Falls are common among inpatients. Several reviews, including 4 meta-analyses involving 19 studies, show that multicomponent programs to prevent falls among inpatients reduce relative risk for falls by as much as 30%. The purpose of this updated review is to reassess the benefits and harms of fall prevention programs in acute care settings and to identify factors associated with successful implementation of these programs. We searched for new evidence using PubMed from 2005 to September 2012. Two new, large, randomized, controlled trials supported the conclusions of the existing meta-analyses. An optimal bundle of components was not identified. Harms were not systematically examined, but potential harms included increased use of restraints and sedating drugs and decreased efforts to mobilize patients. Eleven studies showed that the following themes were associated with successful implementation: leadership support, engagement of front-line staff in program design, guidance of the prevention program by a multidisciplinary committee, pilot-testing interventions, use of information technology systems to provide data about falls, staff education and training, and changes in nihilistic attitudes about fall prevention. Future research would advance knowledge by identifying optimal bundles of component interventions for particular patients and by determining whether effectiveness relies more on the mix of the components or use of certain implementation strategies.

See also:

Web-Only
CME quiz (Professional Responsibility Credit)
Supplement
Previous Studies and Reviews

The 4 systematic reviews are a 2008 review from the Cochrane Collaboration by Cameron and colleagues (12), a 2008 review by Coussment and coworkers (13), a review by Oliver and colleagues originally published in 2007 (14) and then updated in 2010 as a narrative review (1), and a 2012 review by DiBardino and colleagues (15). All 4 reviews scored well on the assessment of multiple systematic reviews (AMSTAR) criteria for systematic reviews (11 out of 11, 10 out of 11, 10 out of 11, and 8 out of 11, respectively), which evaluates such items as comprehensiveness of the search, assessment of the quality of included studies, and methods for synthesizing the results (16). The Cochrane review searched for randomized trials to assess the effectiveness of fall reduction interventions for older adults in nursing care facilities and hospitals (12). Of the 41 included trials, 11 were conducted in hospital settings, 4 of which addressed multicomponent interventions. The review by Coussment and coworkers identified 4 multicomponent studies, 2 of which were included in the Cochrane review (13). The review by Oliver and colleagues used broader inclusion criteria than the Cochrane review, which led to the inclusion of 43 trials, case-control studies, and observational cohort studies (14). Thirteen of these studies were classified as multicomponent inpatient interventions. Oliver and coworkers’ updated narrative review focused directly on hospital fall prevention and discussed 17 multicomponent studies spanning from 1999 to 2009, which include the 6 trials in the Cochrane and Coussment and colleagues’ reviews (1, 13). The recent review by DiBardino and coworkers (15) identified 6 primary research studies in the acute care inpatient setting, 3 of which were included in the Oliver and colleagues’ 2010 update.

Supplemental Search

Our supplemental search started with studies identified by Hempel and coworkers, focusing on individual and cluster randomized, controlled trials with large sample sizes that assessed multicomponent interventions in acute care hospitals, in the general population or older adult population. We were looking for “pivotal studies,” defined by Shojania and colleagues (17) as trials that may call into question the results of an existing review. Studies were screened by a clinician and nonclinician, each of whom was experienced in systematic reviews. This search identified 2 new relevant studies, both of which showed statistically significant improvements in intervention groups when compared with control groups and which we discuss briefly later. We also describe a third study because of its unique design. Because Oliver and coworkers’ 2010 update used Downs and Black (18) to assess the quality of individual studies, we did the same for the 2 new studies. We assessed the strength of evidence across studies using a framework developed for the Agency for Healthcare Research and Quality patient safety review (19). To identify studies in which a principal goal was reporting on implementation, we surveyed the results of our updated search and queried experts for additional studies.

This review was supported by the Agency for Healthcare Research and Quality, which had no role in the selection or review of the evidence or the decision to submit the manuscript for publication.

Benefits and Harms

Benefits

Table 2 presents details about the 21 effectiveness studies included in previous reviews or our updated search.
Inpatient Fall Prevention Programs as a Patient Safety Strategy

The 4 reviews we identified reached similar conclusions. The reviews by Cameron and colleagues (12) and Oliver and coworkers (14) found that multicomponent in-facility prevention programs result in statistically and clinically significant reductions in rates of falls. Cameron and colleagues included 6478 older adults from 4 randomized trials in a pooled analysis that found a 31% decrease in the rate of falling (pooled rate ratio [RR], 0.69 [95% CI, 0.49 to 0.96] and a 27% decrease in the incidence of falls when compared with usual care among 3 trials involving 4824 participants (RR, 0.73 [CI, 0.56 to 0.96]) (12). Oliver and coworkers (14) included 5 randomized trials and 8 before-and-after studies in a pooled analysis that found an 18% decrease in the rate of falling (RR, 0.82 [CI, 0.68 to 1.00]). Coussement and colleagues (13) included 2 randomized trials, 1 before-and-after study, and 1 cohort study and found a pooled RR similar to that of Oliver and coworkers; however, this effect was not quite statistically significant (RR, 0.82 [CI, 0.65 to 1.03]). DiBardino and colleagues’ review (15) pooled data from 6 studies (including 1 randomized trial, 1 quasi-experimental study, and 4 before-and-after studies) and found a pooled odds ratio of 0.90 (CI, 0.83 to 0.99). The studies included in these reviews used interventions with 3 to 7 components and compared them with control participants who received usual care (for example, “control ward had no trial intervention” [23] and control participants who “followed conventional routines” [33]).

We rated the first trial identified in our update search as having a low risk of bias. In this cluster randomized trial, Dykes and coworkers (24) compared the fall rates in 8 units at 4 urban U.S. hospitals over a 6-month period. Control units in each hospital received usual care, which included fall risk assessments, signage for high-risk patients, patient education, and manual documentation in patient records. The intervention units at each hospital tested the Falls Prevention Tool Kit, which was developed by the study team. This kit is a health information technology application that includes a risk assessment and tailored signage, patient education, and plan-of-care components. Adjusted fall rates in the intervention units (3.15 per 1000 patient days [CI, 2.54 to 3.90]) were lower than those of control units (4.18 per 1000 patient days [CI, 3.45 to 5.06]), yielding a rate difference of 1.03 (CI, 0.57 to 2.01). A particularly strong effect was found in patients aged 65 years or older (rate difference, 2.08 per 1000 patient days [CI, 0.61 to 3.56]).

In the second study, which we also judged to have low risk of bias, Ang and colleagues (20) randomly assigned patients in 8 medical wards of an acute care hospital in Singapore to a target intervention or usual care. An assessment tool was used to match high-risk patients with appropriate interventions, in addition to an educational session tailored to patient-specific risk factors, in the intervention group. Both groups received usual care, which included environmental modifications, review of medications and fall history, and generic fall prevention advice. The proportion of patients with at least 1 fall in the intervention group was 0.4% (CI, 0.2% to 1.1%), whereas in the control group it was 1.5% (CI, 0.9% to 2.6%), for a relative risk reduction of 0.29 (CI, 0.1 to 0.87).

One other study worth noting, by van Gaal and colleagues (39, 40), evaluated a program that targeted 3 patient safety practices (pressure ulcers, urinary tract infections, and fall prevention) simultaneously. They found an overall positive effect on development of any adverse event, a composite measure of pressure ulcers, urinary tract infections, and falls. The study was not powered to assess falls separately, but it is worth noting that the point estimate for the relative risk reduction in falls was 0.69, which is within the range of results reported in other studies and meta-analyses. The value of this study is the demonstration of simultaneous improvements in several safety intervention targets that may be relevant to the same patient population.

Harms

Most trials of fall prevention programs did not report any harms, although 1 reported constipation from intake of vitamin D (13). Whether trials explicitly assessed the possibility of harms was mostly unclear. Despite little empirical evidence, concern exists that some fall prevention interventions may lead to harms. For example, Oliver and colleagues (1) detailed many potential harms, including those that would result from increased use of restraints or sedating medications.

IMPLEMENTATION CONSIDERATIONS AND COSTS

Structural organizational characteristics, existing quality and safety infrastructure, patient safety culture, teamwork, and leadership are believed to be important contexts for understanding the effectiveness of fall prevention programs (41, 42).

<table>
<thead>
<tr>
<th>Component</th>
<th>Studies Including This Component, n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient education</td>
<td>11</td>
</tr>
<tr>
<td>Bedside risk sign</td>
<td>10</td>
</tr>
<tr>
<td>Staff education</td>
<td>9</td>
</tr>
<tr>
<td>Alert wristband</td>
<td>7</td>
</tr>
<tr>
<td>Footwear</td>
<td>7</td>
</tr>
<tr>
<td>Review after fall</td>
<td>7</td>
</tr>
<tr>
<td>Toileting schedules</td>
<td>7</td>
</tr>
<tr>
<td>Medication review</td>
<td>6</td>
</tr>
<tr>
<td>Environment modification</td>
<td>5</td>
</tr>
<tr>
<td>Movement alarms</td>
<td>5</td>
</tr>
<tr>
<td>Bedrail review</td>
<td>4</td>
</tr>
<tr>
<td>Exercise</td>
<td>4</td>
</tr>
<tr>
<td>Hip protectors</td>
<td>3</td>
</tr>
<tr>
<td>Urine screening</td>
<td>2</td>
</tr>
<tr>
<td>Vest, belt, or cuff restraint</td>
<td>1</td>
</tr>
</tbody>
</table>
### Structural Organizational Characteristics

Studies evaluating fall prevention programs were done in various geographic areas and settings, including the United States, Australia, the United Kingdom, Sweden, Singapore, France, Switzerland, the Netherlands, and Germany (see Table 3 of the Supplement). Several were conducted in an academically affiliated or teaching hospital. Sizes of hospitals varied from small (fewer than 100 beds) to large (greater than 500). Some studies encompassed several hospitals (for example, 4), and others involved multiple wards. These data show that fall prevention programs have been implemented in hospitals of varying size, location, and academic or teaching status. No studies reported on financial concerns (for example, how patient care or the interventions were financed), although 1 U.S. study mentioned the potential effect of reimbursement on the emphasis on fall prevention (24).

### Existing Infrastructure

Existing organizational infrastructure was described rarely, with only 5 of the 21 studies describing this for their settings. In 4 studies, this description was limited to their usual fall prevention care. The fifth study provided a more explicit statement, namely, “prior to this study none of the wards carried out specific fall assessments or interventions . . . there was no specialist falls clinic or other falls service available at this hospital” (28). Two studies reported on the presence or absence of information systems that could be used in fall prevention programs (24, 26).

### Patient Safety Culture, Teamwork, and Leadership

Although some studies briefly mentioned patient safety culture, teamwork, or leadership, only 4 studies presented expanded explanations of those factors. Grenier-Sennelier and colleagues (26) used a framework from Shorr...

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**Table 2. Abridged Evidence Tables*  

<table>
<thead>
<tr>
<th>Study, Year (Reference)</th>
<th>Study Design</th>
<th>Setting</th>
<th>Participants</th>
<th>Quality Score†</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ang et al, 2011 (20)‡</td>
<td>RCT</td>
<td>8 medical wards; acute care; Singapore</td>
<td>1822 patients</td>
<td>25</td>
<td>Significantly fewer falls</td>
</tr>
<tr>
<td>Barker et al, 2009 (21)</td>
<td>Before-and-after</td>
<td>Small; acute care; Australia</td>
<td>271 095 patients</td>
<td>16</td>
<td>Significantly fewer injuries</td>
</tr>
<tr>
<td>Barry et al, 2001 (22)</td>
<td>Before-and-after</td>
<td>Small; long-stay and rehabilitation; Ireland</td>
<td>All patients admitted to 95 beds for 3 y</td>
<td>15</td>
<td>Significantly fewer injuries</td>
</tr>
<tr>
<td>Brandis, 1999 (7)</td>
<td>Before-and-after</td>
<td>Acute; Australia</td>
<td>All patients admitted to 500 beds for 2 y</td>
<td>11</td>
<td>Nonsignificantly fewer falls</td>
</tr>
<tr>
<td>Cumming et al, 2008 (23)</td>
<td>Cluster RCT</td>
<td>24 wards; acute and rehabilitation; Australia</td>
<td>3999 patients</td>
<td>27</td>
<td>Nonsignificantly fewer falls</td>
</tr>
<tr>
<td>Dykes et al, 2010 (24)†</td>
<td>Cluster RCT</td>
<td>8 units; medical; urban United States</td>
<td>All patients admitted or transferred to units over 6-mo study period</td>
<td>27</td>
<td>Significantly fewer falls</td>
</tr>
<tr>
<td>Fonda et al, 2006 (25)</td>
<td>Before-and-after</td>
<td>4 wards; elderly acute and rehabilitation; Australia</td>
<td>3961 patients</td>
<td>20</td>
<td>Significantly fewer falls</td>
</tr>
<tr>
<td>Grenier-Sennelier et al, 2002 (26)</td>
<td>Before-and-after</td>
<td>400 beds; rehabilitation; France</td>
<td>All admitted patients over 4 y</td>
<td>11</td>
<td>Significantly fewer falls</td>
</tr>
<tr>
<td>Haines et al, 2004 (27)</td>
<td>RCT</td>
<td>3 wards; subacute, rehabilitation, and elderly; Australia</td>
<td>626 patients</td>
<td>26</td>
<td>Significantly fewer falls</td>
</tr>
<tr>
<td>Healey et al, 2004 (28)</td>
<td>Cluster RCT</td>
<td>8 wards; acute and rehabilitation; 3 hospitals; United Kingdom</td>
<td>3386 patients</td>
<td>26</td>
<td>Nonsignificantly fewer falls</td>
</tr>
<tr>
<td>Koh et al, 2009 (29)</td>
<td>Cluster RCT</td>
<td>2 hospitals; acute; Singapore</td>
<td>All admissions over 1.5 y</td>
<td>14</td>
<td>Nonsignificantly fewer falls</td>
</tr>
<tr>
<td>Krauss et al, 2008 (30)</td>
<td>Before-and-after</td>
<td>General medicine; acute academic hospital; United States</td>
<td>All admissions over 18 mo</td>
<td>18</td>
<td>Nonsignificantly fewer falls</td>
</tr>
<tr>
<td>Mitchell and Jones, 1996 (31)</td>
<td>Before-and-after</td>
<td>1 acute and 1 subacute ward; 32 beds; Australia</td>
<td>All patients admitted to 32 beds for 6 mo</td>
<td>16</td>
<td>Nonsignificantly fewer falls</td>
</tr>
<tr>
<td>Oliver et al, 2002 (32)</td>
<td>Before-and-after</td>
<td>Elderly medical unit; acute hospital; United Kingdom</td>
<td>3200 patients admitted annually; data over 2 y</td>
<td>8</td>
<td>Nonsignificantly greater falls</td>
</tr>
<tr>
<td>Schwendimann et al, 2006 (6)</td>
<td>Before-and-after</td>
<td>300 beds; internal medical, geriatric, orthopedic; Switzerland</td>
<td>34 972 admissions</td>
<td>15</td>
<td>Nonsignificantly fewer falls</td>
</tr>
<tr>
<td>Stenvall et al, 2007 (33)</td>
<td>RCT</td>
<td>3 wards; orthogeriatric, geriatric, orthopedic; Sweden</td>
<td>199 patients</td>
<td>25</td>
<td>Significantly fewer falls</td>
</tr>
<tr>
<td>Udén et al, 1999 (34)</td>
<td>Before-and-after</td>
<td>Geriatric department; acute hospital; Sweden</td>
<td>379 patients</td>
<td>12</td>
<td>Nonsignificantly greater falls</td>
</tr>
<tr>
<td>van der Helm et al, 2006 (35)</td>
<td>Before-and-after</td>
<td>Internal medical and neurology wards; acute hospital; the Netherlands</td>
<td>2670 patients</td>
<td>11</td>
<td>Nonsignificantly greater falls</td>
</tr>
<tr>
<td>Vassallo et al, 2004 (36)</td>
<td>Cohort</td>
<td>3 wards; rehabilitation; United Kingdom</td>
<td>825 patients</td>
<td>25</td>
<td>Nonsignificantly fewer falls</td>
</tr>
<tr>
<td>von Renteln-Kruse and Krause, 2007 (37)</td>
<td>Before-and-after</td>
<td>Elderly acute and rehabilitation wards; Germany</td>
<td>7254 patients</td>
<td>17</td>
<td>Significantly fewer falls</td>
</tr>
<tr>
<td>Williams et al, 2007 (38)</td>
<td>Before-and-after</td>
<td>3 medical wards and 1 geriatric unit; Australia</td>
<td>1357 admitted patients during 6-mo intervention</td>
<td>17</td>
<td>Significantly fewer falls</td>
</tr>
</tbody>
</table>

RCT = randomized, controlled trial.  
* From reference 1.  
† Downs and Black Quality Score (18), evaluated by Oliver and colleagues (1)—except for entries in italics, which were evaluated by Ms. Miake-Lye and Dr. Shekelle.  
‡ New studies added from updated search.
Inpatient Fall Prevention Programs as a Patient Safety Strategy

**Implementation**

Implementation details are also considered to be important in understanding the effectiveness of fall prevention programs (41). The most commonly reported implementation details in the 21 studies were patient characteristics and the initial plan, or the intended intervention components. Some studies reported the intended roles of project staff, or by whom the intended intervention components were to be completed. Most studies reported the recipients of any training component, with slightly fewer reporting the type of training or giving a description of the training and even fewer studies reporting the length of training. Thus, the context and duration of training needed to implement fall prevention programs need better descriptions.

Several studies provided the materials used in program implementation, and some reported on adherence or fidelity to the designed initiative and how and why the plan evolved. Adherence or fidelity was most often characterized in a qualitative statement. According to Brandis (7): “The strategies implemented . . . had high acceptance by staff.” Williams and colleagues (38) found staff involvement crucial to fidelity: “[I]nvolving ward staff . . . so that they take ownership of the project and do not perceive it as being driven by middle management were important strategies.”

Dykes and coworkers (24) provided a strong example of adherence reporting, in which protocol adherence was measured by completion of components in both control (81%) and intervention (94%) wards. Such quantitative data on protocol adherence should be encouraged in future evaluations of fall prevention programs. Measures of adoption and reach were usually provided in the form of a flow chart—6 studies presented these data for providers, and 8 presented the data for patients.

In addition to the studies previously discussed, we identified 11 studies that focused primarily on implementation. None were randomized, clinical trials and all studies had either pre–post or time-series designs. Six studies were poststudy evaluations of fall prevention implementations that reported detail about the potential reasons for effectiveness or lack thereof. Nine of the 11 studies assessed implementation at only 1 or 2 facilities. Four studies reported no beneficial effects of the fall prevention program and highlighted potential implementation factors that may account for the lack of success. One study explicitly assessed the effect of some contextual factors on intervention success across 34 facilities (described later) (45). One study explicitly assessed sustainability. From these 11 studies, we identified the following 7 themes about effective implementation: leadership support is critical, both at the facility level (for example, hospital director) and at the unit level (for example, unit director or “clinical champions”); engagement of front-line clinical staff in the design of the intervention helps ensure that it will mesh with existing clinical procedures; use of multidisciplinary committees is needed to guide or oversee the interventions; the intervention should be pilot-tested to help identify potential problems with implementation; information systems that are capable of providing data about falls can facilitate evaluation of the causes and adherence to the intervention components and potentially be a crucial facilitator of the intervention; changing the prevailing nihilistic attitude that falls are “inevitable” and that “nothing can be done” is required to get buy-in to the goals of the intervention (46, 47); and education and training of clinical staff are necessary to help ensure that adherence does not diminish. Table 5 of the Supplement presents evidence from the 11 studies supporting each theme.

**Costs**

The Cochrane review found no economic evaluations of the fall prevention programs that met inclusion criteria (12). Oliver and colleagues (1) estimated the cost for specific combinations of components in terms of environment and equipment and in terms of staff; most costs were low or inconsequential.

**The Effects of Context on Effectiveness**

We identified only 1 study that explicitly assessed the effect of context on effectiveness (45). Across 34 Veterans Affairs health centers (a mix of acute care and long-term care facilities), leadership support was cited as one of the strongest factors for success. At 1-year follow-up, high-performing sites reported greater agreement with questions assessing leadership support, teamwork skills, and useful information systems than low-performing sites.

**Discussion**

The evidence base indicates that inpatient multicomponent programs are effective at reducing falls and that consistent themes are associated with successful implementation. However, there is no strong evidence about which components are most important for success. The effects of context have not been well-studied; however, multicomponent interventions have been effective in hospitals that vary in size, location, and teaching status. The cost of implementing fall prevention programs has not been rigorously assessed but generally does not involve capital expenses or hiring new staff.

Our results about effectiveness are consistent with previous reviews on inpatient fall prevention programs. Our review additionally identifies 7 themes associated with suc-
cessful implementation. Some themes, such as education or training and leadership support, are often included in general lists of factors for successful implementation of any intervention, whereas themes that may be more specific to fall prevention programs include development and guidance by a multidisciplinary committee and changing the prevailing attitudes of nihilism with respect to falls.

Our findings that multicomponent fall prevention programs are effective in inpatient settings may seem at odds with recent U.S. Preventive Services Task Force recommendations not to automatically do a multifactorial fall assessment in community-dwelling adults aged 65 years or older (48). However, there is no contradiction because, although the goal is to prevent falls in both community-dwelling and hospitalized patients, the settings are different. The hospital environment is more tightly controlled than the outpatient setting, where it is more difficult to ensure that risk factors for falls are appropriately managed. In fact, as Tinetti and Brach (49) note, community-based multifactorial programs achieve greater reduction in falls when identified risk factors are actually managed.

Our review has several limitations. Like all reviews, we are limited by the quality and quantity of the original research articles. Also, we did not do an exhaustive update of existing reviews. With several previous reviews reaching consistent results, including a total of 19 effectiveness studies, we focused instead on identifying "pivotal studies" that may call into question the conclusions of previous reviews. None were found; additional large randomized, controlled trials supported the conclusions of existing reviews. Our assessment of implementation themes is novel and deserves prospective evaluation (for example, one that could measure the degree of leadership support or staff attitudes about fall prevention before and during an intervention).

For multicomponent inpatient fall programs, our review provides both evidence that such programs reduce falls and insight into how facilities can successfully implement them. Future research would most effectively advance the field by determining whether an "optimal" bundle of components exists or whether effectiveness is primarily a function of successful implementation.

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Critical revision of the article for important intellectual content: I.M. Miake-Lye, S. Hempel, D.A. Ganz, P.G. Shekelle.
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Collection and assembly of data: I.M. Miake-Lye, S. Hempel, P.G. Shekelle.