

# Strategies to prevent falls and fractures in hospitals and care homes and effect of cognitive impairment: systematic review and meta-analyses

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References to the studies included in the systematic review (w1-w44) and three tables showing key features, quality scores, and outcome measures are on [bmj.com](http://bmj.com).

## ABSTRACT

**Objectives** To evaluate the evidence for strategies to prevent falls or fractures in residents in care homes and hospital inpatients and to investigate the effect of dementia and cognitive impairment.

**Design** Systematic review and meta-analyses of studies grouped by intervention and setting (hospital or care home). Meta-regression to investigate the effects of dementia and of study quality and design.

**Data sources** Medline, CINAHL, Embase, PsychInfo, Cochrane Database, Clinical Trials Register, and hand searching of references from reviews and guidelines to January 2005.

**Results** 1207 references were identified, including 115 systematic reviews, expert reviews, or guidelines. Of the 92 full papers inspected, 43 were included. Meta-analysis for multifaceted interventions in hospital (13 studies) showed a rate ratio of 0.82 (95% confidence interval 0.68 to 0.997) for falls but no significant effect on the number of fallers or fractures. For hip protectors in care homes (11 studies) the rate ratio for hip fractures was 0.67 (0.46 to 0.98), but there was no significant effect on falls and not enough studies on fallers. For all other interventions (multifaceted interventions in care homes; removal of physical restraints in either setting; fall alarm devices in either setting; exercise in care homes; calcium/vitamin D in care homes; changes in the physical environment in either setting; medication review in hospital) meta-analysis was either unsuitable because of insufficient studies or showed no significant effect on falls, fallers, or fractures, despite strongly positive results in some individual studies. Meta-regression showed no significant association between effect size and prevalence of dementia or cognitive impairment.

**Conclusion** There is some evidence that multifaceted interventions in hospital reduce the number of falls and that use of hip protectors in care homes prevents hip fractures. There is insufficient evidence, however, for the effectiveness of other single interventions in hospitals or care homes or multifaceted interventions in care homes.

## INTRODUCTION

Falls are common in hospitals and care homes,<sup>1</sup> where rates vary from three to 13 falls per 1000 bed days. In 2004-5, 275 000 falls were reported in hospitals in the United Kingdom<sup>2</sup>—60% of all reported incidents. About 30% of falls in hospitals and care homes result in physical injury and 3-5% in fracture.<sup>3,4</sup> Falls may also lead to loss of function, anxiety, depression,

impaired rehabilitation, increased length of hospital stay, and inability to return to previous residence, thus contributing to additional health and social care costs.<sup>5-7</sup> Falls in institutions may result in complaints or litigation from families.<sup>8,9</sup> All of this leads to anxiety for staff and proprietors, who require guidance on best practice in preventing falls and injuries.

Falls often indicate underlying frailty or illness and thus require a broad approach to assessment and management.<sup>10,11</sup> Most evidence about successful prevention strategies, however, is derived from less frail and more clinically stable people living in their own homes.<sup>10,11</sup>

Such evidence may not translate to transient populations who are medically unstable with a high prevalence of cognitive impairment, as is typical in hospitals or care homes. We synthesised and evaluated the evidence for prevention of falls and fractures in hospitals and care homes to inform the development of guidance on best practice and investigated the impact of dementia on the effectiveness of the identified interventions.

## METHODS

Full details about methods are on [bmj.com](http://bmj.com)

**Literature search strategy**—We searched Medline, CINAHL, Embase, PsychInfo, Cochrane Database of Systematic Reviews, and the Register of Clinical Trials for guidelines, and did hand searched references (see [www.reading.ac.uk/ihs/bmj\\_falls.htm](http://www.reading.ac.uk/ihs/bmj_falls.htm)). When possible, we contacted authors of included studies to ascertain their knowledge of unpublished data or ongoing trials.

**Identification of articles for inclusion**—Our initial inclusion criteria were deliberately broad. We sought studies of patients in hospitals or care homes that reported the number or rate of falls or fractures or people who fell (“fallers”) as a primary or secondary outcome. For inclusion, the data also had to be reported in such a way that we could calculate log rate ratios or log relative risks and their variances.

**Abstraction of data and outcomes**—We used the quality score of Downs and Black to assess papers.<sup>12</sup> One of three pairs of peer assessors (DO/MG, JC/CV, FM/FS) scored each included study and extracted data. Each pair worked independently with a further assessor arbitrating if necessary. We grouped studies into nine categories according to type and setting of the intervention. Two statisticians (YG and AW) abstracted quantitative outcome data. The three outcomes were

falls per person year, fractures/1000 person years, and percentage of people falling. Measures of the effect of the intervention relative to the control were the log rate ratio for falls and fractures and the log relative risk of falling.

## RESULTS

The literature search resulted in the final inclusion of 43 studies. The key features and quality scores for the 43 included studies are summarised in table A on bmj.com. Outcome measures and 95% confidence intervals are summarised in tables B and C on bmj.com. We present our results for each of the nine categories of intervention and setting and forest plots only for three key interventions and four outcomes and only for random (not fixed) effects. Other meta-analyses are available on our website ([www.reading.ac.uk/ihs/bmj\\_falls.htm](http://www.reading.ac.uk/ihs/bmj_falls.htm)).

### Multifaceted interventions

*In hospital*—We included 13 studies<sup>w6-18</sup>: three were individually randomised, two were cluster randomised trials, and eight were prospective (historical control “before and after” studies), which with one exception<sup>w8</sup> were of poor methodological quality. Components of interventions were varied and included risk assessment, risk factor assessment, care planning, medical/diagnostic approaches, changes in the physical environment, education programmes, medication review, hip protectors, removal of physical restraints, and exercise (see table A on bmj.com). There was evidence of heterogeneity between the studies ( $I^2=80\%$  for falls, 59% for fractures, and 58% for fallers) The rate ratio was 0.82 (95% confidence interval 0.68 to 0.997) for falls (fig 1) and 0.59 (0.22 to 1.58) for fractures. The relative risk for fallers was 0.95 (0.71 to 1.27).

*In care homes*—We included eight studies,<sup>w1-w4 w19-w23</sup> one of which yielded two datasets.<sup>w3 w4</sup> Three were individually randomised and five were cluster randomised controlled trials. The components of the interventions were varied and included all those listed for hospital patients (see table A on bmj.com). Quality scores were generally high. There was significant heterogeneity for falls ( $I^2=87\%$ ), although this was much less for fallers (24%) and non-existent for fractures.

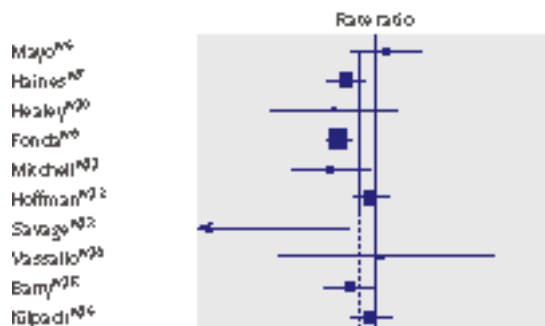


Fig 1 | Meta-analysis for multifaceted interventions in hospital—falls (random effects model)

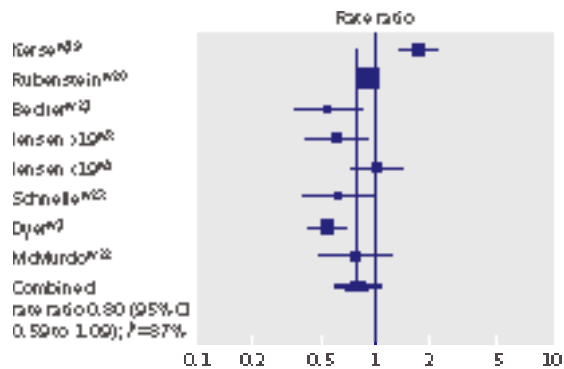


Fig 2 | Meta-analysis for multifaceted interventions in care homes for falls (random effects model)

The rate ratio was 0.80 (0.59 to 1.09) for falls (fig 2) and 0.91 (0.54 to 1.53) for fractures. The relative risk for fallers was 0.92 (0.82 to 1.03) (fig 3). Sensitivity analyses performed for falls and fallers, varying the intraclass correlation coefficient between 0 and 1, had little impact on the conclusions; confidence intervals always included 1, though the width of the random effects confidence intervals reduced with increasing correlation.

### Single interventions

All the single interventions described were also components of one or more of the multifaceted interventions in care homes and hospitals, and the full results are contained on bmj.com.

*Hip protectors in care homes*—We included 11 studies<sup>w24-w34</sup>: five were individually randomised controlled trials, five were cluster randomised controlled trials, and one was a prospective historical control study. Quality scores were generally high. The rate ratio was 0.67 (0.46 to 0.98) for hip fractures and 0.97 (0.77 to 1.22) for falls. The results for hip fractures were sensitive to the magnitude of the intraclass correlation coefficient. The conclusions regarding hip fractures are therefore uncertain.

*Removal of physical restraint in either setting*—We included five studies<sup>w35-w39</sup>: two were prospective with historical controls and three were observational cohort studies. Studies were generally of moderate methodological quality. There was significant heterogeneity for falls ( $I^2=99\%$ ) and fallers (91%). The rate ratio was 0.59 (0.19 to 1.77) for falls, and the relative risk for fallers was 0.83 (0.42 to 1.66). Only one study provided data on fractures.

*Fall alarm devices in either setting*—We included only one study: a small prospective historical control cross-over study of moderate methodological quality in a care home.<sup>w40</sup> This showed a significant effect on falls, though not on fallers or fractures. It was a small study, however, with a low quality score, making general conclusions hard to draw.

*Exercise in either setting*—We included two individually randomised controlled trials.<sup>w5 w41</sup> Neither showed any effect on falls, despite good adherence and a range of other benefits.

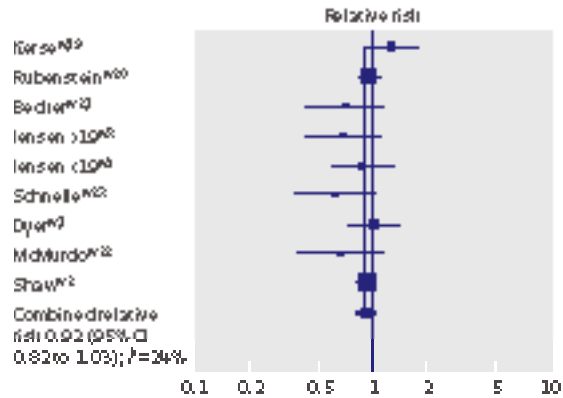


Fig 3 | Meta-analysis for multifaceted interventions in care homes for fallers (random effects model). Jensen et al carried out subgroup analyses according to MMSE (mini mental state examination) <19 v >19

*Changes or differences in the physical environment in either setting*—We included only one study, which compared carpeting with vinyl flooring.<sup>w5</sup> There were few participants, and there was no significant effect on the rate of falls.

One review that we identified but excluded was a large observational cohort study in a UK care home that compared rates of falls and fractures in residents' rooms with concrete or wooden floors and carpeted or uncarpeted.<sup>13</sup> They found that wooden carpeted floors were associated with the lowest rate of fractures. Also a retrospective observational cohort study of falls in a general hospital showed that falls on wooden flooring were associated with a significantly lower rate of injuries.<sup>14</sup>

*Calcium and vitamin D in care homes*—Only two published studies were eligible for inclusion, both individually randomised controlled trials.<sup>w42 w43</sup> Compared with placebo there was a significant effect on the rate of hip fracture,<sup>w42</sup> and compared with calcium alone there was a significant effect on the fall rate.<sup>w43</sup> Two key studies have been published since our review. Both were large randomised controlled trials from care homes in residents with a high prevalence of vitamin D deficiency.<sup>15 16</sup> One showed a significant effect on falls and fractures<sup>15</sup> and the other found no evidence of prevention for either outcome.<sup>16</sup>

*Medication review in either setting*—Only one study reported review of medication as a single intervention in preventing falls.<sup>w44</sup> This small hospital based study reported a rate ratio for falls of 0.53 (0.30 to 0.95).

#### Meta-regression

The results of meta-regressions to assess the effect of prevalence of dementia on effect size for each of the three reported outcome measures were not significant.

#### DISCUSSION

There have been two major approaches to interventions to reduce falls in hospital and care homes: those based on a single intervention and those that combine

various interventions. In this systematic review and meta-analysis we found some evidence for modest reductions in rates of falls in hospital patients with multifaceted interventions and in rates of hip fractures with hip protectors in people in care homes. However, we found insufficient evidence for any other interventions in these settings.

We identified 13 studies with multifaceted approaches to preventing falls in hospital. The components of these interventions were varied, the settings and populations heterogeneous, and the study design and quality highly variable. Two high quality randomised controlled trials<sup>w7 w10</sup> and one high quality before and after study<sup>w8</sup> described significant effects on rates of falls, with meta-analysis showing a reduction of 18%, which was just statistically significant, though with no comparable effect on fractures or fallers.

Of eight studies reporting multifaceted interventions in care homes, all were described as randomised controlled trials and were generally of good quality, though adjustments for clustering were rarely undertaken in the original analyses. While some individual trials showed a large effect size on falls (though not on fractures or fallers),<sup>w3 w21</sup> the meta-analyses for multifaceted interventions in care homes did not show any significant effects. There was insufficient power to detect a difference in fracture rates in these studies so the results are inconclusive.

We identified 11 studies on the use of hip protectors, 10 of which were randomised controlled trials. There was evidence to show an overall effect of hip protectors on rates of hip fracture. However, given the number of cluster randomised trials in this meta-analysis and the sensitivity of the results to the magnitude of the intraclass correlation coefficient, which necessarily had to be imputed for most studies, we consider it unwise to draw definite conclusions about efficacy.

There was no evidence for exercise as a single intervention in preventing falls or fractures, though it was a component of several successful multifaceted interventions and conferred a range of other benefits. Five studies on removal of physical restraint (of necessity, largely with observational cohort or case control designs) showed no evidence of significant effect on falls or fractures in either direction. There were not enough trials of fall alarm devices, changes in physical environment, or medication review as single interventions. Oral calcium and vitamin D at appropriate doses reduced rates of falls<sup>w42, w43</sup> and fractures<sup>w43</sup> for older people in care homes in the two included studies. A recent randomised controlled trial in care home residents in Australia<sup>15</sup> mirrored these findings (though it was published too late for inclusion), but a subsequent UK study<sup>16</sup> failed to replicate them, confusing the picture. Many of the single interventions described were also components of multifaceted interventions.

Our findings suggest that there is reasonable evidence that using a structured multifaceted intervention for hospital inpatients may have a modest effect on falls but not on fractures. Replication of such studies

**WHAT IS ALREADY KNOWN ON THIS TOPIC**

Falls are the most common adverse incident in hospitals and care homes, nearly always affecting frail elderly people, many of whom have dementia or delirium. Risk management must be balanced against the need to promote functional independence and to respect autonomy. Previous reviews and guidelines have focused largely on elderly people living in the community and those without cognitive impairment.

**WHAT THIS STUDY ADDS**

There is evidence for modest reductions in fall rates in hospital patients from multifactorial interventions and on hip fractures from hip protectors in care home residents. There is insufficient evidence for any other interventions in these settings.

would not be a high priority, but closer investigation of specific components is required. A similar approach in care homes has yielded significant reductions in falls, fallers, and fractures in some large individual studies, but this is not substantiated by meta-analysis so the case for effectiveness is unproved. The use of high dose calcium and vitamin D has proved effective in three studies in care homes but ineffective in a more recent and larger study, suggesting that effects might be setting and population specific. For all other interventions listed, there is currently no evidence to support widespread implementation. With fractures as an outcome, for all interventions except for hip protectors there was insufficient power to detect a significant difference, so that the case remains unproved rather than disproved.

Our review illustrates an increasingly prevalent view<sup>17</sup> that an over-reliance on the primacy of the randomised controlled trial as the main source of clinical evidence may not be suitable where interventions are complex and individual consent is hard to obtain.

An approach of realistic evaluation,<sup>18</sup> where factors such as context, case mix, adherence, quality of intervention, and process are considered, may be more suitable in answering many pragmatic questions around “real life” clinical practice.<sup>19,20</sup>

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**Ethical approval:** Not required.

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## Rectal examinations can improve your hearing

A profoundly deaf, elderly man was admitted to the emergency care centre where I work. Constipation seemed to be the primary medical problem, although communication was somewhat difficult because of his severe lack of hearing.

It was decided on the ward round that he needed a digital rectal examination, a task that was allocated to me. After several long minutes of shouting into the patient's “good” ear, I had obtained consent from the entire admissions unit. As I began I noticed an unusual looking skin tag. Further investigation revealed that it

was not, in fact, anatomical, but a hearing aid firmly wedged between his buttocks.

The gentleman was delighted that I'd found his hearing aid because he'd been enduring a world of inconvenient silence for four days. His enthusiasm to put it in its rightful position left him disappointed when we insisted on cleaning it first.

Rectal examinations are more useful than I thought—they can improve your hearing.

Frances Marr, F1 doctor, North Tyneside Hospital, Tyne and Wear