed facilities and in less than 5% of facilities for residents with Parkinson’s Disease.

Likewise, use of hip protector garments was not reported by any facilities surveyed in New Zealand (Butler et al., 1998b). Interestingly, a subsequent investigation revealed that group discussion / education sessions improved the receptivity of nursing staff and residents to the use of the garments as a strategy to prevent fractures (Butler et al., 1998a). Staff and resident education, in conjunction with the provision of appropriate resources, are vital to ensure the implementation and ongoing compliance with appropriate intervention strategies (Butler et al., 1998a).

In addition, the extreme frailty of some residents prevents them from participating in some forms of intervention, or results in limited compliance. This makes them all the more reliant on staff and carer involvement and commitment to implementing falls prevention strategies. Schnelle and colleagues (1996) reported that 30% of residents were unable to continue with an exercise intervention, due to hospitalisation, transfer from the facility, or death.

Uptake and adherence to recommended interventions has continued to be highlighted as a moderate limiting factor in many of the recent studies in residential care settings which have achieved successful reductions in falls or fall-related injuries. Some of the specific adherence issues raised in these studies have been highlighted in the sections of this review where the specific intervention has been reviewed. In all areas, further development and evaluation of strategies to maximise uptake and sustained engagement with appropriate falls prevention activities is warranted.

*These examples highlight the need for future falls and injury prevention programs to consider issues of training and education (staff, resident and carer or volunteers), adequate resources (exercise programs, hip protector garments, vitamin D supplements, staffing) and appropriate intervention strategies to optimise facility and resident compliance to ensure maintenance of gains. Facility specific factors that may limit compliance need to be identified by staff, residents and families, and subsequently addressed within individual falls prevention programs.*

### 5.10 Cultural Issues

Quite marked differences in falls rates have been reported between residential care settings in different countries. Lipsitz and colleagues (1994) reported that falls rates were nearly four times higher in the United States of America than in Japan (49% versus 13% respectively), with Japanese residents recording significantly greater quadriceps muscle strength than residents in America. It is possible that such disparity could be due to intrinsic cultural differences in falls risk, or to differences in nursing home criteria between the two countries. The authors hypothesised that cultural differences such as squatting or sleeping on the floor may maintain muscle strength and result in fewer falls in old age for Japanese residents (Lipsitz et al., 1994). Another study comparing functional status in Mexican American and non-Hispanic white nursing home residents determined that the former were more functionally dependent and had on average a greater number of medical conditions (cerebrovascular disease, acute infections, diabetes, hypertension) (Mulrow et al., 1996). These factors would tend to place them at a higher risk for falling.
No studies of this type have been completed in residential care settings in Australia.

Given the diversity in the ethnic background of older Australians, culturally specific issues will need to be addressed to optimise uptake and sustainability of falls prevention programs. Further research in this area is indicated.
‘An analysis of research on preventing falls and falls injury in older people (Update 2004): Part 3 – Hospital settings.’

CONTENTS-FALLS PREVENTION IN HOSPITAL SETTINGS:

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6. Falls among older people in hospital settings - Introduction

Reported falls rates vary substantially dependent on the hospital setting investigated. In the acute setting, figures ranging from 2 - 5% have been reported (Bakrich et al., 1997; Mahoney, 1998). In sub-acute, or rehabilitation settings, up to 46% of patients have been reported as falling at least once during their hospitalisation, with high rates being reported for specific clinical groups such as stroke (Forster & Young, 1995; Tutuarima et al., 1997). This is most likely related to the complexities associated with these medical diagnoses, and the often high level of dependence in the functional status of the population involved. Furthermore, the focus of therapies within sub-acute / rehabilitation settings is usually on the facilitation of normal activity and encouragement of independence, which can also be associated with an increased risk of falls. Staff in these settings face the challenge of optimising and encouraging activity and independence whilst at the same time minimising risk of falls.

Falls can occur in patients of all ages, although there is a marked increase in falls rates in hospitals for patients aged over 65 years (Halfon et al., 2001; Vassallo et al., 2000).

Consequences of falls in hospitals include:
- increased risk of complications (including fracture);
- increased likelihood of development of fear of falling or loss of confidence;
- extended length of stay;
- added diagnostic procedures and/or surgeries; as well as
- potential litigation (Hendrich et al., 1995).

Each of these in isolation or in combination can also result in serious physical and psychological effects, especially for older patients (Rhymes & Jaeger, 1988), and add significant costs to the health care system. Using case-control methodology, Bates et al (1995) reported significantly increased hospital length of stay for fallers compared to controls who were matched for age, gender, and length of stay until time of the fall (average 20 days compared to 12.5 days). There was an estimated increased hospitalisation cost of $US4,233 for each faller compared to the controls (Bates et al., 1995). Furthermore, the risk of institutionalisation is often increased by in-patient falls (Gluck et al., 1996; Grenier-Sennelier et al., 2002; Aditya and Sharma, 2003). Given these high rates of falls and the subsequent implications, falls and falls injury prevention initiatives in hospital settings should be a priority.

Falls are one form of adverse event in hospitals that are currently documented utilising a standardised incident monitoring reporting system (for example, the Australian Incident Monitoring System – AIMS; or RiskMan® Medical Incident Reporting Database). In an analysis of AIMS data, Rigby and colleagues (1999) reported that 38% of incident reports in hospitals were associated with falls. Interestingly, more than 50% of falls in hospital settings are not witnessed (Nyberg & Gustafson, 1995; Vassallo et al., 2000), and so a significant proportion remain “unclassified” following investigation. Patients 65 years of age and older account for more than 40% of all in-patient days in acute care facilities (Innouye et al., 1993), with longer and more frequent hospitalisations reported in this age group (Palmer et al., 1998). The focus of the acute in-patient stay is usually on the medical care of disease-specific illnesses, with less attention given to functional status and outcome. Indeed, it is these latter factors that may be critical determinants of quality of life, physical independence, cost of care, and prognosis among older adults (Hirsch et al., 1990). In addition, the relative frequency of potentially preventable adverse incidents, such as falls, during hospitalisation further impacts
on functional outcome.

There are several key issues that add to the complexity of implementing and evaluating falls prevention initiatives in the hospital setting. One of these is the generally short period of admission, particularly in the acute hospital setting. The management of acute illness and/or surgery and the limited time of admissions often constrain the ability to identify falls risk and to institute appropriate intervention strategies for the individual in acute care. In the rehabilitation or sub-acute hospital setting, hospitalisation is often longer as older patients gradually progress their balance, strength and walking abilities, as well as practicing and developing their independence in the range of personal, domestic, and ideally instrumental activities of daily living, before being discharged home. In particular, patients are often encouraged to increase their mobility and to walk in more challenging environments similar to those they will need to adapt to on return home. The transition to independent mobility following significant pathology such as stroke, lower limb or spinal fracture, or surgery is a period of moderate risk of falls, and one where a range of falls prevention initiatives have the potential to minimise this risk.

The aim of this section of the report is to review the current research evidence for what is effective in preventing falls and fall-related injury in the hospital setting, and to identify gaps and priorities for future falls prevention activity and research.

Even in sub-acute or rehabilitation admissions, the episode of care may continue for only a few weeks. As well as minimising falls risk during the admission, it is therefore important that hospital staff encourage falls prevention strategies appropriate to the patient’s discharge setting. Recovery of balance, mobility and independence are often ongoing following discharge from the acute, sub-acute or rehabilitation hospital. The immediate period following discharge home from hospital is associated with four times the risk of falling for older people, compared with 3 months after discharge (Mahoney et al, 2000). Furthermore, falls related injuries accounted for 15% of all hospital re-admissions within the first month after discharge (Mahoney et al, 2000). There is a need for effective communication, linkages, and adequate resourcing between services in the acute, sub-acute / hospital, community, and residential care settings to ensure smooth transition and optimal management for the older person as they leave the hospital setting.

6.1 Overview of falls risk factors

The accuracy of data on falls events is important in studies evaluating risk factors for falls. Some of the problems associated with reduced falls recall in studies of older people in the community setting are overcome in hospital settings by the use of incident reporting systems, which include documentation of falls events. A standardised data set for reporting of incidents and accidents, in the Australian hospital system - The Australian Incident Monitoring Study (AIMS) has been developed by the Australian Patient Safety Foundation. This system was established to identify patient safety problem areas and to develop, implement and monitor cost and/or risk-effective strategies for improvement of safety in hospitals. Importantly, it facilitates centralisation of data about incidents including falls. For further information contact www.apsf.net.au. Another hospital computerised incident reporting system (RiskMan® Medical Incident Reporting Database) has been introduced into a number of hospital settings in Australia (website: www.riskman.net.au).

Falls risk factors for older people in hospital settings have been reported by numerous studies.
There is limited comparability between studies due to focus on different risk factors, and different classification of risk factors being investigated. While there are some similarities with falls risk factors reported for both community and residential care settings, there are some differences. Falls risk factors in the hospital setting have been reviewed by Evans et al (2001), and include:

a/ intrinsic factors
- age (sharp rise over 60 years of age) (Jones et al., 1991; Halfon et al., 2001; Pils et al., 2003);
- male gender (Halfon et al., 2001; Pils et al., 2003);
- diagnostic status (patients with circulatory-system disorders were the most likely to fall, followed by nervous-system, respiratory, musculo-skeletal and digestive system disorders) (Jones et al., 1991). Halfon et al (2001) also identified pre-existing morbidity as an independent risk factor for falls in hospitals;
- previous cerebrovascular accident (Salgado et al., 1994);
- history of falls (Gluck et al., 1996; Frels et al., 2002);
- depression (Hendrich et al., 1995);
- cognitive impairment (acute or premorbid), particularly confusion, impaired orientation (Salgado et al., 1994) and misperception of functional ability (Stevenson et al., 1998);
- incontinence of bowel and bladder (Stevenson et al., 1998; Pils et al., 2003);
- requiring assistance for ambulation / impaired balance (Stevenson et al., 1998; Frels et al., 2002), or use of a gait aid (Pils et al., 2003);
- sensory deficiencies, such as impaired vision (Oliver et al., 1997) and dizziness / vertigo (Hendrich et al., 1995); and
- use of psychoactive medications (with greater risk for those taking more than two psychoactive medications) (Salgado et al., 1994; Frels et al., 2002).

b/ extrinsic factors
- hospitalised for 19 days or more (Stevenson et al., 1998; Halfon et al., 2001);
- environmental factors (Mitchell & Jones, 1996). For example, most falls in hospital occur around the bed-side, in the bedroom; and
- time of day. For example, falls most commonly occur at times when observation capacity is low (by staff or visitors), eg at shower and meal times, and outside of visiting hours.

The risk of falling increases with the number of risk factors (Salgado et al., 1994). Some risk factors have been shown to be associated with increased risk of multiple falls in hospitals, including confusion, unsafe gait, and antidepressant medications (Vassallo et al., 2002). In addition, the type of patient care setting will influence these factors, for example, those patient groups whose medical condition impacts directly on one or more falls risk factors, such as stroke, have high falls rates in the hospital setting (Forster & Young, 1995).

6.2 Falls risk factor - intervention matrix

Compared to the number of intervention studies evaluating falls prevention in community settings, relatively little work has been carried out investigating the effectiveness of falls prevention programs in hospital settings. The remainder of this section of the report focuses on an analysis of this literature.

A matrix has been developed to provide an overview of the degree of evidence of effectiveness of specific falls prevention program types in reducing falls (Table 3). Programs
have been tabulated according to which falls risk factor/s were addressed by the specific intervention type. The highest level of evidence for a particular intervention type and risk factor has been recorded, with relevant references noted.

*Studies which have demonstrated significant improvements in falls or falls injury rates have been included in the Matrix, although given the very small number of these, several additional studies have been added which identified a strong trend towards reducing falls rates (and in one case, falls injury).*

A summary of these studies is provided at the end of this report. Other relevant papers are discussed throughout the report.

An overview of single and multiple intervention falls prevention programs for older people in hospital settings is shown in Section 6.3.
Table 3. Falls risk factor - intervention matrix (older people in hospital settings).

<table>
<thead>
<tr>
<th>Interventions</th>
<th>Falls risk factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td></td>
</tr>
<tr>
<td>Exercise</td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td>A**, B**</td>
</tr>
<tr>
<td>Individual</td>
<td></td>
</tr>
<tr>
<td>Walking</td>
<td></td>
</tr>
<tr>
<td>Medical</td>
<td></td>
</tr>
<tr>
<td>Screen</td>
<td></td>
</tr>
<tr>
<td>Medication</td>
<td>C**</td>
</tr>
<tr>
<td>Geriatric Care Unit</td>
<td></td>
</tr>
<tr>
<td>Nursing – risk assessment</td>
<td></td>
</tr>
<tr>
<td>Nursing – toileting regime</td>
<td>F***</td>
</tr>
<tr>
<td>Environment</td>
<td></td>
</tr>
<tr>
<td>Sensory</td>
<td></td>
</tr>
<tr>
<td>Improved use of gait aids</td>
<td></td>
</tr>
<tr>
<td>Injury Minimisation</td>
<td>H***</td>
</tr>
<tr>
<td>Multiple strategies</td>
<td>J</td>
</tr>
<tr>
<td></td>
<td>J</td>
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</tbody>
</table>

A. Hauer et al., 2001  B. Hauer et al., 2002  C. Murdock et al., 1998  D. Brady et al., 1998  E. Lieu et al., 1997  

Unless otherwise stated, reported studies are Level II evidence (randomised controlled trials)
* Level I – systematic review;  ** non-significant trend in RCT for reduced falls or falls injuries
*** Level III - significant reduction in falls or falls injury (non randomised study)  **** subanalyses for those with cognitive impairment resulted in significant reduction in fractures
### 6.3 Overview of intervention strategies

A systematic review of the literature in the hospital setting has revealed a wide variety of intervention strategies aimed at reducing the occurrence of falls, and subsequent injury, based on the modification and reduction of detailed risk factors associated with falls. These include:

<table>
<thead>
<tr>
<th>Education</th>
<th>Health Professional Education</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Falls Risk Factors</td>
</tr>
<tr>
<td></td>
<td>Patient / Carer Education</td>
</tr>
</tbody>
</table>

| Exercise  | Exercise versus Bed Rest     |

| Environment | Assessment / Modification |

#### Clinical Assessment and Review

- Medical Screen (including medication)
- Specialised Units
- Multiple Strategy (targeted)

#### Injury Minimisation

- Clothing (hip protector garments / footwear)
- Assistive Devices (walking aids / restraints)
- Increased Surveillance

Discharge planning and follow-up post discharge
7. Research evidence in reducing falls and falls injuries: Hospital settings

7.1 Education

Education has been frequently cited in the literature as an important component of a hospital-based falls prevention program. Education programs may target staff, patients, and or their family / carers. Fleck and Forrester (2001) identified that 80% of hospital staff underestimated the frequency of in-patient falls by 75% or more, that they had difficulty identifying the ramifications of falls, had limited knowledge of falls risk factors, and limited understanding of appropriate falls prevention strategies in the hospital setting. These findings highlight the importance of falls prevention training programs for hospital staff. Indeed, this study identified moderate improvements in staff knowledge on the parameters described above (Fleck and Forrester., 2001) post intervention (viewing a 20 minute fall prevention educational video). Some examples of falls prevention training programs which have been described in the published literature include:

- staff training to increase awareness of falls risk factors and appropriate intervention strategies (Hendrich et al., 1995). Schmid (1990) included falls prevention education for staff from a range of departments (dietetics, social work, medicine, building management), so that patients could be monitored more globally. Employees were reminded of the program periodically through a daily news bulletin;
- a training video targeting staff (Fleck and Forrester., 2001);
- education of patients and family with regard to risk factors, safety issues and activity limitations (Patrick et al., 1999). These issues are important both during hospitalisation, as well as in preparation for discharge from the hospital;
- training patients in safe methods of transferring and completion of activities of daily living (Patrick et al., 1999); and
- orienting patients to their immediate environment and describing methods for obtaining assistance (Creditor, 1993). A high rate of falls has been shown to occur during the first one to two weeks of hospitalisation, which can be a period of unfamiliarity with a new environment, new procedures, and a time when staff are becoming familiar with a new patient’s abilities and risks (Hill et al., 1988; Mion et al., 1989).

As with residential care settings, workforce training is likely to play a key role in falls prevention initiatives in hospital settings. Key features of a workforce training program for staff in hospital settings to reduce falls risk among patients may include:

- strategies for early identification of an individual’s falls risk;
- recognition of single and multiple, intrinsic and extrinsic factors contributing to risk;
- ways of maintaining a low risk environment;
- close monitoring of “at risk” patients; and
- early identification of the need for involvement of the multidisciplinary team.

There is increasing evidence in the education literature indicating that different approaches to education may achieve quite different levels of learning. Complex behaviour change in individuals and system change in hospitals is required to achieve reduced falls and injuries in this setting. In order to achieve change in practice which may reduce falls rates in hospitals, there are a number of criteria which need to be met:

- staff need to perceive that falls among patients are a major problem;
- staff need to perceive that there is potential benefit of specific interventions aimed at reducing falls and falls related injuries among patients; and
• Staff should have an active involvement in the development and implementation of falls prevention programs.

Little research has been done, however, to evaluate the efficacy of education alone in reducing fall rates among hospitalised patients. In a geriatric psychiatric hospital, a staff training program in conjunction with a falls risk assessment resulted in a significant reduction in falls, using a pre-post design methodology (Savage and Matheis-Kraft., 2001). Lieu and colleagues (1997) conducted a three year study to determine the effectiveness of lectures and educational material in the prevention of falls in a geriatric ward. Although the prevalence of falls was reduced (from 9% to 7%), this was not statistically significant. This form of conventional workforce training alone would not appear to be the most effective way of reducing fall rates in the hospital setting. Different models of workforce training need to be explored. In particular, an approach which actively involves staff in identifying factors within their own setting and with individual patients, and in the development of management plans to minimise falls risk within the broader hospital environment as well as for individual patients, may be more effective. All hospital staff have a key role in falls prevention for older patients, and as such, workforce training approaches warrant further investigation.

An Australian randomised controlled trial by Haines et al (in press) utilised a patient / carer education arm as one of four interventions introduced based on a multidisciplinary falls risk assessment on admission to the sub-acute hospital setting. The education consisted of an information booklet provided to at risk patients, and individual information sessions delivered by an occupational therapist for at risk patients who did not have cognitive impairment. This multifactorial intervention achieved a significant reduction in falls, although the effectiveness of the individual components in isolation was not reported.

Further research is necessary to determine the effectiveness of different approaches to workforce training, as well as patient and family education, in preventing in-patient falls.

7.2 Exercise

7.2.1 Effect of lack of exercise / activity

Immobilisation, or bed rest, is a common consequence of hospitalisation and may contribute to adverse outcomes, including deterioration in function and mobility, possible nursing home placement (Hirsch et al., 1990; Mahoney 1998), and comorbid complications during and after hospitalisation. These complications include: loss of muscle strength, reduced bone mineral density, cognitive impairments, nutritional deficits, and urinary incontinence (Creditor, 1993), with subsequent increased risk for falling (Nyberg & Gustafson, 1995). Hirsch and colleagues (1990) reported that, of the patients who were dependent in ambulation at discharge from an acute and tertiary care hospital, 70% had been completely independent in ambulation two weeks prior to admission. Similar deterioration was seen for transferring, toileting, feeding and grooming. In cases where a hospitalised older person is dependent in transfers and mobility, they must rely on others for assistance (staff and / or family and friends), and may spend a considerable part of their hospital stay in bed. Over two-thirds of falls occur around the bedside (Hanger et al., 1999; Vassallo et al, 2000; Frels et al., 2002). Furthermore, Nyberg and Gustafson (1995) determined that 37% of falls on a geriatric stroke unit occurred during transfers (the majority of which were unassisted) and 25% from a sitting or lying position.

Bed rest during the day should be minimised for all older in-patients, except where management of an acute medical condition requires otherwise.
Interestingly, Lazarus (1991) assessed the provision of physical activity to 500 older patients on acute medical and surgical wards (100 in each of five hospitals) during the first seven days of hospitalisation. The authors determined that 24% of the patients had no documented ambulation in that time and that none of the patients (n=119) that were bed/chair bound had any medical record documentation for range of movement or strengthening exercises. Only 14 of these patients received physical therapy. In addition, on 41% of the days, patient activity differed from that which was ordered. Issues such as poorly delineated staff roles, unclear communication, lack of established policies and procedures, and other operational factors may affect provision of activity in hospital settings. These need to be assessed in order to prevent further deterioration in function and increased falls risk for older people in hospital settings.

Interventions that may encourage activity include education (of staff, patient and family), environmental factors (such as appropriate footwear and provision of seating), attention to medication use (such as sedatives), exercise prescription and activity orders (whether these be in supine, in the chair, or when ambulating) (Mahoney, 1998).

### 7.2.2 Exercise prescription

There is good evidence in community dwelling older people, and to a lesser degree for older people in residential care settings, that strength, balance, function, and fear of falling can be improved with exercise approaches. Within the hospital setting, however, there is little research among older people generally which has demonstrated that exercise in itself can result in improvements in these factors and contribute to subsequent reductions in falls rates. In part, this is due to the nature of the health problems precipitating hospitalisation.

Nevertheless, numerous studies have shown significant improvements in most of these parameters in specific clinical groups during hospitalisation, when exercise or balance and mobility training have been incorporated as part of the management program; for example:

- stroke (Dean & Mackey, 1992; Hill et al., 1997; Weiner et al., 1993);
- hip fracture (Finlay, 1993; Petrella et al., 2000; Sherrington et al., 2003);
- frail older patients undergoing rehabilitation (Sullivan et al., 2001); and
- Geriatric Evaluation and Management patients (Rubenstein et al., 1984).

However, a limitation of the design of each of these studies is that they do not separate the proportion of recovery which is spontaneous and due to time (which in some of these clinical groups can be considerable), and that specifically due to the exercise program. Despite these issues, research needs to be undertaken to compare current practice against a combined program of current practice in conjunction with a specific balance and mobility training program for older patients in hospital.

One randomised controlled trial has evaluated a strength training program in an aged care rehabilitation unit, with falls used as an outcome measure (Donald et al., 2000). This study compared routine physiotherapy, to routine physiotherapy combined with a strength training program. Significant improvements were achieved on some of the strength measures, however there was no significant difference in falls rates between the two groups. This study design was complicated by utilising two different floor surfaces within each exercise group, and very small sample sizes.

Mahoney (1998) described the essential components of an exercise program for hospitalised older people as one which included:
• staff and patient education;
• monitoring of blood pressure;
• stretching / strengthening / aerobic training; and
• bed and chair exercises.

Functional activities, such as transferring, frequent toileting (either ambulating or using a bedside commode), personal hygiene, walking (eg to and from appointments), and other opportunities for incidental activity need to be encouraged and supervised as necessary. The use of physiotherapy is discussed primarily in the prescription of exercises for patients on bed rest because of medical indications, and for patients who are unsafe in ambulation and transfers. However, the physiotherapist has a key role in progressing mobility and balance training, and in conjunction with the occupational therapist, in facilitating functional training and preparation for the return home. In-patient rehabilitation may be indicated for patients who appear unable to return to their pre-hospital living situation because of functional decline in the acute hospital setting.

A randomised controlled trial by Haines et al (in press) utilised an exercise program as one of four components of a multifactorial falls prevention program in the sub-acute setting. The exercise program was conducted in addition to routine therapy for patients with identified balance and mobility problems on an initial falls risk assessment., it incorporated the principles of Tai Chi, combined with functional activities such as transferring, stepping, reaching and weight shift. The exercise sessions were conducted by a physiotherapist three times weekly in addition to routine therapy. The multifactorial falls prevention program achieved a significant reduction in falls, however the individual effect of the exercise intervention was not evaluated.

7.2.3 Exercise programs targeting older patients following discharge from hospital

Several randomised controlled trials have evaluated the efficacy of exercise interventions following hospital discharge, for patients with high risk of recurrent falls (for example, following hip fracture). Although these studies incorporate exercise interventions following discharge home from hospital, they highlight the importance and potential benefits of a coordinated discharge strategy that incorporates follow-up exercise.

Hauer et al (2001 and 2002) identified significant improvements in strength, balance and function, with a three month, three times weekly, centre based group exercise program targeting these parameters. Some of these benefits were maintained three months following completion of the program. Participants had experienced one or more injurious falls requiring hospitalisation to be included in the study. The intervention group undertook the exercise classes in addition to routine therapy. Falls incidence reduced by 25% in the intervention group, although this difference was not statistically significant.

One study targeting frail older people being discharged home from hospital did not identify a benefit in physical health outcomes or falls in the home based quadriceps strengthening exercise arm of a randomised controlled trial (Latham et al., 2003a) (see Section 3.2.1.2). The authors highlight some limitations in the methodology of this study which could account for the negative findings. In particular, only one leg muscle group (the quadriceps) was exercised, and the method of strength training utilised a non-functional approach. Of note, this strength training program aimed to utilise a high intensity approach, and there was a higher number of musculo-skeletal injuries in the home exercise program group. This highlights the need for
close monitoring of performance, graduated increase in intensity, and perhaps consideration of alternative exercise approaches to high intensity strength training, for frail older patients.

*There is increasing evidence that exercise interventions in hospitals, and in particular targeting in-patients with exercise programs follow-up after hospital discharge, can prevent deconditioning, improve or maintain mobility and function, and possibly reduce falls rates among older patients. Given the additional strong evidence of effectiveness for this approach in community settings, further investigation of exercise interventions, particularly during the hospitalisation period, should be a priority for future research. Other issues to be considered include identification of the optimal level of activity or exercise necessary both to enhance mobility and function and to reduce patient falls. The exercise approach is likely to differ for specific clinical groups and different hospital settings and needs to be incorporated into hospital policy and staff training.*

### 7.3 Environmental safety

The hospital environment has been considered extensively in the literature in terms of risk factors for falling, location of incident and modification of hazardous factors (Creditor, 1993; Nyberg & Gustafson, 1995; Salgado et al., 1994). In the rehabilitation setting, only 11% of falls were classified as due to extrinsic (environmental) factors (Nyberg & Gustafson, 1995). The most frequent location was the patient’s room, followed by the dining room, bathroom and corridor, with 25% occurring while sitting or lying. Over two-thirds of falls occur around the bedside in the rehabilitation setting (Hanger et al., 1999), with similar findings recorded in the acute hospital environment (Lieu et al., 1997; Vassallo et al., 2000). Environmental falls hazards which have been identified in the hospital setting include:

- unstable furniture (Jones et al., 1991);
- improper use of bedrails and physical restraints (Frengley & Mion, 1998);
- inadequate lighting (Jones et al., 1991);
- slippery floors (Healey, 1994);
- cluttered areas (Healey, 1994); and
- poorly fitting shoes (Jones et al., 1991).

The effect of floor surface on falls in hospitals has been investigated in two small studies, with conflicting results. In a randomised controlled trial comparing carpet and vinyl floor surfaces (combined with two exercise interventions), a strong trend was evident for more falls occurring on carpet (Donald et al., 2000). A possible explanation for increased risk of falls on carpet may be a tendency for reduced foot clearance in patients (Elble et al., 1992), which may result in increased scuffing of the feet on carpet relative to vinyl. The second study evaluated the role of flooring type in relation to the injuries received when older patients fell in the hospital setting (acute geriatric and rehabilitation wards) (Healey et al, 1994). Using retrospective analysis, 27 patients were found to have fallen on carpet (four of whom were injured), and 186 patients were found to have fallen on vinyl flooring (with 91% receiving injuries) over a four year period. The groups were similar in terms of age, but no other comparisons were made to identify potential contributory factors to the differences identified. One possible explanation of these results proposed by the authors is that carpet floor covering may absorb some of the impact of falls, reducing the likelihood of injury compared to those who fall on vinyl flooring. However, the study design does not preclude a range of other potential factors accounting for the differences in falls injuries observed. Additionally, issues of cost, infection control, and cleaning, particularly with respect to incontinent patients, need to be considered when evaluating flooring type in the hospital setting. No other studies have
investigated the effect of other floor surfaces on falls or falls injuries. Given the potential influence of floor surface on both falls and falls injury risk, these conflicting results highlight the need for well designed research in this area.

In addition, acute care units, and specifically those for acutely ill, frail older patients, are often not designed appropriately for the care of this population. Environmental structure / design can make patient monitoring more difficult, enhance noise levels, increase social isolation, minimise functional demands, and influence the occurrence of confusion and agitation (Frengley & Mion, 1998). These are important issues for consideration where new hospitals or wards are being designed, or when existing buildings are being refurbished.

### 7.3.1 Environmental modification

The use of environmental modification as a strategy to prevent falls in the hospital setting has been commonly reported (Patrick et al., 1999; Salgado et al., 1994; Schmid, 1990). Environmental modifications may be instituted following routine environmental audits targeting falls hazards in the hospital environment. Some recommended environmental modification strategies in the hospital setting have included:

- use of a call bell system (Tideiksaar et al., 1993);
- use of modified, less hazardous beds / chairs positioned at the most appropriate height (Creditor, 1993);
- care with placement of furniture (Frengley & Mion, 1998);
- evaluation of lighting, patient clothing, floor covering (Salgado et al., 1994);
- colour scheme (to reduce agitation) (Frengley & Mion, 1998); and
- reduction in use of physical restraints (Hanger et al., 1999).

Frengely (1999) also emphasised the need for a radical redesign of hospital beds, so that rails were no longer an essential feature and the frame could be lowered to the ground. These types of beds are now available in Australia, although further investigation is necessary to determine the suitability of this type of product, and its effect in reducing falls and falls injuries among hospitalised patients.

### 7.3.2 Environmental modification as part of post discharge follow-up

A randomised controlled trial compared falls outcomes associated with routine post discharge care, relative to an enhanced discharge planning and follow-up program (Nikolaus and Bach, 2003). The enhanced discharge program incorporated a home assessment and modification program, together with advice and support to facilitate recommended changes, training in the use of technical and mobility aids, and a follow-up three month visit. Both groups also received comprehensive geriatric assessment and recommendations at discharge. The sample were older people admitted to hospital with evidence of functional decline. After 12 months, there were significantly fewer falls (31%), and significantly fewer recurrent fallers in the enhanced discharge planning and follow-up group.

*Environmental and facility-specific factors potentially play an important role in some falls among hospitalised patients. To date there are no randomised controlled trials, and only a few studies utilising primarily descriptive or retrospective methodologies, investigating the effectiveness of environmental modifications alone in reducing falls and related injuries among older people in hospital settings. Home environmental assessment, modification,*
and follow-up should form part of routine discharge management for older patients at risk of falls.

7.4 Clinical Assessment

Clinical assessment is a widely used intervention in hospital falls prevention programs. This may involve a brief, simple, screening tool to identify at risk individuals, or a detailed assessment identifying specific risk factors. Although the brief screening tool would enable the application of generic or untargeted falls prevention interventions, the detailed assessment tool enables staff to identify which risk factors apply to the resident enabling targeted intervention to reduce individual falls risk. A brief screening tool may also be used to identify patients who require a more detailed assessment. Clinical assessment may also include detailed assessment of specific risk factors, eg – medication, vision etc. In the hospital setting where short lengths of stay, and acute and existing chronic conditions combine to increase falls risk, many important considerations for the assessment or screening process need to be determined – who assesses, how often and at what intervals.

7.4.1 Medical screen

7.4.1.1 Clinical Falls Risk Assessment

Accurate clinical assessment of an individual’s falls risk and the subsequent implementation of falls prevention strategies would appear to be important components of a hospital-based falls prevention program. Important criteria for a clinical falls risk assessment include that it:

- is practical to use in busy hospital wards;
- requires minimal or no equipment;
- is easy to administer;
- has high prediction accuracy; and
- is linked to an action plan.

Several studies have described the development of a nursing assessment tool to identify those patients at high risk of falling (Hendrich et al., 1995; Oliver et al., 1997), with the rationale that appropriate interventions can then be implemented to minimise these risks. Hendrich and colleagues (1995) evaluated a risk factor assessment with seven components:

- recent history of falls;
- depression;
- altered elimination (voiding) patterns;
- dizziness or vertigo;
- primary diagnosis of cancer;
- confusion; and
- altered mobility.

“Risk points” were calculated for each factor and the patient’s degree of risk classified (low/high/extremely high risk). This tool provided a framework for therapeutic interventions based on risk factor assessment, but has yet to be studied in terms of accuracy of classifying risk, falls reduction and staff compliance.

A study in a geriatric unit of a Swedish hospital identified an increase in the recording of risk assessment (from 0 to 96%) after the implementation of a risk assessment (a non-validated
tool) and recording program (Uden et al., 1999). Similar tools have been found to have a moderate to high level of reliability and validity in both an acute care setting in the United States of America (Schmid, 1990), and an elderly care unit (including stroke rehabilitation) in the United Kingdom (Oliver et al., 1997). The former study determined that the highest discrepancy in interrater reliability for the assessment tool was in the area of prior fall history. Other authors have found a similar under-reporting of falls history, with almost 75% of recent falls prior to hospitalisation not documented in the hospital admission by medical and nursing staff (Edelberg et al., 1998).

Each of these studies described above involved the nursing assessment of falls risk among hospitalised patients. Brady and colleagues (1993) took a slightly different approach and studied a proactive nursing intervention, aimed at reducing potential falls in a geriatric rehabilitation unit. The intervention was based on four peak times for falls within the unit (8am, 2-3pm, 10pm, 5-6am), which had been identified in a retrospective audit. Thirty minutes prior to the start of these times, a nursing staff member would review each patient’s need for toileting, assistance in or out of bed or chair, and need for fluids or food. Over two weeks, there was a reduction in the number of falls, compared to similar time frames in the preceding two years. This approach may be most effective when used in conjunction with nursing assessment of falls risk, but further research is needed to expand these ideas, and should be evaluated with stricter research design methodology.

In addition, Patrick and colleagues (1999) described a multidisciplinary approach to falls risk screening on a geriatric rehabilitation ward in Canada, whereby each risk factor was evaluated by the member of the team who had the greatest expertise in that area. For example, balance and mobility were assessed by the physiotherapist, visual impairment by the physician, mental status by the psychologist, medications by the pharmacist, functional status by the occupational therapist and falls history by the nursing staff. Reliability and sensitivity to change have been reported to be good for components of the tool (Patrick and Blodgett., 2001). This more lengthy and time consuming approach has yet to be studied in terms of accuracy in classifying falls risk, cost effectiveness and efficacy in developing intervention strategies for reducing falls, but is an example of a different format that may be more appropriate in the rehabilitation setting.

Another falls risk assessment tool that has been validated in the hospital setting is the Conley scale, validated in a medical / surgical ward in an acute hospital setting (Conley et al., 1999). In this study the authors noted that assessment on admission only, did not capture changes in patients’ condition and that the predictive accuracy of the tool could be improved with more regular (daily) application.

A potential problem with some falls risk screening or assessment tools is that they over-classify fallers. An example of this was reported by O’Connell and Myers (2001 and 2002), where the Morse Falls Scale was used in aged care units of an acute hospital as a basis for identifying high risk patients (with stickers, dots, and bracelets). However, 75% of patients were classified at high risk. Sensitivity (the proportion of fallers accurately classified as a faller by the tool) was 83%, however, specificity (the proportion of non fallers accurately classified as a non-faller by the tool) was only 29%. This means that over 70% of people who did not fall during their admission were classified at high risk of falling. This can have the potential effect of reducing the value of risk screening or assessment. It also limits the utility of the tool if it is to be used for determining allocation of limited resources, such as a bed alarm, or being placed in the high supervision area of the ward. Eagle and colleagues (1999) identified that the accuracy of the Morse Falls Scale was similar to that of nurses’ clinical judgement, although again both misclassified a high proportion of non-fallers as fallers.
Similarly, Myers and Nikoletti (2003) found both a falls risk assessment developed by Schmid (1990) and MacAvoy et al (1996), and nurses judgement misclassified a high proportion of non-fallers as fallers.

As when identifying falls risk for older people in residential care settings, several important issues warrant consideration when adopting a risk screen/assessment approach in hospital settings. These include:

- **Timing of the risk assessment.** Options include on admission, after an acute event, fall, or change in status, or at regular time intervals post admission;
- **Who does the assessment?** Options include nursing staff, medical staff, physiotherapists, occupational therapists, or a multidisciplinary team;
- **Level of detail involved in the risk assessment.** Most of the reported tools are brief, without clear operational definitions for classification on each item. This will result in limited accuracy of falls risk classification. Assessment utilising objective tools with a range of levels is likely to be able to yield greater accuracy, although this has not been formally evaluated in hospital settings. A disadvantage of incorporating more objective tools in the risk assessment is that it is likely to increase the time demands of the assessment.
- **Accuracy of the falls risk classification.** It is important that as few people as possible are misclassified with respect to their falls risk. If an older person at risk of falls is classified as not being at risk, with no prompt to implement appropriate falls prevention actions, the consequences may be a serious, injurious fall. If a person not at risk is identified as being at risk, the strategies implemented may cause unnecessary anxiety about risk of falling for the individual, and possibly translate into long term fear of falling and reduction in activity level even after discharge from hospital. This may subsequently increase risk of falls long term. Each of these possibilities needs to be minimised. Prospective studies using sensitivity and specificity analyses are required to evaluate the accuracy of falls risk assessment tools.
- **Level of training and experience in using the screen/assessment tool and the protocols and policy regarding use and follow-up of results.**

Research results also indicate that it is likely that one falls risk screening tool may not be equally effective across the range of acute, sub-acute and rehabilitation hospitals. A study by Oliver and colleagues (1997) identified that a falls risk assessment tool developed in an inner city hospital had reduced utility when subsequently tested in a district general hospital, and in a separate study in a Canadian hospital (Coker et al., 2003).

Only one randomised controlled trial has used a falls risk assessment as the basis of targeting falls prevention interventions in a sub-acute hospital setting, and achieved significant reduction in falls (Haines et al., in press). The study used a multidisciplinary falls risk assessment, with the medical staff assessing previous falls history, chronic medical conditions and medications, nursing staff assessing toileting needs and need for information or falls risk alert card, physiotherapy staff assessing gait and transfers, and occupational therapy staff assessing bathing and dressing, and potential benefit of an education program. Potential for non-compliance with intervention was also assessed. Based on assessment findings, interventions included a Falls Risk Alert Card, information brochure, exercise group, education sessions, and hip protectors. Predictive accuracy of this assessment tool (the PJT-FRAT) has been reported as good (Haines et al., 2003).

Another example of an Australian falls risk screening tool evaluated among in-patients in an Aged Care and Rehabilitation Hospital (Peninsula Health Care Network) in Melbourne is the
Falls Risk Assessment Tool (FRAT). The FRAT consists of four items, with the underlying difference to many other screening tools that it grades the level of severity of risk on each of the four items, rather than just identifying the presence or not of each risk factor. The FRAT has been shown to have a good level of sensitivity and intermediate specificity in accuracy of classifying fallers and non-fallers (Smith et al, 2001).

Perrell and colleagues (2001) provide a useful overview of the range of falls risk assessment tools which have been validated in hospital, residential care, and community settings, summarising the strengths and weaknesses of the various tools. They highlight the need in the acute setting for the tool to be quick and easy to administer.

*The application of falls risk assessment tools to clinical practice, their accuracy in predicting falls, and the effectiveness of subsequent management strategies in reducing and monitoring falls, needs further research in a variety of hospital settings and with different clinical groups. To date, there is only one multifactorial falls prevention program based on a falls risk assessment in the sub-acute hospital setting that has been effective in reducing falls using a randomised controlled trial design, and none in the acute or other specialist hospital settings.*

7.4.1.2 Limited adverse occurrence screening

Limited adverse occurrence screening is a continuous process of retrospective screening and review of in-patient medical records to detect adverse patient occurrences, with actions implemented that aim to reduce likelihood of future adverse occurrences. It is referred to as limited, because only a few patient outcomes are reviewed. In a study by Wolf (1996) eight general patient outcomes were used as a criteria for limited adverse occurrence screening:

- death;
- return to operating theatre within seven days;
- transfer from general ward to intensive care unit;
- unplanned readmission within 28 days of discharge;
- cardiac arrest;
- transfer to another acute care facility;
- length of stay greater than 35 days (reduced to 21 days in 1993-4); and
- theatre booking cancelled (Wolf, 1996).

In this study, Wolf (1996), a medical review determined that 0.97% of all records screened contained an adverse patient occurrence, with 56.8% of these considered not to be preventable or of minor significance. Recommended action for the other cases included: changing the relevant hospital policy, undertaking a quality assurance program to investigate the event in detail, discussion with the doctor involved and review of the doctor’s clinical privileges or reporting the case to the hospital insurers. Over a three year period, it was found that the rate of adverse occurrences fell from 69 (1.35% of all patient discharges in the first year), to 33 (0.58% of all patient discharges in the third year) (p<0.0001) and there was no significant change in severity of occurrence. Falls as a type of adverse event were not specifically considered and so, despite the promising results, no conclusions can be drawn from this study regarding falls prevention and hospital policy. However, this approach may be useful as part of ongoing monitoring and evaluation of strategies implemented to reduce falls among older hospitalised patients.

Approximately one third of all people who fall in hospitals fall more than once (Vassallo et al., 2002). Morse (1997) identified that almost 70% of patients who fall more than once were
undertaking the same precipitating activity when they fell subsequently. As such, valuable information can be derived from the circumstances of a fall, to inform future preventative activity. Root cause analysis can be a useful approach to systematically exploring factors contributing to a fall (Gowdy and Godfrey, 2003).

7.4.1.3 Toileting

Urinary and bowel incontinence have been cited in the literature as factors associated with increased risk of falling among older people in hospital. A number of factors may contribute to this increased risk, including urinary urgency, urinary frequency, reduced mobility and balance when hurrying, and reduced dexterity (in manipulating undergarments etc). A study by Bakarich and colleagues (1997) investigated the effectiveness of using a nursing assessment of mental status and mobility, combined with a toileting regime, to reduce falls in elderly patients admitted to the medical and surgical wards of an acute teaching hospital. All patients were assessed and subsequently classified as being “at risk” or “not at risk” of falling. Only those in the former group received the toileting intervention (every two to four hours), which consisted of patients being approached each two hours regarding the need for toileting. The results indicated that 5% of all patients fell, with more than half (54%) of these occurring in subjects classified as “at risk” of falling. Further analysis revealed that there were significantly fewer (53%) falls in the “at risk” group who were assessed and then received the toileting intervention, than in the same group who were assessed but were not toileted according to the study protocol. Poor staff compliance with both the assessment and intervention was identified as a limiting factor by the authors of this study, with failure to comply with the toileting protocol on 58% of shifts. Staffing levels, work priorities, and lack of knowledge may all be factors which limited the effectiveness of this management program.

The use of proactive nursing strategies to prevent falls in hospitalised older people (in areas such as risk assessment and toileting) requires further investigation both in terms of the interventions themselves and strategies to promote staff awareness and behavioural change.

7.4.1.4 Medication

Many psychotropic drugs have side-effects reported such as sedation, postural hypotension and impaired balance and mobility, which may increase an individual’s risk of falling. Inappropriate prescription of this type of medication in order to control mood, mental status or behaviour may be considered a form of chemical restraint (Tideiksaar, 1998). Murdock and colleagues (1998) studied patient falls in a psychiatric hospital over a two year period following the mandatory introduction of a policy requiring measurement of lying and standing blood pressure after a fall, and the reporting of results to the responsible clinician for implementation of a medication review. There was no reduction in the rate of first falls, but a statistically significant reduction occurred in the number of repeat falls. In addition, there was a statistically significant increase in the frequency with which blood pressure was measured following implementation of the new policy. A possible explanation is that the reduction in repeat falls was related to adjustments in medication as a result of clinical observations with regard to postural hypotension, and also to a greater awareness of the problem brought about by policy change.

Passaro et al (2000) identified an odds ratio of 1.7 (95% confidence intervals 1.2 – 2.3) for falls for patients taking benzodiazepines, compared to patients not taking benzodiazepines. Benzodiazepines with a short half life were shown to be significant independent predictors of falls in this sample.
In a large meta-analyses, psychotropic medications were found to be associated with an increased risk of falls (pooled odds ratio = 1.73), with this further increasing in patients taking more than one psychotropic drug (Leipzig et al., 1999a). The use of cardiac and diuretic medication was also associated weakly with falls in older adults, with a pooled odds ratio (95% confidence interval) ranging from 1.08 (1.02 - 1.16) for diuretic use and 1.59 (1.02 - 2.48) for some cardiac medications (Leipzig et al., 1999b). Unfortunately, the risks for each medication type were not broken down to reflect risk in hospital settings only.

There have been no randomised controlled trials, and little research conducted into the effectiveness of formal medication review and modification in reducing falls or falls related injury rates for older people in hospital settings. Given the evidence regarding medication review and modification in reducing falls risk in both community and residential care settings it is clear that medication is an important factor for review in hospital patients at risk of falling. The impact of medications on rate of falls in the hospital setting warrants further investigation.

7.4.1.5 Nutrition

Malnutrition is common in hospitalised older patients, with 16% severely malnourished on admission (Covinsky et al., 1999). This group has been reported to be significantly more likely than moderately or well nourished patients to die within 90 days and one year after discharge, and to have delayed functional recovery, and higher rates of nursing home use.

Adequate nutrition is critical to optimising recovery and enhancing participation in therapy programs for older people in hospital, both of which have the potential to reduce falls rates. It also plays an important role in improving wound healing, improving energy levels for increased physical activity, and improving bowel and bladder function. Potential factors associated with reduced nutrition in hospital settings include:

- unfamiliar food;
- special dietary requirements (eg low salt) making food less appealing;
- difficulties of eating in bed;
- swallowing and communication difficulties; and
- loss of dentures (Creditor, 1993).

Appropriate review of older people in hospital by a dietitian and / or a speech pathologist may facilitate early identification of nutrition, swallowing or eating problems, as well as provide a range of management options. Review of denture use and fit, and developing communal eating areas may encourage better eating patterns in older hospitalised patients. There have been no randomised controlled trials investigating the effectiveness of nutrition management on reducing falls or injury rates in hospital settings.

Many older Australians are vitamin D deficient, which can result in muscle weakness and reduced bone strength (Sambrook et al., 2002). Vitamin D and calcium supplementation combined have been shown to be effective in reducing fractures of the hip in community and residential care settings. If vitamin D deficiency is considered a possible diagnosis for older hospitalised patients, investigations should be implemented to determine whether vitamin D and calcium supplementation should be considered.

7.4.1.6 Cognitive impairment
Executive functions are cognitive abilities that allow an individual to interact with their environment in an efficient and effective manner (Rapport et al., 1998). In a study of 90 patients admitted to an urban rehabilitation hospital in the United States of America, measures of executive functioning were significantly associated with falls (Rapport et al., 1998). The implications of these findings are that patients with motor and sensory impairments, whose judgement (ie executive functioning) is intact, will be aware of the limitations imposed by their disability and are less likely to initiate behaviour that jeopardises their safety. In contrast, impulsivity, difficulties in problem solving, and an inability to benefit from feedback observed among patients with executive functioning impairment, places them at higher risk for accidents and demands the implementation of proactive intervention strategies (Rapport et al., 1998).

A study of falls in a geriatric stroke rehabilitation unit determined that 58% of falls were as a result of the patient performing activities or tasks contrary to the instructions of the rehabilitation team and that a significantly larger proportion of patients involved in such accidents were cognitively impaired (Nyberg & Gustafson, 1995).

In addition to the cognitive elements, a number of other factors have been highlighted as contributing to falls in people with cognitive impairment. These include changes in gait, balance, and central processing with respect to mobility tasks, direct effects and side effects of medications, orthostatic hypotension, and carotid sinus hypersensitivity (Shaw., 2002). Investigation of each of these areas and management directed to those identified may help to reduce the falls risk for a patient with cognitive impairment.

Despite cognitive impairment being an strong independent risk factor for falls in hospitals (Salgado et al., 1994; Stevenson et al., 1998; Shaw., 2002), there have been no randomised controlled trials in the hospital setting which have targeted this group. The successful RCT multifactorial falls prevention program in the sub-acute hospital setting included participants with cognitive impairment, so long as consent for participation was received from family or carers (Haines et al., in press). Sub-analysis was not performed to evaluate program effectiveness for the sub group with cognitive impairment. In the residential care setting, a sub-analysis of a randomised trial using a multiple intervention approach (Jensen et al, 2002b) identified a significant reduction in fractures in residents with marked cognitive impairment (Jensen et al., 2003). However, falls were not reduced in this sub-group.

Falls prevention management strategies for cognitively impaired older people in hospital are likely to be different from more broadly targeted falls prevention programs. This is an important area which has received very little research focus to date.

Possible intervention strategies for older hospitalised patients with cognitive impairment include:
- early diagnosis and treatment of medical conditions causing acute confusional states (Salgado et al., 1994);
- clear, precise instructions;
- use of clocks and calendars to provide some reality orientation (Creditor, 1993);
- immediate provision of assistance when requested;
- use of bed or chair alarms; and
- greater supervision of at risk patients (eg locate room close to nurses station, additional staff or use of volunteers) (Nyberg & Gustafson, 1995).
Innouye and colleagues (1999) reported a significant reduction in the rate of acute confusion (delirium) in hospitalised older people using a multidisciplinary intervention strategy. Six risk factors for confusion were targeted for the intervention: cognitive impairment, sleep deprivation, immobility, visual and hearing impairment, and dehydration. Strategies included: orientation boards, cognitively stimulating activities, nonpharmacologic sleep enhancement protocols, ambulation and exercises, use of visual aids and adaptive equipment, alternative communication techniques, and early recognition of dehydration. These strategies yielded some promising results, and warrant further evaluation in terms of health care costs, and other related outcomes such as mortality, re-hospitalisation, falls prevention, and residential care admission.

The lack of research in this area and its importance as a falls risk factor indicates that the role of cognitive impairment in falls and targeted falls prevention strategies need to be studied more extensively.

7.4.2 Other Models of Acute Care

7.4.2.1 Geriatric Care Units (GCUs)

Geriatric In-patient Care Units have been advocated as a means of restoring or optimising functional status of hospitalised older people in preparation for discharge (Huber & Kennard, 1991; Meissner et al., 1989). Older patients often experience a loss of physical functioning during the course of an acute illness requiring hospitalisation (Hirsch et al., 1990). This functional decline is often associated with prolonged hospital stay, waiting for the discharge destination to be determined and prepared (Palmer et al., 1994). Key components of specialised units for the older people include:

- an integration of geriatric assessment;
- direct patient-centred care;
- interdisciplinary involvement with regular meetings and inservices;
- a prepared environment; and
- home planning, with a focus on independent patient functioning (Palmer et al., 1994).

Several studies have evaluated the effectiveness of Geriatric Care Units (GCU) in maximising patient function (Landefeld et al., 1995; Rubenstein et al., 1984), comparing patients admitted to a GCU during their stay with those admitted to a medical unit of the same hospital. Using a randomised controlled study design, Rubenstein and colleagues (1984) reported that patients admitted to the specialised care unit were significantly more likely to improve their functional status and morale at one year follow-up than controls. In addition, these patients had significantly lower mortality than controls and were significantly less likely to have been discharged to a residential care facility or to have spent time in this setting during the follow-up period. In addition, the control group patients had substantially more acute-care hospital days, nursing home days and acute care hospital readmissions. The promising results may reflect the provision of more specialised screening examinations (eg audiology, ophthalmology, dentistry, psychology and social work) and follow-up care in a geriatric medical out-patient clinic for those on the GCU. Another randomised controlled trial investigated outcomes for older patients managed in a special unit designed to improve older patients’ functional independence compared to a group receiving usual care in a medical ward (Landefeld et al., 1995). Results of this study included that a significantly greater proportion of older patients were classified as “much better” with respect to functional independence at discharge, relative to the general medical ward group, and significantly fewer of those in the specialist unit group were discharged to long term care institutions. Hospital length of stay for
the two groups was similar. Neither of these studies used falls rates as an outcome measure, but they provide encouraging results in terms of short and long term functional gains and costs to the individual and the community for older people admitted to wards providing specialist geriatric care.

Several other studies have compared outcomes for older people admitted to GCU's relative to those admitted to medical or medical / surgical wards, though have not used a randomised controlled design (Huber & Kennard, 1991; Meissner et al., 1989). Huber and Kennard (1991) compared outcomes from a GCU and a medical surgical ward and identified improved level of function, slightly reduced length of stay, and slightly reduced costs associated with the GCU, although these differences were not significant for the groups overall. Another comparative study by Meissner and colleagues (1989) also identified improved function in the GCU patients, although hospitalisation costs were significantly increased compared to the control group. However, hospital readmissions over the subsequent 12 months were lower for the GCU patients.

**The effectiveness of Geriatric Care Units in reducing falls and falls related injuries during hospitalisation or in the period following discharge from hospital has not been investigated. Given the good evidence of this approach in improving functional outcomes, further research in this area is warranted.**

7.4.2.2  Hospital-in-the-home care

Home-based acute care has been advocated as an alternative to in-patient hospitalisation (Scott, 1999). It would appear to be feasible in specific cases of uncomplicated illness and certainly shows promise in controlled trials with respect to general health outcomes (Caplan et al., 1997). In the same way, the need for transfer into hospital settings from residential care settings may be avoided in some cases if staff of residential care facilities were able to provide intravenous therapy, careful fluid management, and elemental feeding (Scott, 1999).

Accelerated discharge programs, with associated intensive therapy in the home have been trialed with patients with several medical conditions (such as stroke and hip fracture) that have traditionally had the majority of their management conducted as a hospital in-patient. Randomised trials by Indredavik et al (2000) and Mayo et al (2000) have reported positive functional benefits associated with this approach for stroke patients, and Crotty et al (2001) have reported positive outcomes for patients with hip fracture. Falls rates have not been investigated in any of these studies. Given the high rate of falls which have been reported in the first month for patients discharged from hospitals generally (Mahoney et al., 2000), and the strong movement to earlier discharge programs, this is an important area for future research.

**Incidence of falls among older people utilising the home-based hospital model has not been explored, nor has the comparative effectiveness of falls prevention programs in the hospital as opposed to the home setting. Other associated issues which also need consideration include carer stress and incidence of other potential complications which may necessitate subsequent hospital re-admission.**
7.4.2.3  Day hospital care / Community Rehabilitation

Following discharge from the acute-care setting, it is important that effective transfer to appropriate community resources is made to ensure ongoing treatment and management. Day hospital or community rehabilitation care is one setting that has a pivotal position between hospital and home-based services and provides multidisciplinary assessment and rehabilitation. A systematic review was undertaken to determine the effectiveness of day hospital attendance in prolonging independent living for older people (Forster et al., 1999). Incorporating the results of 12 controlled clinical trials, day hospital care was compared with comprehensive care (a range of in-patient, out-patient and domiciliary geriatric services), domiciliary care (therapy provided in the patients home or day centre), and no comprehensive elderly care (patients who were eligible for, but not referred to, existing services). Overall there was no significant difference between day hospitals and alternative services for death, disability or use of resources, although the former group showed trends towards reductions in hospital bed use and placement in institutional care. Falls rates were not compared between settings.

A pilot project in the day hospital setting using a multidisciplinary approach targeting falls prevention has been reported by McQueen (2003). Referral criteria for inclusion in the falls prevention program were being cognitively unimpaired, being independently mobile (with or without a gait aid), having suffered at least one fall in the preceding 12 months, or expressing concern over fear of falling. The pilot program included eight once weekly sessions, incorporating graded exercise, home safety discussions, education on osteoporosis and diet, falls action planning, getting up from the floor, and social and recreational activities designed to improve balance. A pre-post methodology was used to describe outcomes for the first 11 people to complete the program. There were overall improvements in mobility, confidence, and reduction in self reported falls from 18 in the six months prior to the program, to three in the six months following the program.

Further research is necessary to determine the efficacy of out-patient services such as day hospitals / community rehabilitation centres in terms of cost effectiveness, improvements in functional status, prevention of falls and reduction in hospital and residential care admission rates. The referral process and continuity of care between services and settings is an important area for further investigation.

7.5  Multiple Strategy

The most common falls intervention approach described in hospital settings involves the implementation of multiple strategies, addressing general falls risk factors (untargeted), or addressing an individual’s falls risk factors following an assessment (targeted).

7.5.1  Targeted multiple strategy falls prevention programs

The majority of programs have been reported to consist of an initial assessment of falls risk on admission, with the subsequent development of an individualised care plan with the goal of preventing patient falls. Interventions strategies have included:

- increased patient observation (Lieu et al., 1997; Boswell et al., 2001; Mercer., 1997; Gowdy and Godfrey., 2003; Haines et al., in press);
- use of signs to alert staff/family regarding safety risk (Schmid, 1990; O’Connell and Myers., 2001; Gowdy and Godfrey., 2003; Haines et al., in press);
environmental modifications - eg. call bell system, restraint use. (Schmid, 1990; Mercer., 1997; Gowdy and Godfrey., 2003);

- bladder training (Hendrich et al., 1995; Mercer., 1997; Gowdy and Godfrey., 2003);
- assistance with and promotion of mobility (Mitchell & Jones, 1996; Mercer., 1997);
- patient reorientation and staff / patient / family education (Mitchell & Jones, 1996; Mercer., 1997; Gowdy and Godfrey., 2003; Haines et al., in press); and
- hip protectors ( Haines et al., in press).

Review of falls risk can vary from every shift, to every three days (Lieu et al., 1997), to weekly or to whenever the patient status changes (Schmid, 1990). This timing of review appears to be an important part of the process, with Stevenson and colleagues (1998) indicating that admission assessment may be less important than ongoing assessment in identifying falls risk. Indeed, despite promising results in the initial recording of patient falls risk, Uden and colleagues (1999) found that nursing care plans and evaluations of outcome remained unsatisfactory, with the authors indicating that more continuous evaluation was necessary. Issues associated with clinical falls risk assessment programs have been discussed in detail in Section 7.4.1.1.

In evaluating the effectiveness of these strategies, most studies have retrospectively audited falls incidents over a preceding time frame, and then compared this with data collected prospectively during the intervention phase of the study. Mitchell and Jones (1996) reported a trend for a reduction between the pre and post intervention phases, but this was not statistically significant. Schmid (1990) also found an initial decrease in the number of falls per patient day (54%) following the initiation of the program, but this averaged to a 20% decrease after 12 months. Both studies hypothesised that the reduction may be due to enhanced staff awareness and that strategies must be employed to maintain this over a longer time frame. Gowdy and Godfrey (2003) also reported over 40% reduction in falls rates following implementation of a multifactorial intervention in the hospital setting (using pre-post design methodology). A key conclusion from this study was that the culture change required to support improved patient safety takes substantial time, energy, and administrative support. Likewise, more than a 20% reduction in falls was reported in a rural hospital using a multiple intervention approach (Hathaway et al., 2001), and Brandis (1999) reported a 17% reduction in fallers and 33% reduction in falls injuries following a multiple intervention approach.

Using a slightly different model, Lieu and colleagues (1997) conducted a three phase study over three years in the geriatric ward of a Singapore hospital. Following phase one (retrospective review of falls), nursing staff were educated in falls prevention. Phase two involved the prospective collection of falls data, with the subsequent development of a simple nursing assessment protocol, which included a falls risk assessment and a checklist of actions to minimise falls occurrence. Phase three involved the prospective collection of falls data. The results indicated that the reduction in falls occurrence from phases one to two (with education only) was not statistically significant, but became significant after the implementation of the nursing assessment protocol. The development of a protocol by the staff themselves, and its ease of administration (less than five minutes) may have contributed to the results obtained in this study. Increased awareness alone (education), however, was insufficient to significantly reduce falls rate.

Although most of the falls prevention programs reported in this section have been developed and instituted by nursing staff, it is important to ensure that where possible, the full multidisciplinary team provides input into the identification of risk and management
strategies. This includes medical, physiotherapy, occupational therapy and where appropriate, podiatry and dietitian review.

The study by Haines et al (in press) utilised a multidisciplinary falls risk assessment to target intervention strategies. This randomised controlled trial is the only study of this type to demonstrate a significant (30%) reduction in falls in the hospital setting.

Further research is necessary to evaluate the effectiveness of a falls risk assessment tool, in conjunction with a multifaceted falls intervention protocol, in minimising the occurrence of falls and related injuries for a variety of hospitalised patients. The specific components required in such a protocol, may vary depending upon the patient population involved.

7.5.2 Untargeted multiple strategy falls prevention programs

A study by Patrick and colleagues (1999) described the implementation of standardised nursing intervention protocols on a geriatric rehabilitation unit in order to manage patients at high risk of falling. Six protocols were developed for patients with different levels of risk and independence. These addressed factors such as supervision, identification of high risk patients, visual alerts, mobility and transfers, toileting schedules, education of patient and family members and medication management. Protocols for dependent patients assessed to be at high risk for falling included visual alerts, seat belts for wheelchairs, constant supervision and for dependent patients at moderate to high risk, the use of bed-rails.

The use of an untargeted, multiple falls intervention protocol appears to have a role to play in the hospital setting, particularly in terms of increasing staff awareness to potential strategies for patients in a variety of risk categories. Further research is necessary to compare the effectiveness of targeted and untargeted strategies in preventing in-patient falls.

7.6 Other interventions

7.6.1 Feet and footwear

As in the community and residential care settings, the condition of the feet (e.g. pain, poor quality of nails, sensory impairment), and appropriateness of footwear can be important in limiting risk of falling. Patient footwear in hospitals is often inadequate, although there is very little published information in this area. A review in the sub-acute setting identified that 86% of patients did not have appropriate footwear, with over half wearing slippers (Hill et al., 2002). Inadequate footwear is likely to increase the risk of a fall in a given situation where balance is challenged. Similarly, 41% of patients were identified as in need of regular podiatry services for foot problems which could increase risk of falling (Hill et al., 2002). No randomised trials have evaluated interventions targeting improved footwear or footcare in the hospital setting, nor the community or residential care settings. One pre-post study identified reduced falls by residents in a residential care facility by introduction of treaded socks to improve foot grip, particularly where urinary incontinence was evident (Meddaugh et al., 1996). Given the prevalence and impact of poor footwear and foot pathology on balance and mobility, attention to these issues in clinical practice in the hospital setting, and as the focus of future research, is clearly indicated.
7.7 **Injury Minimisation**

7.7.1 **Physical and Chemical Restraints**

Physical restraints are defined as any mechanical or protective device applied to limit the free movement of the patient (Lee et al., 1999). Examples include: wrist or leg restraints, hand mitts, gerichairs with fixed tray tables, and full siderails (Frengley & Mion, 1998). The misuse of psychoactive medication has been reported in the literature and can be considered a form of chemical restraint (Tideiksaar, 1998). The author considered that inappropriate use would include: prescription in excessive doses, use as the sole treatment without investigation into alternative interventions, and administration for purposes of discipline or convenience of the staff.

Concern about the lack of effectiveness and safety of restraints has been growing in recent times. Data from studies performed in the United States of America has reported an incidence of physical restraint use in the acute care setting, ranging from 13% to 17% (Mion et al., 1989; Robbins et al., 1987). Interestingly, it would appear that these figures are not as high in the United Kingdom, where restraint use has been recorded in only 8.4% of patients (O'Keeffe et al., 1996). Higher rates have been reported in specific clinical populations. A prospective study of physical restraint use in the geriatric unit of an acute-care psychiatric hospital reported that the incidence of use was 27.1% (DeSantis et al., 1997), with similar figures reported in the rehabilitation setting (Mion et al., 1989; Schleenbaker et al., 1994). The use of bedrails is even more frequent (Hanger et al., 1999), and is considered standard care for older people in many hospitals.

The most commonly reported reasons for the use of physical restraints are:
- to prevent falls and subsequent injury (Lee et al., 1999);
- to prevent patient disruption of therapy (Frengley & Mion, 1998);
- to control patients exhibiting confusion or agitation (DeSantis et al., 1997); and
- inadequate staffing (Lee et al., 1999).

In the medical and surgical wards of an acute care hospital, abnormal cognition, surgery, and the presence of monitoring and support devices (e.g. intravenous lines) were significantly associated with restraint use (Robbins et al., 1987). In the psychiatric setting, patients with a diagnosis of dementia, impaired mobility, and behavioural problems were the most likely to be restrained (DeSantis et al., 1997). In the rehabilitation setting, decreased mental status, low admission Functional Independence Measure (FIM) score, and stroke or traumatic brain injury were associated with restraint use (Schleenbaker et al., 1994).

There has been considerable controversy in the research literature about the use of physical restraints, with reports that they may actually increase agitation and falls (Tinetti et al., 1992). Arbesman and Wright (1999) identified significant odds ratios for falling for people who were physically restrained within seven days prior to a fall, compared to randomly selected, length of stay matched controls. Bakarich and colleagues (1997) identified that 15% of falls occurred despite use of restraints. In addition, negative perceptions regarding the use of restraints have been reported by the patients themselves (Mion et al., 1989) and family members (Kanski et al., 1996). Hospitals have been found liable both for the use of physical restraints and for not using them (Frengley & Mion, 1998). Certainly, there is an ethical dilemma around emphasising patient safety at the expense of patient autonomy, and this may be influenced by factors such as the ratio and level of training of nursing personnel, the use of medications and cultural or political issues (Frengley & Mion, 1998).
Queensland Health have recently published guidelines for restraint reduction in health care settings (Queensland Health, 2003). These provide a useful framework for implementing practice change in the area of restraint use reduction, including a strong emphasis on observation and evaluation, and staff education.

*Guidelines for controlling the use of physical and chemical restraints in the hospital setting need to become the standard for customary practice, be incorporated into hospital policy and be used as the appropriate legal standard that defines the parameters of liability.*

7.7.1.1 **Restraint reduction**

Education of staff, patients and family is an important component of restraint reduction in the acute care setting (Frengley & Mion, 1998). A study by Lee and colleagues (1999) in Hong Kong determined that, in general, the knowledge of nursing staff as to the potential physical and psychological consequences of restraint use was inadequate. This highlights the need for more intensive education and research regarding the impact and efficacy of restraints, the current regulations regarding their use and the availability of potential alternatives. Tideksaar (1998) described a number of strategies that could be implemented as alternatives to the use of restraints, and these mirror those reported in a multifactorial falls prevention program. These may include:

- additional nursing supervision;
- assistance from family;
- exercise;
- instruction on safe transfers;
- regular toileting;
- medication review; and
- environmental modification (such as alternative seating, lower bed heights, alarms, accessible call light).

It is only more recently that bedrails (cotsides) have been routinely considered as a form of physical restraint (Frengley, 1999). Increasing attention has been given to the use of bedrails as part of a falls prevention strategy, following work by Parker and Miles (1997) who reported the potential for serious injury and possible death following their use, as well as considerable psychological and physical distress (Schott, 1999). A study by Hanger and colleagues (1999) in New Zealand appears to be the first of its kind to evaluate the use of bedrails in the acute care setting. Bedrail use and falls rates were recorded before and after the implementation of a “bedrail policy” and staff education program. The policy was introduced to discourage overuse of the bedrails, and education was provided regarding appropriate alternatives (for example: quiet single rooms, mattress on the floor, familiar staff, nightlights, regular toileting, and treatment for the cause of confusion or agitation). The results indicated a significant reduction in bedrail use following the intervention, but no significant change in fall rates. Importantly, however, serious injuries were significantly less common after the bedrail policy was introduced, with fewer head injuries. These findings are similar to those reported when physical restraints were removed in the residential care setting. The use of a structured educational intervention, combined with routine consultation by an advanced practice nurse, demonstrated successful restraint reduction in this residential care population and may be another approach that can be utilised in the acute care setting (Evans et al., 1997).

A pre-post study was undertaken in 14 wards in two acute hospitals (primary medical, surgical, and neurology / neurosurgery wards, including intensive care units) with the aim of
reducing physical restraint use by addressing administrative, educational, consultative and feedback factors considered important in achieving practice change in this area (Mion et al., 2001). An extensive range of alternatives to restraint use were implemented throughout the study. Over a 12-15 month period, physical restraint use was reduced by more than 20% in half of the wards. Falls rates were monitored in four of the wards, and in each case falls rates declined with the reduction in restraint use, and there was no increase in patient injuries from falls.

Promising results, in terms of a reduction in injurious falls, have been reported from research into programs aimed at reducing physical restraint usage in the residential care setting, and recently in the hospital setting. There is a need for well controlled randomised studies to clearly identify the effectiveness of restraint reduction programs, in terms of falls and related injury reduction, staff and patient compliance and cost –effectiveness, in the hospital setting. The efficacy of possible alternatives to restraint use also requires evaluation.

7.7.2 Hip protectors
As in other settings, hip protectors have potential to reduce hip fractures in high falls risk patients. There have been no randomised controlled trials of the effectiveness of hip protectors in the hospital settings, despite moderately strong evidence for their effectiveness in residential care settings. The RCT study by Haines et al (in press) utilised hip protectors as one of four interventions, and demonstrated a 28% (non-significant) reduction in injuries, although there was no difference in hip fractures between the intervention and control group.

There is a need for well designed studies to evaluate hip protector use for high falls risk patients in the hospital setting.

7.7.3 Increased surveillance
A number of approaches have been reported to increase the ability to identify when a high falls risk patient is getting out of a bed or chair without supervision.

7.7.3.1 Bed alarm and other monitoring systems

Bed alarm systems have been advocated as an alternative to the use of physical restraints in preventing in-patient falls (Tideiksaar et al., 1993). These devices warn nursing staff when patients who are unsafe to leave their beds unassisted, are attempting to do so. A study by Tideiksaar and colleagues (1993) evaluated the efficacy of such a system in reducing the number of falls in the geriatric unit of an acute care hospital. Patients with an increased risk for bed falls were randomly assigned to an intervention (bed alarm system) or a control group (no alarm). On nine month follow-up, no significant difference in the number of bed falls was found between the groups, although there was a trend toward reduced falls in the intervention group. The system was found to operate well and nurses were able to respond to the majority (92%) of alarm activations in less than one minute. In addition, the use of mechanical restraints to prevent falls declined in the group using the alarm system, suggesting that this may be a viable alternative to physical restraint use and frequent patient observations to prevent falls.
Other systems to increase monitoring of high risk patients, such as the NOCwatch® system reported in the residential care setting (Section 5.7.3) may have potential application in high risk patients in the hospital setting.

7.7.3.2 “Sitters”

Sitters are people who have the role of sitting with patients at high risk of falls, and seeking assistance if these people try to stand up from the bed or chair unsupervised. Sitters may be family members / friends of the patient, trained volunteers (non-nursing), or paid individuals with little or no healthcare background (Boswell et al., 2001). In some instances, several high risk patients are located in the same room with a sitter.

There has been very little research published investigating the effectiveness of sitters. One study identified a small increase in falls rates but improved patient satisfaction with staff response to call bells and overall care when paid sitters were used in a hospital setting (Boswell et al., 2001). Further research is indicated to determine the usefulness of this approach to increasing surveillance.

7.7.3.3 High visibility locations

Placing high risk patients in high visibility areas, eg near the nurses’ station, is a strategy that is often considered and implemented in the hospital setting. Appropriate placement not only enables staff to observe the patient but also quickly intervene if at risk behaviour is demonstrated. Although to date there are no studies that have evaluated the effectiveness of this strategy it is a simple strategy that relies more on logistics and planning rather than any additional resources.

7.7.3.4 Identification bracelets and other identifiers of falls risk

One of the few randomised controlled trials to be described in the hospital setting, was performed to evaluate the efficacy of identification bracelets in preventing falls in a rehabilitation hospital (Mayo et al., 1994). Patients at high risk for falling were randomly assigned to an intervention or control group. The intervention group was given an identification bracelet, in addition to the usual hospital band, and this was to act as a reminder for patients to be vigilant about falls risk when moving around the hospital. The control group did not receive this bracelet and had to remember independently to be careful. After one year, no significant difference was found between the groups in terms of falls rates, indicating that a simple warning to patients is insufficient to reduce risk of falls, and other intervention strategies are necessary to achieve change.

Identification bracelets, falls risk alert cards and other falls risk identifiers, have been used as part of several multiple intervention falls prevention projects in hospitals. These studies have shown mixed results using pre-post research designs (O’Connell and Myers, 2001; Mercer, 1997; Haines et al., in press).

When using fall risk identifiers it is important that protocols are established so that all staff are aware of what action needs to be taken when an at risk person, as indicated by the identifier, is seen ambulating independently or undertaking any other high risk activity.

More research needs to be done to evaluate the efficacy of bed alarm systems and other alternative strategies to increase surveillance of high falls risk patients, in reducing falls
and injuries among older people in hospital settings. The costs involved and the efficacy of the approach in a variety of hospital settings would be important factors requiring consideration.

7.8 Discharge planning and post-discharge follow-up

Falls are a common problem for older people being discharged home from hospital, with 15% reporting falls in the first month after return home, and 11% of these falls resulting in serious injuries (Mahoney et al., 2000). As such, hospital discharge planning needs to have a stronger focus on falls prevention. Several randomised controlled trials have evaluated the effectiveness of improved follow-up post discharge from hospital on a range of outcomes, including reducing falls after returning home.

Nikolaus and Bach (2003) conducted a randomised control trial to determine the effectiveness of a home intervention team that provided an environmental hazards assessment, advice, modification and training in the use of technical and mobility aids provided. Three hundred and sixty older people (mean age 81.5) showing functional decline, especially in mobility, and living in the community were recruited while they were in-patients in a geriatric hospital. Both groups received a comprehensive geriatric assessment but the intervention group received a diagnostic home visit while the control group received usual care at home. There was a three month follow-up visit to check compliance and to address any additional problems. At one year follow-up there was a significant reduction in the number of falls in the intervention group, and sub group analysis looking at participants with a history of falls found that in the intervention group both the proportion of frequent fallers, and the rate of falls were significantly reduced. There was a significant reduction in the rate of falls for participants in the intervention group who implemented at least one recommended change.

Hauer et al (2001 and 2002) also identified significant improvements in strength, balance and function, with a three month, three times weekly, centre based exercise program targeting these parameters, with some of these benefits maintained three months following completion of the program. The intervention group undertook the exercise classes in addition to routine therapy. Falls incidence reduced by 25% in the intervention group, although this difference was not statistically significant.

7.9 Cost effectiveness

The Quality in Australian Health Care Study (1994) was commissioned to determine the frequency, nature and outcomes of adverse effects in acute care hospitals (Wilson et al., 1995). Of 14,179 cases reviewed (in New South Wales and South Australia), 17% were associated with an adverse event, with three percent of these involving a fall. These adverse events were considered to be caused by healthcare management rather than a disease process, and lead to hospitalisation, prolonged hospital stay (average of seven days), increased morbidity at discharge, or death. Admissions associated with adverse events increased over the age of 30 and those resulting in more serious disability or death increased markedly with age. Over half were judged to have high preventability by the use of appropriate strategies, but this was not strongly associated with age. Those adverse events involving a fall were found to be highly preventable in 62% of cases. It was estimated that the direct hospital costs of preventable adverse events in Australia in 1992 amounted to nearly $A900 million per annum (Rigby et al., 1999). Additional health care costs associated with in-patient falls have been cited as extended lengths of stay, added diagnostic procedures and/or surgeries, and litigation.
(Hendrich et al., 1995). It was suggested by Rigby et al., (1999) that if some of these events could be prevented, then the funds spared could be used elsewhere in the healthcare system.

Some interesting studies evaluating the effectiveness of Geriatric Care Units (GCUs), reported greater functional improvements (compared with patients treated on a medical unit in the same hospital), at minimal (Meissner et al., 1989), or even slightly lower (Rubenstein et al., 1984) direct costs for hospital care (the latter study being a randomised controlled trial). Indeed, patients assigned to the GCUs had lower mortality, were readmitted to the acute hospital less frequently (Meissner et al., 1989; Rubenstein et al., 1984), and were less likely to have been admitted to a nursing home (Rubenstein et al., 1984). These promising results have indicated that specialised units within the acute care setting can improve outcome, with the costs of providing the service more than recouped over time by savings in the use of other services, such as acute hospitalisation and nursing home care. Unfortunately, falls rates and resultant injury were not compared between the settings in these studies.

Bates and colleagues (1995) undertook a retrospective case control analysis of fallers in an acute hospital setting. Controls were randomly selected from patients who did not fall during the same time period, but were matched to fallers on gender, age, and length of stay until the time of the fall. Using multivariate analyses, falls were independently correlated with increased length of stay, and total costs associated with hospitalisation. On average, fallers had a length of stay 12 days longer than the non-faller controls, and had an estimated increase in hospitalisation costs of $US4,233 for each faller. Likewise, in a psychiatric hospital setting, a retrospective case note review identified that recurrent falls were significantly associated with increased length of stay (Greene et al., 2001).

Falls in hospitals are associated with increased length of stay and increased costs, yet there are currently few published randomised controlled trials in this setting to guide practice. More research is necessary to improve patient safety and minimise falls in a variety of hospital settings, with the development, and implementation of well-researched, appropriate intervention strategies. The subsequent benefits must be evaluated in terms of falls and injury reduction, costs to the health care system, and long-term maintenance or improvement of function for the individual.

7.10 Compliance and sustainability

In the hospital setting, as in residential care, patient and facility factors influence compliance with, and sustainability of, falls prevention strategies. A review of the literature highlights the need for greater emphasis to be placed on these factors, with the majority of studies providing data over a limited time frame. Few studies consider falls and functional status on long-term follow-up following discharge from the hospital setting. Factors influencing compliance and sustainability include:

- lack of established policies and procedures regarding falls and injury prevention. Uden (1999) reported an increase in the recording of falls risk assessment (from 0-96%) following the implementation of a risk assessment and recording program, but commented that nursing care plans and evaluations of outcome remained unsatisfactory. Likewise, Schmid (1990) found that an initial decrease in fall numbers per patient day (54%), following initiation of the program, had averaged to a 20% decrease after 12 months. This highlights the importance of ongoing evaluation of falls prevention programs and strategies to enhance long-term compliance;

- staff and patient compliance with the protocol. Bakarich (1997) reported failure to comply with a toileting intervention in 58% of nursing shifts and determined that this influenced the
results in terms of falls reduction. Similar problems have been reported by Forrester et al (1999);
- staff ratios, education and training. Lieu (1997) hypothesised that a protocol that was easy to administer and involved some form of staff “ownership” may be more effective in terms of falls and injury reduction;
- cultural and religious beliefs and language barriers;
- limited communication between different programs within a hospital that have potential impact on falls prevention (O’Connell and Myers., 2001);
- inadequate provision of resources (e.g. bed alarm systems, specialised care units, levels of staffing); and
- procedures and services for assessment and management for older people identified at risk, after their discharge from hospital.

Further research is necessary to address issues of hospital policy, staff training, provision of resources, and cultural factors in terms of compliance with, and sustainability of, falls prevention strategies in the hospital setting and following discharge.

7.11 Cultural Issues

The majority of studies performed to investigate falls intervention strategies in the hospital setting have been undertaken in the United States of America, Australia, New Zealand and Europe. In each of these countries or regions there is a broad multicultural diversity in areas such as language, religion, and mental and physical health status (Hilton, 1996). Certainly, health issues differ between ethnic groups, with Aboriginal and Torres Strait Islander people, Afro-Caribbean and Asian groups, for example, having a higher incidence of hypertension and diabetes mellitus than the white population (Hilton, 1996). These factors will influence rates of hospitalisation, mortality and reports of disability (Donovan, 1995).

It would appear, however, that there are inequalities in the availability and use of health services among minority ethnic groups (Donovan, 1995; Hilton, 1996). In addition, cultural beliefs may influence attitudes to hospitalisation, including expectations of the service, response to health education (such as falls prevention strategies), participation in intervention strategies (such as exercise, medication reduction, hip protector use) and subsequent compliance with recommendations. In addition, failure to address dietary needs may exacerbate issues of malnutrition, and language barriers may impede the development and implementation of strategies which need to be addressed using bilingual staff or interpreters. Cultural awareness training needs to be considered for all staff to improve their confidence and skills in providing holistic care (including falls prevention initiatives) for older patients from Culturally and Linguistically Diverse backgrounds in the hospital setting.

To date there is no data available on falls occurrence rates in the hospital setting for different ethnic groups, including Aboriginal and Torres Strait Islander people, and no published studies discussing necessary adaptations to falls intervention strategies to accommodate cultural differences and beliefs.

8. Workforce training issues

Workforce training has been identified in all three sectors reviewed for this report - community, residential care, and hospital - as a key approach in falls prevention. It has often been considered under the umbrella of ‘staff education’, and has been a frequently utilised
Despite this, there is very little evidence in the research literature that the current models incorporated under this umbrella are effective at all in reducing falls and falls injury rates. Much of the research into falls prevention programs that include educational interventions highlights that ‘information’ is often confused with ‘education’. There appears to be little systematic attention paid to the elements of educational design that need to be considered for information and increased knowledge to make a difference to the behaviour and actions of health care workers, who in turn may be able to play a key role in falls and fall related injury prevention.

There is a need for a sustained, systematic and learner-centred approach to the education and training of the workforce to ensure that educational solutions are greater than the provision of written or spoken information. For health workers in the community setting, a curriculum developed using the methodology of that utilised by Kerse and colleagues (1999) may be effective in the area of falls and injury prevention. This involved a series of health promotional lectures where health professions, in this case GPs, participating in the program were asked to incorporate the information learnt over the two to three month period into daily practice and to pass on health promotion advice to patients as appropriate (see Section 3.1.2). A similar study is required with other health workers in the community whose contact with older people could be used to promote the prevention of falls. For this study to occur, more needs to be known about how to influence these workers’ motivations, attitudes and knowledge level.

In the area of medical education, Davis and colleagues (1995) published a systematic review of 166 educational interventions aimed at changing doctors’ behaviour. They found that the usual didactic continuing professional education is relatively ineffective. Other approaches such as academic detailing and education by opinion-leaders were found to be more effective (Davis et al, 1995). These could be applied in falls-prevention programs for general practitioners and facility staff.

The area of continuing professional education is complex and has been the subject of little rigorous study. While there is considerable focus in the education literature on principles of learning and teaching, there is little application or testing of this in practice (Dymock et al., 1994; Hager et al., 1997). While seemingly simple to design and deliver, an in-service program, utilising a didactic approach of provision of information, with some opportunity for questions, may not be the best approach to achieving long term behaviour change in both staff and patients or residents in hospital and residential settings. Instead, the basics of good teaching for effective learning need to be applied: meaningfulness, engagement, reflection, repetition and reinforcement, reward, opportunity for practice and correction, and multisense teaching techniques.

Essentially, learners need to be provided with appropriate opportunities to engage with the information and ideas that they are expected to use to bring about behaviour/practice change. Also, the learning needs to be integrated with work practice where possible. For example, project-based learning, induction, performance review and reflecting on learning in team meetings are all opportunities for optimising learning through work. Particularly in hospital and residential care settings, incorporation of active interaction between all key players, investigating key issues within the specific setting, and identifying barriers and motivators for change within these settings, may facilitate the effectiveness of workforce training and result in improved change in behaviour (Lindeman et al., 2000; Lindeman et al., 2002). These approaches provide some positive indication for future directions in workforce training, but warrant investigation as to the most effective elements in achieving the desired behavioural change with resultant improvement in falls outcomes.
Adoption of a standard falls prevention ‘package’ approach to staff education in any of the three sectors is temptingly easy but deserving of serious consideration before design and implementation decisions are made. A large-scale randomised, controlled trial of an educational program to prevent work-associated lower back injury found no long term benefits associated with training. In that study, Daltroy and colleagues (1997) suggested that failure to change behaviour reflects complex factors such as the workers’ level of job satisfaction and negative perceptions of what supervisors and co-workers were doing to improve back safety. They suggest that workplace issues, including management style, may ultimately determine the success or failure of such programs. The organisational context for staff education and training is a key factor that will help or hinder staff learning and changing practice in the area of falls prevention – particularly with regard to staff and management attitudes, that are the basis of the behaviour. It is critical that these factors are acknowledged when processes for learning about falls and falls prevention in particular settings are being designed and promoted.
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### Table of Level II (Randomised Controlled Trials) studies demonstrating effectiveness of interventions in reducing falls or falls related injuries in community dwelling older people.

<table>
<thead>
<tr>
<th>Authors(s), year of publication, country, study aims and length of study</th>
<th>Study population and nature of intervention</th>
<th>Evidence of intervention effects</th>
<th>Level of evidence</th>
</tr>
</thead>
</table>
| **Barnett et al, 2003, Australia (reference 9)**  
Randomised controlled trial to determine whether participation in a weekly group exercise programme with ancillary home exercises improves balance, muscle strength, reaction time, physical functioning, health status and prevents falls in 'at risk' community dwelling older people.  
1 year | Community dwelling older people (n=163); aged > 65 years and identified as 'at risk' of falling.  
1. Intervention: Weekly structured exercise group run in a community setting conducted by an accredited instructor. 1 hour classes over 4 terms for 1 year (37 classes) with progressive work, included provision of home programme with diaries to record participation, and received information re practical falls prevention strategies.  
2. Control: Received written information about falls prevention strategies. | Intervention Group:  
- performed significantly better than the control group in three of six balance measures (but not in measures of strength, reaction time and walking speed or on Short-Form 36, Physical Activity Scale for the Elderly or fear of falling scales).  
- the rate of falls was significantly (40%) lower than the control group (IRR=0.60, 95% CI 0.36-0.99).  
- had non-significantly (34%) fewer injurious falls and a lower proportion of fallers than controls. | II |
| **Buchner et al, 1997, USA (reference 28)**  
(Seattle FICSIT site)  
Randomised controlled study to evaluate the effect of strength and endurance training on falls risk.  
6 months | Community - dwelling adults (n = 105) aged > 65 years, with reduced balance and strength.  
Participants randomly allocated to one of four groups:  
1. Intervention (endurance): Stationary bike (supervised)  
2. Intervention (strength): Resistive exercise of upper and lower body (supervised)  
3. Intervention: Strength and endurance training (supervised)  
4. Control | · No significant differences on balance, gait or physical health status between groups  
· Exercise had a protective effect on risk of falling (relative risk = 0.53 95% confidence interval (CI) 0.3-0.91)  
· 7 - 18 months later, control subjects had more out-patient clinic visits (p<0.06) and were more likely to sustain hospital costs >$5000 (p < 0.05) | II |

IG = intervention group; CG = control group; HP = hip protectors; CI = confidence intervals

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<table>
<thead>
<tr>
<th>Authors(s), year of publication, country, study aims and length of study</th>
<th>Study population and nature of intervention</th>
<th>Evidence of intervention effects</th>
<th>Level of evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cameron et al, 2003, Australia (reference 36)</td>
<td>600 females living in own home, aged 74 years of age or more (mean age 83 years), who had two or more falls or one fall requiring hospital admission in the previous year. 1) Intervention: Hip protector use (and 3 visits and 2 phone contacts by a adherence nurse). 2) Control.</td>
<td>• On an intention to treat analysis there was no difference in the number of hip fractures that occurred in the intervention (21) and control (22) groups. • However the risk of hip fracture when falling while wearing hip protectors, compared with a fall with no hip protectors in place, was significantly reduced (relative risk (RR) 0.23, 95% confidence interval (CI) 0.08 to 0.67).</td>
<td>II</td>
</tr>
<tr>
<td>Campbell et al, 1997, NZ (reference 41)</td>
<td>Community - dwelling, older women (n = 233), aged &gt; 80 years. 1. Intervention: Customised home program of strength, balance and flexibility exercises plus outdoor walking 3 x per week. Supervised by physical therapist. 2. Control: Usual care and social visits.</td>
<td>• Mean rate of falls was lower in exercise than control group (difference 0.47; 95% CI = 0.04 - 0.90) • Relative hazard for a first fall with injury in exercise compared with control group was 0.61 (0.39 to 0.97)</td>
<td>II</td>
</tr>
<tr>
<td>Campbell et al, 1999, NZ (reference 42)</td>
<td>Community - dwelling, older women (n = 103), aged &gt; 80 years (2 year follow-up of 1997 study). 1. Intervention: Customised home program of strength, balance and flexibility exercises plus outdoor walking 3 x per week. Supervised by physical therapist. 2. Control: Usual care and social visits.</td>
<td>• The rate of falls remained significantly lower in the exercise group than in the control group. • The relative hazard for falls in the exercise group was 0.69 (95% CI, 0.49 - 0.97) • The relative hazard for falls resulting in moderate or severe injury was 0.63 (95% CI, 0.42 - 0.95)</td>
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IG = intervention group; CG = control group; HP = hip protectors; CI = confidence intervals
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<td><strong>Campbell et al, 1999, NZ (reference 43)</strong></td>
<td>Community – dwelling adults (n = 93), aged &gt;65 years, currently taking psychotropic medication. 1. Intervention (a): Gradual withdrawal of psychotropic medication compared to control group continuing to take medication 2. Intervention (b): Home-based exercise program compared to control group continuing usual activities.</td>
<td>- The relative hazard for falls in the group withdrawing from medication compared with those taking original medication was 0.34 (95% CI, 0.16-0.74)  - The risk of falling for the exercise group compared with those not exercising was not significantly reduced</td>
<td>II</td>
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<td><strong>Carpenter and Demopoulos, 1990, U.K. (reference 49)</strong></td>
<td>Community dwelling adults (n = 539), aged &gt; 75 years 1. Intervention: Regular home visits by volunteers with appropriate referral to general practitioner or social services. 2. Control</td>
<td>- Number of falls reported in the control group doubled and in the intervention group remained unchanged.  - The intervention group received community support services sooner than the control.</td>
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<td><strong>Chapuy et al, 1992, France (reference 52)</strong></td>
<td>Older women living in apartment buildings or in nursing homes (n = 3270), aged &gt; 69 years 1. Intervention: Vitamin D₃ + Calcium supplementation 2. Control: Double placebo</td>
<td>- Number of hip fractures was 43% lower (p = 0.043) in the intervention compared with the control group  - Bone mineral density of proximal femur increased (2.7%) in intervention group + decreased (4.6%) in the control group</td>
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| Close et al, 1999, UK (reference 60) | Community - dwelling adults (n = 397) aged > 65 years, who had attended an emergency department because of a fall 1. Intervention: Medical and occupational therapy assessment with referral to relevant services if indicated 2. Control: Usual care | • Risk of falling was significantly reduced in intervention group (odds ratio 0.39 [95% CI 0.23 - 0.66] as was the risk of recurrent falls (0.33 [0.16 - 0.68] )  
• Odds of admission to hospital were lower in the intervention group (0.61 [0.35 - 1.05] ) | II |
| Cumming et al, 1999, Australia (reference 78) | Community – dwelling adults aged > 65 years. 1. Intervention: Occupational therapy home assessment, with recommendations and telephone review. 2. Control: Usual care | • 36% of subjects in the intervention group had at least one fall during follow-up, compared with 45% of controls (p = 0.05)  
• Among subjects with a history of falls, the intervention reduced the proportion of fallers by 36% (p = 0.001).  
• The intervention was not effective among people with no history of falls. | II |
| Day et al, 2002, Australia (reference 86) | 1090 people aged 70 and over living at home in the City of Whitehorse. Most were Australian born, aged between 70-84 and rated their health as good. Interventions: Exercise, home hazard modifications, vision improvement (combined into 8 groups defined by the presence/absence of each intervention). | • There was a significant benefit for exercise alone (rate ratio for exercise was 0.82 (95% confidence interval 0.70 to 0.97, P=0.02), and a significant effect (P<0.05) for the combinations of interventions that involved exercise.  
• Home hazard management and vision improvement showed no significant effect.  
• The strongest effect that was observed was for all three interventions combined (rate ratio 0.67 (0.51 to 0.88, P=0.004). | II |

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| Harwood et al, 2004, United Kingdom (reference 143)  
Randomised controlled trial to determine the effects of various calcium and vitamin D regimes on bone biochemical markers, bone mineral density and falls rates.  
1 year | 150 older women recruited after hip fracture surgery.  
Interventions: Compared a single injection of 300,000 units of vitamin D(2), injected vitamin D(2) plus 1 g/day oral calcium, 800 units/day oral vitamin D(3), with control group (no treatment). | . Whether injected or taken orally, vitamin D treated groups showed an increase in bone mineral density suppression of parathyroid hormone and reduced falls. The relative risk of falling in the vitamin D treated groups was 0.48 (95% CI 0.26-0.90) compared to controls.  
. The effect was more apparent in the group also receiving calcium co-supplementation. | II |
| Hogan et al, 2001, Canada (reference 163)  
A randomised controlled trial to assess effectiveness of a standardised, multifaceted, in-home assessment and ensuing care plan in reducing the likelihood of further falls in older people who have fallen compared to usual care.  
1 year | Community dwelling older people aged 65 and over who had fallen in the previous 3 months.  
1. Intervention: Multifaceted in-home assessment (individual and environmental risk factors) and specific care plan.  
2. Control: Usual care. | . There were no significant differences between groups in the number of falls, the proportion of single or multiple fallers or percentage of falls resulting in an emergency department or hospital visit.  
. Sub group analysis found that those with an 80% adherence had fewer (non-significant) falls, and those with 2 or more falls had significantly less falls and a significantly longer time between falls in the intervention group. | II |

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<td><strong>Hombrook et al, 1994, USA (reference 164)</strong></td>
<td>Community - dwelling adults aged &gt; 65 years. 1. Intervention: Home assessment with encouragement to remove or repair hazards Group sessions addressing behavioural environmental &amp; physical risk factors Home exercise program 2. Minimal - Treatment control: Advice on home safety</td>
<td>· Intervention had a statistically significant effect on odds of being a faller (OR = 0.85, p&lt;0.05) · Only 7% reduction in average number of falls in intervention group · Inconclusive results</td>
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<td><strong>Kenny et al, 2001, UK (reference 192)</strong></td>
<td>Patients 50 years and over attending an emergency department with non-accidental falls and diagnosed with cardioinhibitory carotid sinus hypersensitivity (CSH). 1. Intervention: A rate drop response physiologic dual-chamber pacemaker implant. 2. Control: Standard treatment.</td>
<td>· Falls (without loss of consciousness) were reduced by 70%. The CG reported 669 falls (mean 9.3; range 0 to 89), and IG reported 216 falls (mean 4.1; range 0 to 29) at follow-up. This applied to single and multiple fallers. · Injurious events were also reduced by 70% (202 injuries in the CG compared to 61 in IG). · Syncopal events at follow-up were also reduced, though not significantly (28 episodes in paced patients and 47 in controls). There was a significant reduction in syncope events in participants with a history of recurrent falls in the IG compared to CG (p=0.04).</td>
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| **Lord et al, 2003, Australia (reference 234)**  
A study to determine whether falls could be prevented in frail older people living in retirement villages using group exercise designed to improve activities of daily living.  
1 year | 551 frail older people living in retirement villages (self-care and intermediate-care) aged 62-95.  
1. Intervention: group exercise (most weight-bearing exercises), consisting of one hour/twice weekly classes over a 12 month period.  
2. Control: Two groups, one attending a one hour/twice weekly flexibility and relaxation classes and one not taking part in any group activity. | • At one year follow-up, adjusting for age and gender, there were 22% fewer falls in the exercise group than the combined control groups and 31% fewer falls in the 173 subjects with a history of previous falls.  
• At six month retest the exercise group performed significantly better in simple and choice reaction time and 6 minute walk tests, though not in knee extension strength and standing balance. | II |
Randomised controlled study to investigate the effectiveness of weightbearing exercise on bone mineral density and falls  
2 years | Community - dwelling female volunteers (n = 118), aged > 60 years.  
1. Intervention: Group exercise class involving weightbearing exercise to music, plus calcium supplementation  
2. Control: Calcium supplementation | • Difference between groups in numbers of falls was significant between 12 - 18 months into the study (p = 0.011)  
• Modestly significant increase in bone mineral density in exercise group, compared with a decline in the calcium only group | II |
| **Nikolaus & Bach, 2003, Germany (reference 287)**  
A randomised controlled trial of the effectiveness of a home assessment and intervention program in reducing falls.  
1 year | Community living frail older people (n = 360) experiencing a decline in functional capabilities, especially mobility.  
1. Intervention: One home visit during hospitalisation to assess home and prescribe technical aids where necessary, and at least one visit after discharge to inform subjects of risks identified, give advice re changes, facilitate modifications, & train IG participants in use of any technical/mobility aids.  
2. Control: Usual care. | • 31% fewer falls in IG (IRR = 0.69, 95% CI = 0.51-0.97 (P=0.032) but no significant difference in proportion of frequent fallers between groups.  
• For those with a history of falls: proportion of frequent fallers was reduced (P=0.009), and a 37% lower fall rate in the IG sub group (IRR = 0.63.9, 95% CI = 0.43-0.94.7 (P=0.028). | II |

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| **Robertson et al, 2001a, NZ (reference 341)**  
A randomised controlled trial to assess the effectiveness of a trained district nurse individually prescribed home based exercise programme to (1) reduce falls and injuries and (2) estimate cost effectiveness of programme.  
1 year | Community living men and women aged 75 and older.  
1. **Intervention:** Individual exercised program (muscle strengthening and balance training)  
2. **Control.** | **Evidence:**  
- Falls reduced in the 80 and older group but not 75-79 age group.  
- Fewer serious injuries, but same moderate injuries. Savings calculated at of $NZ576 per fall prevented & $NZ1563 per injurious fall prevented for the 80 and older group. | **II** |
| **Robertson et al, 2001b, NZ (reference 342)**  
A controlled trial in multiple centres to assess the effectiveness of trained nurses based in general practices individually prescribing a home exercise programme to (1) reduce falls and injuries and (2) estimate cost effectiveness of the programme.  
1 year | Community living men and women, 80 and older - 3 exercise centres and a similar mix of 4 towns to act as control centres.  
1. **Intervention:** Individual exercise program (muscle strengthening & balance training)  
2. **Control.** | **Evidence:**  
- Reduction in falls (30%) and falls injuries in the intervention centres compared to control centres.  
- There were no significant differences in number of hospital admissions due to falls injury or in costs. However, cost effectiveness was hard to gauge as the sample size was based on falls and not injury rates. | **II** |
| **Steadman et al, 2003, UK (reference 385)**  
A randomised controlled trial to evaluate the effectiveness of an enhanced balance training program in improving mobility and well-being of older people with balance problems.  
24 weeks | 198 patients aged 60 and older with a Berg Balance Scale (BBS) score of less than 45 recruited from a multidisciplinary falls clinic.  
1. **Intervention:** 6 week enhanced balance training consisting of a series of repetitive tasks of increasing difficulty specific to functional balance.  
2. **Control:** Conventional therapy.  
Both groups received instruction and practice in getting up from the floor. | **Evidence:**  
- Both groups showed improvements in Berg Balance score, number of falls, Falls Handicap Index, and Fenchay Activity Index at 6 week and 24 weeks.  
- The IG showed a significant difference in the timed walk (P=0.001) and quality of life measure (P=0.04) (compared with P = 0.54 & P = 0.07 respectively for the CG.) | **II** |

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<td>Steinberg et al, 2000, Australia (reference 387)</td>
<td>252 volunteers recruited from 10 branches of a seniors association representing a community group of active Australians aged 50 and over. Interventions: Group 1 (control) received education, Group 2 received education and exercise, Group 3 received education/exercise/home assessment/modification, Group four received education/exercise/home assessment/modification and clinical assessment and advice re medical risk factors.</td>
<td>• There was a significant reduction in the risk of slips (58%), trips (64%) and a trend for reduced falls (30%) when comparing the IG (group 2, 3 &amp; 4) with the CG.</td>
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<td>Tinetti et al, 1994a, USA (reference 405) (Yale FICSIT site)</td>
<td>Community - dwelling adults (n = 301) aged &gt; 71 years, with more than one risk factor for falling 1. Intervention: Behavioural modifications, review of medication, environmental hazard assessment and modification, gait, balance and strength training (home-based) 2. Control</td>
<td>• Significant difference between groups in time to first fall (0.05) and proportion of subjects who fell (p = 0.04)  • Significant difference in change in scores of falls efficacy (p = 0.02)</td>
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<td>Trivedi et al, 2003, UK (reference 415)</td>
<td>Men and women aged 65-85 living in the community recruited through the British doctors register and a general practice register (n=2686) 1. Intervention: Participants sent one capsule containing 100 000IU vitamin D3 (IG) 2. Control: Matching placebo (CG) Both sent by post every four months for five years (15 doses in total).</td>
<td>• IG had 22% lower rate of 1st fracture at any site (P=0.04) and 33% lower in the hip/wrist/forearm/vertebrae site (P=0.02) and a non-significant trend towards lower total mortality risk (P=0.18).  • Findings were consistent in men and women and in the doctors and general practice population</td>
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| **Wagner et al, 1994, USA (reference 426)**  
Randomised controlled trial to evaluate the effect of a multicomponent intervention program on disability and falls  
2 years | Community - dwelling adults (n=1559), aged > 65 years  
1. Intervention: Assessment by a trained nurse/educator. Initiation of walking program, home safety inspections, recommendations to primary care physician re medical review, hearing/vision tests and information re resources in community  
2. Chronic Disease Prevention: (single visit) Counselling on diet/smoking/stress  
3. Control | • After 1 year, subjects in the intervention group reported significantly lower incidence of falls than control group  
• After 2 years of follow-up there was no significant difference between groups | II |
| **Wolf et al, 1996, USA (reference 257)**  
(Atlanta FICSIT site)  
Randomised controlled trial to evaluate the effect of Tai Chi and computerised balance training on measures of frailty and falls.  
4 months | Community - dwelling adults (n = 200), aged >70 years  
1. Intervention (Tai Chi): Tai Chi Quan in group classes, with encouragement to practice at home  
2. Intervention (Balance Training): Individual sessions using computerised balance machine  
3. Control Group discussion (non-specific): with no change to exercise levels | • Lower Blood Pressure in Tai Chi group before and after 12 minute walk  
• Fear of falling responses were reduced after Tai Chi  
• Tai Chi reduced the risk of multiple falls by 47.5% | II |

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Table of Level II (Randomised Controlled Trials) studies demonstrating effectiveness of interventions in reducing falls or falls related injuries in older people living in residential care.

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<td><strong>Becker et al 2003, Germany (reference 11)</strong>&lt;br&gt;A randomised controlled trial to determine the effectiveness of a multifaceted intervention on falls in nursing home residents.&lt;br&gt;1 year</td>
<td>981 residents from 6 long term care facilities (nursing homes) aged 60 and older (mean age of 85).&lt;br&gt;1. Intervention: Multifactorial intervention involving staff and resident education, advice on environmental adaptations, exercise, and hip protectors.&lt;br&gt;2. Control.</td>
<td>- The intervention group demonstrated a significantly lower rate of falls (p&lt;0.001), fallers (p=0.038) and frequent fallers (p=0.015) than the control group.&lt;br&gt;- There was no significant difference between groups for rate of hip fractures.</td>
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<td><strong>Bischoff et al, 2003, Switzerland (reference 15)</strong>&lt;br&gt;A randomised controlled trial to compare calcium plus vitamin D supplementation with calcium supplementation alone on the mean number of falls and recurrent falls per person.&lt;br&gt;3 months</td>
<td>122 female participants aged 60 or older in long stay geriatric care awaiting nursing home placement.&lt;br&gt;1. Intervention: 1200mg calcium plus 800 IU cholecalciferol (Vitamin D) per day over a 12 week treatment period.&lt;br&gt;2. Control: Received 1200mg calcium per day over a 12 week treatment period.</td>
<td>- After adjustment for confounding variables there was a 49% reduction in the number of falls for the Calcium + Vitamin D (intervention) group (95% CI, 14-71%; p&lt;0.01).&lt;br&gt;- There was no significant difference between groups for the number of fallers, however there was a non-significant trend in favour of the Calcium + Vitamin D group with a 30% lower risk of being a faller.</td>
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<td><strong>Evans et al., 1997, USA (reference 103)</strong>&lt;br&gt;Randomised controlled trial to assess the relative effectiveness of two interventions on the use of physical restraints.&lt;br&gt;12 months</td>
<td>Nursing home residents (n = 643), aged &gt; 60 years.&lt;br&gt;1. Intervention A: Restraint education&lt;br&gt;2. Intervention B: Restraint education with consultation.&lt;br&gt;3. Control.</td>
<td>• Intervention B resulted in statistically significant reduction in use of restraint prevalence.&lt;br&gt;• Significant reduction in serious fall-related injuries between interventions A and B (p=0.026).</td>
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<td><strong>Harada et al, 2001, Japan (reference 142)</strong>&lt;br&gt;A randomised controlled trial to determine the effectiveness of hip protectors for the prevention of hip fractures among Japanese elderly in nursing homes.&lt;br&gt;2 years in the 1st trial (one nursing home) and 1 year in the 2nd trial (5 nursing homes) (Average 377 [SD 250] days [range: 1 to 791]).</td>
<td>164 Japanese female residents from 6 nursing homes with a mean age of 83.2 years.&lt;br&gt;1. Intervention: hip protector use with instructions to wear the protectors 24 hours a day.&lt;br&gt;2. Control.</td>
<td>• The compliance rate (wearing the hip protector for 24 hours) was 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).&lt;br&gt;• The one hip fracture that occurred in the intervention group happened while the resident was not wearing their hip protector.</td>
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<td><strong>Jensen et al, 2002, Sweden (reference 174)</strong>&lt;br&gt;A cluster randomised trial to determine whether a multifactorial intervention program would reduce falls and fall-related injuries.</td>
<td>439 residents from 9 residential care facilities, aged 65 and over.&lt;br&gt;1. Intervention: An 11 week multidisciplinary multifactorial program including staff education, environmental modification, exercise, supply or repair of aids, medication review, hip protectors, post-fall problem-solving conference and staff guidance.&lt;br&gt;2. Control.</td>
<td>• The intervention group had significantly fewer fallers and the time to first fall was longer than the control group. When adjusted for baseline factors the intervention group had significantly fewer multiple fallers and falls per 1000 person days.&lt;br&gt;• There was also a significant difference between the intervention and control groups for having a femoral fracture (adjusted OR=0.23, 95% CI=0.06-0.94).&lt;br&gt;Note: A subsequent sub-analysis, reported in Jensen et al 2003, looked at residents with low (MMSE &gt;19) or high cognition levels (MMSE &lt;19) (n=378). There were no significant differences in falls (there was a trend) in the lower cognition group between the intervention and control groups. There was a significant reduction in femoral fractures in the intervention group with low cognition.</td>
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<td><strong>Kunnus et al, 2000, Finland (reference 185)</strong>&lt;br&gt;A study to determine whether an external hip protector would be effective in preventing hip fractures among older adults.</td>
<td>A total of 1801 ambulatory (with/without a gait aid or with/without need for support by another person) men and women 70 years or older with at least one easily identifiable risk factor for hip fracture recruited from 22 community based health care centres that had treatment units (geriatric long-stay facilities or outpatient care units for supported living at home).&lt;br&gt;1. Intervention: hip protector use.&lt;br&gt;2. Control.</td>
<td>• The risk of hip fracture was significantly reduced in the IG (P=0.008) and there was a non-significant trend towards reduced risk of pelvic fractures.&lt;br&gt;• The risk of other fractures were similar between groups. (Compliance rate was 48%).</td>
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| Lauritzen and Petersen, 1993, Denmark (reference 207) Randomised controlled study to determine the effectiveness of hip protectors in preventing fractures. 11 months | Nursing home residents (n = 665) 1. Intervention: Received pair of external hip protectors 2. Control | • Intervention group had a significantly reduced risk of hip fracture. The relative risk of hip fracture in the IG was 0.44 (95% CI 0.21 – 0.94).  
• The 8 hip fractures in the IG occurred while the HP was not being worn. | II |
| Meyer et al, 2003, Germany (reference 263) A cluster randomised controlled trial to determine the effect of an intervention program aiming to increase hip protector use on hip fractures among elderly people in nursing homes. 18 months | 942 residents from 42 nursing homes (49 clusters) aged 70 years or older, not bedridden and had lived in the nursing home for more than 3 months. 1. Intervention: single nursing staff education session (about risk factors and strategies to prevent falls and fractures and hip protectors) and then staff educated residents. Participants were provided with 3 free hip protectors. 2. Control: received usual care and a brief 10 minute information session and demonstration of hip protectors was provided to the nominated study coordinator as well as 2 hip protectors for demonstration purposes. | • The risk of hip fracture was lower in the IG (4.6% vs 8.1%) than the CG (p=0.072). There were no significant differences in terms of other fractures or falls.  
• After adjustment for cluster randomisation, use of hip protectors by residents who fell was higher in the IG than the control group (68% vs 15%) (p=0.0001). There were fewer hospital admissions in the intervention group (p=0.015) than the control group. | II |

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<td>Ray et al., 1997, USA (reference 326)</td>
<td>Nursing home residents (n = 482) at high risk for falling. &lt;br&gt;1. Intervention: Comprehensive, structured individual assessment, with specific safety recommendations. &lt;br&gt;2. Control.</td>
<td>Fewer recurrent fallers and 31% fewer injurious falls in the intervention group, compared with control, group (although the latter was not statistically significant).</td>
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<td>Toulette et al, 2003, France (reference 411)</td>
<td>20 elderly patients with dementia from residential care, with a history of falling and an average age of 81. &lt;br&gt;1. Intervention: A supervised exercises program to develop muscular strength, proprioception, static and dynamic balance and flexibility (2 sessions per week for 16 weeks). Note: The 10 participants in the intervention group were split into two groups of 5 with 2 physicians per group because of the participant’s physical and cognitive impairment. &lt;br&gt;2. Control.</td>
<td>Balance was significantly improved in the intervention group (p&lt;0.01), but there was no change in the control group. &lt;br&gt;Intervention group walked significantly faster in 10m walking test (p=0.015) and the up and go test upon completion of the trial. &lt;br&gt;Study was under powered to detect statistically significant difference in falls (IG had no falls, CG had 6 falls).</td>
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<td>Bakarich et al., 1997, Australia (reference 8)</td>
<td>Patients in the medical or surgical wards of an acute hospital (n=2023), who were classified as being at risk of falling. Intervention: 2-4 hourly toileting.</td>
<td>· Fewer falls in patients classified as being at risk, who also received the toileting regimen.</td>
<td>III</td>
</tr>
<tr>
<td>Brady et al, 1993, USA (reference 18)</td>
<td>Elderly patients admitted to a rehabilitation hospital (n=25). Intervention: Regular toileting, assistance and fluids offered.</td>
<td>· Decrease in falls (approx. 80%) compared with similar time frames in preceding years.</td>
<td>III</td>
</tr>
<tr>
<td>Donald et al. 2000, UK (reference 91)</td>
<td>54 consecutive patients admitted to an elderly care rehabilitation ward. Interventions 1) Carpeting beside the beds was applied to 2 out of 4 bays in the ward (vs vinyl flooring). 2) Additional leg strengthening exercises (3 sets of 10 lifts with weights using hip flexors and ankle dorsiflexors) repeated twice daily in conjunction with the conventional physiotherapy (vs conventional physiotherapy only).</td>
<td>· There were more falls in those receiving routine physiotherapy than those receiving additional exercise in conjunction with routine physiotherapy (7 vs 4, relative risk 0.21, 95% CI 0.04-1.2, p=0.12). · There were more patient falls in carpeted rooms than those with vinyl flooring (10 vs 1, relative risk 8.3, 95% CI 0.95-73, p=0.05). The sample was too small for any meaningful conclusions.</td>
<td>II</td>
</tr>
</tbody>
</table>

IG = intervention group; CG = control group; HP = hip protectors; CI = confidence intervals
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<tr>
<th>Authors(s), year of publication, country, study aims and length of study</th>
<th>Study population and nature of intervention</th>
<th>Evidence of intervention effects</th>
<th>Level of evidence</th>
</tr>
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| Haines et al., In Press, Australia (reference 136)  
A randomised controlled trial to determine the effectiveness of a multidisciplinary risk assessment and targeted interventions.  
9 months | 616 consecutive patients admitted to sub-acute hospital wards.  
1. Intervention: Multidisciplinary risk assessment and targeted interventions, including a falls risk alert card with an information brochure; a group exercise program; an education program, and hip protectors.  
2. Control: Usual care. | - Significantly reduced (30%) the number of falls in the intervention group.  
- Non-significant trend for reduction in proportion of patients who had a fall related injury (28% lower in the IG, p=0.2) | II |
| Hanger et al., 1999, NZ (reference 140)  
A study to assess the effectiveness of a bedrail policy and education in reducing falls and related injuries..  
12 months | Patients admitted to elderly care wards of an acute hospital (n=1968).  
Intervention: Policy change, restricting use of bedrails, and education to staff. | - Significant reduction in number of bedrails following implementation of the policy (p=0.02).  
- Serious injuries following falls were significantly less common (p=0.008), with fewer head injuries. | III |
| Mitchell et al., 1996, Australia (reference 266)  
Pre/post test study to assess the effectiveness of a multiple intervention strategy in reducing fall rates.  
12 months | Elderly patients on a medical ward.  
Intervention: Falls risk assessment, identification of high risk patients, prevention strategies, education, alarms. | - After 6 months there was a sizeable reduction in fall rates post-intervention, although this was not statistically significant. | III |

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<td><strong>Schmid, 1990, USA (reference 358)</strong>&lt;br&gt;Study to evaluate the development and effectiveness of a fall risk assessment tool in reducing fall rates.&lt;br&gt;12 months</td>
<td>Hospitalised patients at risk for falls.&lt;br&gt;Intervention: Patient identification, nursing care plan, environmental modifications, education.</td>
<td>· 54% decline in fall per patient days following implementation of program.</td>
<td>III</td>
</tr>
<tr>
<td><strong>Tideiksaar, et al., 1993, USA (reference 402)</strong>&lt;br&gt;A randomised case controlled study to determine the efficacy of a bed alarm system in reducing falls from bed on a geriatric evaluation and treatment unit.&lt;br&gt;9 months</td>
<td>Random allocation of “at risk” patients in a geriatric evaluation and treatment ward to an experimental group (n=35) or control group (n=35).&lt;br&gt;1. Intervention: Bed alarm system to monitor patients getting out of bed unsupervised.&lt;br&gt;2. Control.</td>
<td>· Reduced number of falls (non-statistically significant trend) in intervention group.</td>
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