

# Prevention of Falls in Older Persons: AGS/BGS Clinical Practice Guideline

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## 1. INTRODUCTION

### Background

Older adults are at higher risk of falling than younger individuals, and are more likely to sustain an injury as the result of a fall. (Campbell et al., 1990; Rubenstein et al., 2002). Falls are not only associated with greater morbidity and mortality in the older population, but are also linked to reduced overall functioning and early admission to long-term care facilities. (Brown et al., 1999; Rubenstein et al., 1994; Tinetti, 1986). Reducing fall risk in older individuals is therefore an important public health objective. (Sattin, 1992)

The Guideline for the Prevention of Falls in Older Persons, a joint endeavor of the American Geriatrics Society, the British Geriatrics Society, and the American Academy of Orthopaedic Surgeons, was published in May, 2001. (JAGS 2001) The aim of the Guideline was to assist health care professionals in their assessment of fall risk and in their management of older adults who have fallen or are at risk of falling. The present publication offers an update to the earlier guideline by evaluating evidence and analyses that have become available since 2001 and by providing revised recommendations based on these evaluations.

For older community residents, effective fall prevention has the potential to reduce serious fall-related injuries, emergency department visits, hospitalizations, nursing home placements, and functional decline. Evidence from randomized controlled trials and other types of studies supporting the beneficial effects of fall prevention programs has done little to change the lack of attention to fall risk in clinical practice. A recent study confirmed that effective fall risk assessments and strategies to prevent falls can significantly reduce serious injuries (hip and other fractures, head injuries, joint dislocations) as well as use of fall-related medical services. (Tinetti, 2008)

Multifactorial assessment coupled with tailored interventions based on the assessment findings can have a dramatic public health impact while improving quality of life in the older population. The multidisciplinary panel that developed this Update was led jointly by representatives of the American Geriatrics Society and the British Geriatrics Society. Panel participants included members of the American Academy of Orthopaedic Surgeons, the American Board of Internal Medicine, the American College of Emergency Physicians, the American Geriatrics Society, the American Medical Association, the American Occupational Therapy Association, the American Physical Therapy Association, the American Society of Consultant Pharmacists, the British Geriatrics Society, the John A. Hartford Foundation Institute for Geriatric Nursing at New York University, and the National Association for Home Care and Hospice. The panel met in one face-to-face meeting, and thoroughly evaluated the content and validity of each section of the update in a series of subsequent conference calls. An experienced moderator facilitated these meetings. The resulting Update is the product of many months of discussion and consensus building. This final document has been reviewed and approved by all organizations participating in the panel.

## **Selection of Evidence**

The panel collected evidence via a three-step process. First, an experienced researcher carried out a literature search to identify meta-analyses, systematic literature reviews, randomized controlled trials, controlled before-and-after studies, and cohort studies published between May 2001 and April 2008 (Note<sup>1</sup>). The researcher also examined reference lists of included articles, and utilized the expert knowledge and experience of panel members to locate additional relevant publications.

In addition to Medline/PubMed, the following databases were searched: Database of Abstracts of Reviews of Effectiveness, Centre for Reviews and Dissemination/Health Technology Assessment, and the Cochrane Central Register of Controlled Trials. For Medline/PubMed searches, the investigator utilized a combination of subject heading and free text searches with the following search terms: “falls,” “fallers” and “time to first fall.” Limits were set for language (English), type of research (randomized controlled trial, systematic review – including Health Technology Assessment review, clinical trial, controlled clinical trial, and meta-analysis) and age  $\geq 65$  years. Intermediate outcome studies, inpatient or hospital studies, and studies of fracture outcomes were excluded. The search selected evidence from original clinical trials that a) provided sufficient detail regarding methods and results to enable use and adjustment of the data; and b) allowed relevant outcomes to be abstracted from the data presented in the article.

In addition to studies identified by these methods, a number of seminal studies published prior to May, 2001, were also included if more recent updates in these areas of research or analysis were not yet available. In the second stage of the search process, three panel members performed a title review of the collected publications and requested abstracts from relevant randomized controlled trial reports. The review of abstracts and the exclusion/inclusion process identified 91 studies that met the inclusion criteria.

In the final evaluation stage, full texts of the included studies were retrieved and abstracted to evidence tables. The abstracted data and the full texts were made available to the members of the panel during the development of the update.

The search and evaluation process allowed panel members to comprehensively summarize the last decade of evidence regarding the risk of falling and the interventions that have been

investigated for the purpose of reducing falls in older adults. However, because definitions of interventions differ from study to study, and are often not clearly elaborated, the panel chose to emphasize outcomes from individual studies rather than stressing the results of meta-analyses. The panel did, however, refer to five recent meta-analyses and evidence-based guidelines in its deliberations.

We have excluded discussion of interventions aimed at bone health (e.g., medications for osteoporosis), and have chosen not to address the topics of syncope, restraints, bone protection (e.g., hip protectors), or in-patient hospital-based fall prevention. Syncope in the context of falls is fully addressed in the 2004 European Falls Guidelines (Brignole, 2004).

Because the guideline is intended to assist health care providers, we have excluded discussion of population-based interventions. Although we have focused on fall prevention in community-domiciled older adults for this update, we have also provided specific recommendations concerning two subgroups: older persons in long-term care and older persons with cognitive impairment.

### **Structure of the Guideline**

The clinical algorithm describes the step-by-step process of decision-making and intervention that should occur in the management of persons who present in a clinical setting with recurrent falls or difficulty walking, or in the emergency department after an acute fall. General and specific recommendations for each point in the algorithm are included in the annotations section following the algorithm. The links to these recommendations are embedded in each relevant step of the diagram.

The annotations include a brief discussion of the research supporting the recommendations. Most also present the rationale behind the grading of the evidence as well as a determination of the strength of the recommendations. The Evidence Tables list the studies that were considered in making decisions regarding the level of evidence for each recommendation. These tables are preceded by Evidence Statements in which information from a selection of the most relevant studies is provided in order to highlight key issues in the research cited.

For some interventions, outcome data were insufficient to allow evidence-based recommendations to be made, or the existing literature was ambiguous or conflicting. In these cases, the panel made recommendations based on consensus after intensive discussion.

### Grading the Strength of Recommendations

A standardized format based on an evidence rating system used by the U.S. Preventative Services Task Force was used to critically analyze the literature and grade the evidence for this document. (Harris et al., 2001) In this approach, the grade for the strength of a recommendation depends on the overall quality of evidence and on the magnitude of net benefit. The panel members rated the overall quality of evidence using the terms shown in Appendix B, Table 1. Net benefit (benefit minus harm) was rated as “substantial,” “moderate,” “small,” or “zero or negative” as described in Appendix B, Table 2. Based on these determinations of overall quality of evidence and magnitude of benefit for each intervention, the panel assigned a grade for each recommendation using the definitions in the following table:

**Table 1. Strength of Recommendation Rating System**

<b>A</b>	A strong recommendation that the clinicians provide the intervention to eligible patients. <i>Good evidence was found that the intervention improves health outcomes and the conclusion is that benefits substantially outweigh harm.</i>
<b>B</b>	A recommendation that clinicians provide this intervention to eligible patients. <i>At least fair evidence was found that the intervention improves health outcomes and the conclusion is that benefits outweigh harm.</i>
<b>C</b>	No recommendation for or against the routine provision of the intervention is made. <i>At least fair evidence was found that the intervention can improve health outcomes, but the balance of benefits and harms is too close to justify a general recommendation.</i>
<b>D</b>	Recommendation is made against routinely providing the intervention to asymptomatic patients. <i>At least fair evidence was found that the intervention is ineffective or that harm outweighs benefits.</i>
<b>I</b>	Evidence is insufficient to recommend for or against routinely providing the intervention. <i>Evidence that the intervention is lacking, or of poor quality, or conflicting, and the balance of benefits and harms cannot be determined.</i>

*Based on the U.S. Preventive Services Task Force rating system (Harris et al, 2001)*

**Note<sup>1</sup>:**

The panel reviewed the RCTs published between April 2008 and July 2009 and concluded that the additional evidence did not change the ranking of the evidence or the guideline

recommendations. Of note, the negative RCTs of multifactorial interventions all involved risk factor assessment with referral without direct intervention or ensuring that the interventions were instituted.

## Goal

To optimize assessment and interventions for reducing the number of falls in older people.

## Vision statement of the Guideline Working Group

The panel anticipates that these guidelines will provide a stimulus for widespread use of effective, evidence-based fall prevention services for older adults. Public awareness of the benefits of such prevention will also increase leading to more demand for fall prevention services by older adults and their advocates. Health care providers across diverse disciplines and settings and at multiple points of access will be able to use the generic criteria provided in these guidelines to appropriately screen individuals for risk of falls. All people identified as being at risk will be offered a multifactorial assessment and tailored interventions, with the understanding that these interventions need to be integrated and balanced with other health care priorities. Preventive services will result in a reduction in the incidence of falls and will maximize functional and quality-of-life outcomes.

## Definitions

**Fall:** For the purposes of this update, a fall is defined as “an event whereby an individual unexpectedly comes to rest on the ground or another lower level without known loss of consciousness.”

**Multifactorial fall risk assessment:** Assessment of known predisposing factors within the person and in the environment that increase the risk of falling.

**Intervention domains (categories):** Medication, exercise, vision, postural hypotension, heart rate and rhythm, vitamin D, foot and footwear, home environment, education.

**Single intervention:** An intervention in one of the preceding categories, such as a balance and strength exercise program, medication adjustment, vision improvement, home/environmental modification, footwear adjustment, educational programs.

**Multifactorial intervention:** An intervention made up of a subset of interventions that are selected and offered to an individual to address the specific risk factors identified through a multifactorial fall risk assessment.

**Multicomponent intervention:** A set of interventions addressing more than one intervention domain or category offered to all participants in a program (population approach).

## **Discussion**

Most papers reporting epidemiological data or clinical interventions related to falls in older individuals have not defined a fall. Since this Update is intended for use in the context of health care assessment at a level of detail appropriate to the context, a simpler definition was considered preferable to that of the 2001 Guidelines.

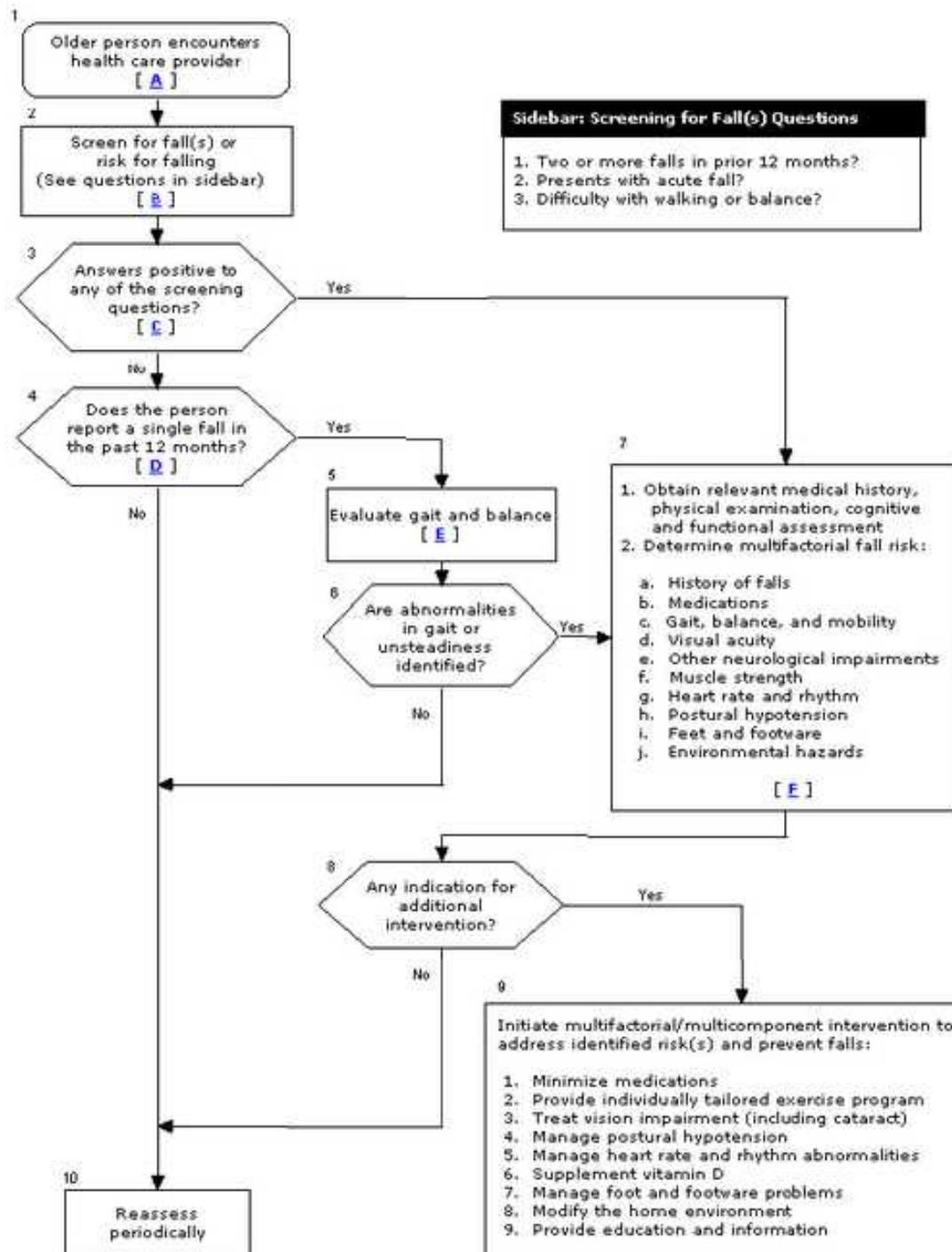
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### **Note<sup>2</sup>:**

The panel reviewed the RCTs published between April 2008 and July 2009 and concluded that the additional evidence did not change the ranking of the evidence or the guideline recommendations. Of note, the negative RCTs of multifactorial interventions all involved risk factor assessment with referral without direct intervention or ensuring that the interventions were instituted.

## 2. SCREENING AND ASSESSMENT

### Algorithm



## Algorithm Annotations

### Annotation A: Older Person Encounters Health Care Provider

This guideline algorithm is to be used in the clinical setting for assessment and intervention to reduce falls among community-residing older persons ( $\geq 65$  years). The guideline algorithm is not intended to address fall injuries *per se* or falls that occur in hospital.

### Annotation B: Screen for Falls or Risk for Falling

*Background:* The screening for falls and risk for falling is aimed at preventing or reducing fall risk. Structuring and standardizing the screening process may improve adherence of providers to the guideline recommendations. The use of a finite number of simple questions, requiring a yes/no answer, may also simplify documentation. Any positive answer to the screening questions puts the person screened in a high-risk group that warrants further evaluation.

All older persons who are under the care of a health professional (or their caregivers) should be asked at least once a year about falls, frequency of falling, and difficulties in gait or balance.

#### Recommendations:

1. All older individuals should be asked whether they have fallen (in the past year).
2. An older person who reports a fall should be asked about the frequency and circumstances of the fall(s).
3. Older individuals should be asked if they experience difficulties with walking or balance.

### Annotation C: Screen Positive for Falls or Risk for Falling?

*Background:* Falls among older persons can be caused by several factors. Persons at higher risk of falling, identified by screening, should be assessed for known risk factors, which include a history of falls; taking multiple medications (particularly psychotropic medications); problems with gait, balance, or mobility; impaired vision; other neurological impairments; reduced muscle strength; problems with heart rate or rhythm; postural hypotension; foot problems. The assessment by itself will not reduce falls. However, the assessment is essential to allow tailoring the intervention and follow-up to the individual risk.

A multifactorial fall risk assessment should be performed for community-dwelling older persons who

- report recurrent (two or more) falls
- report difficulties with gait or balance
- seek medical attention or present to the Emergency Department because of a fall.

- report difficulties with gait or balance
- seek medical attention or present to the Emergency Department because of a fall.

Recommendations:

4. Older persons who present for medical attention because of a fall, report recurrent falls in the past year, or report difficulties in walking or balance (with or without activity curtailment) should have a multifactorial fall risk assessment.
5. Older persons who cannot perform or perform poorly on a standardized gait and balance test (see Annotation E: Gait and Balance) should be given a multifactorial fall risk assessment.

*Rationale.* The recommendations for assessment are based on epidemiological studies demonstrating an association between risk factors and falls (see *Background* for risk factors) and from experimental studies in which assessment followed by intervention demonstrated benefit (see *Interventions to Prevent Falls*, below). Thus, the suggested assessment describes what steps need to be taken to understand an individual's risk factors and apply effective intervention(s). The risk factors identified in the assessment may be modifiable (e.g., muscle weakness, medication adverse effect, or hypotension) or non-modifiable (e.g., hemiplegia or blindness). However, knowledge of all risk factors is important for treatment planning. Essential components of the fall-related patient assessment were identified whenever possible from successful controlled trials of fall prevention interventions. The justification for assessment to identify a specific risk factor was strongest when successful treatment or other risk-reduction strategies were explicitly based on this specific risk factor. In some cases, the link between identified risk factors and the content of interventions was not clear. When conclusive data on the importance of specific aspects of the assessment were not available, decisions were based on panel consensus.

*Evidence Statements.* Multifactorial falls risk assessment and management programs may be the most effective intervention for reducing both the risk for falling and the monthly rate of falling, assuming that the interventions are carried out (Chang, 2004). Recent trials of multifactorial risk assessment followed by referral without assurance of completion of the intervention have not proven effective.

Multidisciplinary, multifactorial, health/environmental risk factor screening and/or intervention programs that are likely to be beneficial in the community are those aimed at: a) an unselected

population of older people; b) older people with a history of falling; c) older people selected with known risk factors; and d) older people in long-term care facilities. (Gillespie, 2003)

Annotation D: Does the Person Report a Single Fall in the Past 12 Months?

*Background:* A (first) single fall may indicate difficulties or unsteadiness in walking or standing. In older individuals, a fall may be a sign of problems in gait or balance that were not present in the past. For the purposes of early detection and risk modification, the person should be observed for gait and balance deficits.

Many older persons are not aware of deterioration in their normal gait or balance. A simple test can identify deficits in gait and balance and whether there is a need for further evaluation and intervention.

Recommendations:

6. Older persons who report a single fall in the past 12 months should be evaluated for gait and balance.

Persons with two or more falls in the past 12 months or with gait or balance abnormalities have a strong likelihood of subsequent falls and therefore would benefit from a multifactorial falls risk assessment. While persons reporting a single fall within the prior 12 months but with no problems with gait or balance may similarly derive benefit from multifactorial assessment and intervention, the evidence for this is lacking.

Annotation E: Evaluate Gait and Balance

*Background:* The purpose of the gait and balance evaluation is to identify older individuals who need a multifactorial assessment of risk factors for falling. Because deficits in balance and gait are the most predictive risk factors for falls, a quick test is recommended.

Gait and balance deficits should be evaluated in older individuals reporting a single fall as a screen for identifying individuals who may benefit from a multifactorial fall risk assessment. For persons who screen positive for falls or fall risk, evaluation of balance and gait should be part of the multifactorial fall risk assessment.

Recommendations:

7. Older persons who have fallen should have an assessment of gait and balance using one of the available evaluations.[B] (See list below.)
8. Older persons who have difficulty or demonstrate unsteadiness during the evaluation require a multifactorial fall risk assessment.
9. Older persons reporting only a single fall in the past year and reporting or demonstrating no difficulty or unsteadiness during the evaluation do not require a fall risk assessment.

*Rationale.* Frequently used tests of gait or balance include the *Get up and Go* test (Mathias, 1986); *Timed Up and Go* test (Podsiadlo et al, 1991), the *Berg Balance Scale* (Berg et al, 1989), the *Performance-Oriented Mobility Assessment* (Tinetti 1986; Tinetti et al 1988), and others.

*Evidence Statements.* No adequate prospective study has been published that permits selection of a specific test of balance and gait nor is there adequate validation of a cut-off score for any of the tests for identification of future fallers from a population of single fallers or from a mixed community of individuals not selected for fall status.

**Timed Up and Go test.** The systematic review undertaken to evaluate the *Timed Up and Go* test by the ProFANE research group, as yet unpublished, did not find any studies that addressed adequately defined populations prospectively tested against falls outcomes. In a retrospective study (Whitney 2004), and two case-control studies (Shumway-Cook 2000, Dite 2002), different definitions of fall status were utilized. Two studies (Shumway-Cook, Rose 1997) compared people with recurrent falls to people without falls (excluding persons who had fallen once). In each of the above studies, cut-off scores were selected based on their sample (ranging from 10 to 14 seconds). Two studies (Rose and Whitney) also evaluated a cut-off suggested by Shumway-Cook (13.5 seconds). Sensitivity ranged from 30% to 89% and specificity from 56% to 100%. The sensitivity, in particular, was much lower when the cut-off score was pre-suggested and not dependent on data from the sample. In summary, the methodological quality and variability made meta-analyses unsuitable.

**The Berg Balance Scale.** Although the *Berg Balance Scale* is widely used and can distinguish fallers from non-fallers in case-control studies, it lacks a gait assessment component. A recent small case-control study comparing the *Berg Balance Scale* against other functional tests of mobility and balance demonstrated that it had better discriminating ability than the *Performance-Oriented Mobility Assessment Score* or the *Timed Up and Go* test, with high sensitivity and specificity. The most effective screening item for identifying risk was "retrieve an object from the floor" from the *Berg Balance Scale* (Chiu, 2003)

**Performance-Oriented Mobility Assessment.** The *Performance-Oriented Mobility Assessment* has not demonstrated a reliable cut-off score for predicting falls. However, a recent review (in French) of postural stability assessments concluded that older assessments, including the *Berg Balance Scale* and the *Functional Reach Test*, do not have the necessary validity, and that the *Performance-Oriented Mobility Assessment* and the *Timed Up and Go* test are preferable in terms of feasibility and validity as postural assessments for older people. This review reiterated, however, that the predictive ability of these tests for future falls was modest. (Perennou, 2005)

### Evidence Table

	Evidence	Source	LE	QE	SR
1	Performance tests of gait and balance are adequate for the detection of people at risk of falling. The tests we suggest are the <i>Get Up and Go</i> test, <i>Timed Up and Go</i> test, <i>Berg Balance Scale</i> or the <i>Performance-Oriented Mobility Assessment</i> .	Mathias, 1986 Podsiadlo, 1991 Berg, 1992 Tinetti, 1986 Tinetti, 1988	I	Fair	B

*LE = level of evidence; QE = quality of evidence; SR = strength of recommendation.*

### Annotation F: Determine Multifactorial Fall Risks

*Background:* A multifactorial fall risk assessment can reveal the factors that put an older adult at risk of falling and can help identify the most appropriate interventions.

The assessment may be carried out by a single clinician or, alternatively, more than one clinician may complete the components most relevant to their expertise. Assessments should be performed by clinicians with appropriate skills and training (e.g., a physician, nurse practitioner, physical therapist, occupational therapist, or pharmacist).

A multifactorial fall risk assessment followed by intervention to modify any identified risks is a highly effective strategy to reduce both falls and the risk of falling in older persons.

### Recommendations:

10. The multifactorial fall risk assessment should be performed by a clinician (or clinicians) with appropriate skills and training.

11. The multifactorial fall risk assessment should include the following:

a. Focused History

- History of falls: Detailed description of the circumstances of the fall(s), frequency, symptoms at time of fall, injuries, other consequences
- Medication review: All prescribed and over-the-counter medications with dosages
- History of relevant risk factors: Acute or chronic medical problems, (e.g., osteoporosis, urinary incontinence, cardiovascular disease)

b. Physical Examination

- Detailed assessment of gait, balance, and mobility levels and lower extremity joint function
- Neurological function: Cognitive evaluation, lower extremity peripheral nerves, proprioception, reflexes, tests of cortical, extrapyramidal and cerebellar function
- Muscle strength (lower extremities)
- Cardiovascular status: Heart rate and rhythm, postural pulse and postural blood pressure; and, if appropriate, heart rate and blood pressure responses to carotid sinus stimulation
- Assessment of visual acuity
- Examination of the feet and footwear

c. Functional Assessment

- Assessment of activities of daily living (ADL) skills including use of adaptive equipment and mobility aids, as appropriate
- Assessment of the individual's perceived functional ability and fear related to falling
- (Assessment of current activity levels with attention to the extent to which concerns about falling are protective [i.e., appropriate given abilities] or contributing to deconditioning and/or compromised quality of life [i.e., individual is curtailing involvement in activities he or she is safely able to perform due to fear of falling])

d. Environmental Assessment

12. The multifactorial fall risk assessment should be followed by direct interventions tailored to the identified risk factors, coupled with an appropriate exercise program.[A]

*Rationale.* The results of several individual studies have shown that a multifactorial risk assessment that was not tied to intervention was not effective in reducing falls. Multifactorial falls risk assessment and management programs may be the most effective intervention for reducing both the risk for falling and the monthly rate of falling, assuming that the interventions

are carried out (Chang, 2004). Recent trials of multifactorial risk assessment followed by referral without assurance of completion of the intervention have not proven effective.

**Risk Factors for Falling.** Many published studies have documented important identifiable risk factors for falling. In the initial version of this Guideline, this literature was reviewed extensively and summarized. While not systematically updated here, the literature on fall risk factors has had no major changes. These risk factors can be classified as either intrinsic or extrinsic. Major intrinsic risk factors include lower extremity weakness, previous falls, gait and balance disorders, visual impairment, depression, functional and cognitive impairment, dizziness, low body mass index, urinary incontinence, orthostatic hypotension, female sex and being over age 80. Extrinsic risk factors include polypharmacy (i.e., taking over four prescription medications), psychotropic medications, and environmental hazards such as poor lighting, loose carpets, and lack of bathroom safety equipment.

Perhaps as important as identifying risk factors is appreciating the interaction and probable synergism between multiple risk factors. Several studies have shown that the risk of falling increases dramatically as the number of risk factors increases. Tinetti et al. surveyed community-dwelling older adults and reported that the percentage of persons falling increased from 27% for those with no or one risk factor to 78% for those with four or more risk factors. (Tinetti et al, 1988)

Similar results were found among an institutionalized population. (Tinetti, 1986) In another study, Nevitt et al. reported that the percentage of community-living persons with recurrent falls increased from 10% to 69% as the number of risk factors increased from one to four or more. (Nevitt et al, 1989)

Robbins et al. used multivariate analysis to simplify risk factors so that maximum predictive accuracy could be obtained. They employed only three risk factors – hip weakness, unstable balance, taking more than four medications – in an algorithm format. With this model, they predicted 1-year risk of falling ranged from 12% for persons with none of the three risk factors to 100% for persons with all three. (Robbins et al, 1997)

### 3. INTERVENTIONS TO PREVENT FALLS

#### a. Older Persons Living in the Community

##### Multifactorial/Multicomponent Interventions to Address Identified Risk(s) and Prevent Falls

*Background.* Most falls result from interactions between long- and short-term factors within the host and precipitating factors in the environment. [Tinetti 1988, 1995] Observational studies have shown that each of the following conditions or factors increases the subsequent risk of falling: arthritis; depressive symptoms; postural (orthostatic) hypotension; impaired cognition, vision, balance, gait, or muscle strength; use of psychoactive medications; and treatment with four or more prescription medications. Furthermore, the risk of falling has been shown to increase as the number of these risk factors increases. [Tinetti 1988, Nevitt, 1989, Robbins 1989] In clinical trials, researchers have attempted to modify either a single risk factor or multiple risk factors, and both strategies have been shown to be effective in reducing the rate of falling. Targeting multiple risk factors appears to be effective only if efforts are made to ensure that the interventions are carried out. The reduction in fall risk may be associated with the number of risk factors improved or eliminated [Tinetti et al., 1996].

Two methods for reducing multiple risk factors have been tested in clinical trials. The first method, termed “multicomponent intervention” in this guideline, refers to a set of interventions offered to all participants in a program that addresses more than one intervention category. This method has been used most often in long-term care settings. In the second method, called “multifactorial intervention,” participants are offered only the tailored subset of interventions that target the risk factors that have been identified through a fall risk factor assessment. This targeted or tailored approach has been implemented primarily among community-dwelling older persons. [Hauer, 2006] There is a great deal of heterogeneity among the designs of the multifactorial and multicomponent studies and they can be differentiated in many dimensions (i.e., health care based vs. population based, high risk population vs general older adults, direct intervention vs. referral). Since differentiation of these approaches was beyond the scope of this guideline we therefore included trials with multifactorial or multicomponent approaches regardless of dimensions.

Most of the components included in multicomponent or tailored multifactorial interventions can be described under the broad headings of exercise and physical activity, medical assessment and

management, medication adjustment, environmental modification, and education. These components represent distinct areas of expertise and clinical practice. Therefore, the interventions are often administered by several clinicians from various disciplines, presenting challenges of coordination.

In deciding which groups of older adults will benefit most from multicomponent or multifactorial interventions, it is helpful to review the evidence for relevant subgroups of older adults. The main subgroup addressed in this section and throughout the guideline is the population of older persons residing in the community. For the populations of older people residing in long-term care settings or of individuals with cognitive deficits, information is offered in Appendix A and B of this update.

Initiate strategies that combine interventions targeting more than one risk factor to reduce falls. Attention to the following domains are particularly effective: environmental adaptation; balance, transfer, strength and gait training; reduction in medications, particularly psychoactive medications; management of visual deficits, postural hypotension, and other cardiovascular and medical problems.

Recommendations:

13. A strategy to reduce the risk of falls should include multifactorial assessment of known fall risk factors and management of the risk factors identified. [A]
14. The components most commonly included in efficacious interventions were:
  - a. Adaptation or modification of home environment [A]
  - b. Withdrawal or minimization of psychoactive medications [B]
  - c. Withdrawal or minimization of other medications [C]
  - d. Management of postural hypotension [C]
  - e. Management of foot problems and footwear [C]
  - f. Exercise, particularly balance, strength, and gait training [A]
15. All older adults who are at risk of falling should be offered an exercise program incorporating balance, gait, and strength training. Flexibility and endurance training should also be offered, but not as sole components of the program. [A]
16. Multifactorial/multicomponent intervention should include an education component complementing and addressing issues specific to the intervention being provided, tailored to individual cognitive function and language. [C]
17. The health professional or team conducting the fall risk assessment should directly implement the interventions or should assure that the interventions are carried out by other qualified healthcare professionals. [A]

*Rationale.* An intervention strategy based on a multifactorial assessment of known fall risk factors and followed by linked interventions appears to be an effective approach for reducing the

rate of falls among cognitively intact, community-living older people at risk of falling. However, to date, studies evaluating multifactorial interventions have not been designed to assess the contribution of each component. Therefore, we are unable to make strong recommendations concerning the benefits accrued from individual intervention components. Recommendations are based on the most commonly included components of the effective interventions.

The multifactorial/multicomponent approach to interventions designed to prevent falls in older persons is supported by a significant body of evidence including two meta-analyses by the Cochrane Collaborative and by Chang et al (2004). Additional studies have been published since these meta-analyses which supplement the earlier evidence. The need for careful monitoring and follow-up is highlighted in several studies in which nine of ten that documented assessment and intervention processes that were carefully overseen and monitored proved to be beneficial. This contrasted with studies which provided only advice, knowledge or unmonitored referral in which only two of 12 were effective. These findings were also corroborated in recent meta-analyses. (Gates et al, 2008)

#### *Evidence Statements.*

#### Systematic reviews

**Gillespie et al., 2003.** A meta-analysis of five randomized controlled trials found that "multidisciplinary, multifactorial, health/environmental risk factor screening and intervention programs" significantly reduced the number of participants falling and also reduced the incidence of falls among community-dwelling older people.

**Chang et al., 2004.** This meta-analysis of 40 randomized controlled trials investigated the effectiveness of multifactorial assessments plus various combinations of multiple interventions aimed at preventing falls in older adults. The results demonstrated a significant reduction in the risk of falling (risk ratio, 0.88) in the assessment and intervention groups compared to "usual care" or control groups. Monthly rate of falling was also significantly lower (incidence rate ratio, 0.80). Multifactorial assessment and management programs were the most effective component in reducing fall risk (incidence rate ratio, 0.82; number needed to treat, 11).

**Hill, 2002.** The effectiveness of strategies for preventing future falls was examined in this meta-analysis which pooled data from 12 studies of fall prevention. Eight of the studies included

exercise (three offered exercise only) and three included comprehensive risk assessment and targeted interventions. The analysis found a 4% decrease in the rate of falls for individuals in treatment groups receiving various fall prevention interventions. Exercise alone was not significantly effective. Exercise combined with other risk factor modifications was more effective in community-based programs compared to programs in residential institutions. Fall prevention programs showed greater effects when outcomes were measured for 12 months or longer.

**Weatherall, 2004.** This report estimated the effectiveness of fall prevention programs from the randomized controlled trials cited in the 2001 guideline and in another published guideline from 2000 (Feder et al., 2000). The authors evaluated 17 studies available up to August, 2002. The analysis demonstrated that: a) exercise as a sole intervention may have a beneficial effect but the results are not conclusive; b) multiple intervention programs are more effective than exercise alone (number needed to treat: multiple interventions, 9.8 versus exercise alone, 19.5); c) a “visit and advice” intervention may be effective but has the largest number needed to treat estimate. The authors concluded that multiple intervention strategies were particularly effective for fall prevention.

#### *Targeted randomized controlled trials*

**Tinetti et al., 1994,** utilized a multiple risk factor intervention strategy. Subjects had at least one risk factor for falling. After assessment, subjects in the intervention group received targeted interventions in the following areas: medication adjustments; home hazard review and adjustment; behavioral 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, with 35% falling in the intervention group compared to 47% falling in the control group ( $P=0.04$ ). Adjusted incidence-rate ratio for falling in the intervention group compared to controls was 0.69. The percentage of subjects with particular fall risk factors also declined significantly from baseline.

**Close et al., 1999**, focused on older people presenting to an emergency department after a fall. The study utilized a core assessment by medical and occupational therapy staff, with subsequent referral to other specialist services if required. After one year, the number of falls in the intervention group (183) was significantly lower than that in the control group (510;  $P=0.0002$ ). Risk of falling was also significantly reduced with intervention (odds ratio, 0.39) as were the risk of recurrent falls (odds ratio, 0.33) and likelihood of admission to hospital (odds ratio, 0.61).

**Clemson, 2004** evaluated a multicomponent community-based program called “Stepping On.” This program, which employs a small-group learning environment, is effective in reducing falls in at-risk people living at home. Key aspects of the program are based on evidence that falls can be prevented by a) improving lower limb strength and balance; b) optimizing environmental and behavioral home safety; c) conducting regular medication reviews; and d) undergoing regular vision screening. Interventions included cognitive behavioral learning strategies for self-efficacy and decision-making; education about risk management; a lower limb strength and balance exercise program; medication management; and home and community safety. The “Stepping On” program was associated with a 31% reduction in falls compared to usual care.

**Day et al., 2002.** Three interventions (group exercise, home hazard management, and vision improvement) were offered to older individuals living in the community. A significant fall prevention effect was demonstrated for group-based exercise, the most potent single intervention (rate ratio, 0.82). A significant effect was also found for combinations of interventions that involved exercise. Balance measures improved in association with exercise. Neither home hazard management nor treatment of poor vision were effective alone, but the strongest effect occurred with all three interventions combined (rate ratio, 0.67). With all three interventions, the annual fall rate decreased by 14% (number needed to treat, 7).

**Lightbody et al., 2002.** This study evaluated a nurse assessment and management plan and care pathway development for older people discharged home from emergency departments after a fall. The intervention consisted of a fall risk assessment in the home that addressed modifiable risk factors (medication, electrocardiogram, blood pressure, cognition, visual acuity, hearing, vestibular dysfunction, balance, mobility, feet and footwear). The intervention was carried out by a trained nurse 2-4 weeks after the index fall. Identified risk factors were addressed using referral

to existing services. Advice and education about safety in the home were also provided. At the six-month follow-up, a non-significant trend towards lower falls was found in the intervention group compared to usual care. Fewer fall-related admissions (8 versus 10) and bed days (69 versus 233) were reported.

**Davison, 2005**, conducted a randomized clinical trial in which conventional care was compared to a multifactorial assessment and intervention (medical, physiotherapy and occupational therapy) in individuals presenting with a fall or fall-related injury and at least one additional fall in the preceding year. Significantly fewer falls (36% reduction) occurred in the intervention group (relative risk, 0.64) although the proportion of subjects continuing to fall and the number of fall-related presentations and hospital admissions did not differ between groups. Duration of hospital admission was reduced and falls efficacy was better in the intervention group.

#### *Untargeted randomized controlled trials*

**Steinberg et al., 2000**, evaluated a multicomponent intervention aimed at major fall risk factors in reducing slips, trips and falls. Volunteers were randomized to receive one of four interventions: a) an education program (oral presentation with pamphlet); b) the education program plus an exercise class once a month; c) education, exercise, plus a home safety assessment with financial and practical support for home modification; and d) education, exercise, home modification plus clinical assessment and advice on medical fall risk factors. At one year follow-up, a statistically significant reduction in the risk of slips and trips and a trend towards a reduction in the risk of falling was found in all intervention groups relative to the control group.

**Whitehead et al., 2003**. Patients presenting to the emergency department after a fall were randomized to usual care or to an intervention consisting of a falls risk assessment and an evidence-based prescription faxed to their physician. Fall rates as well as compliance with advice were monitored for six months. Patients in the intervention group were more likely to comply with preventative advice (odds ratio, 12.3) but there was no significant reduction in falls in the intervention group (odds ratio, 1.7).

Evidence Table

	<b>Evidence</b>	<b>Source</b>	<b>LE</b>	<b>QE</b>	<b>SR</b>
1	For community-living older adults at risk of falling, a multifactorial assessment followed by linked intervention is effective. Evidence suggests that the health professional or team conducting the fall risk assessment should assure that the interventions are carried out by health professionals to ensure effectiveness. Multifactorial assessment without ensuring intervention beyond advice and information provision is ineffective.	Campbell, 1999 Chang, 2004 Clemson, 2004 Close, 1999 Coleman, 1999 Davison, 2005 Day, 2002 Gallagher, 1996 Gillespie, 2003 Hogan, 2001 Hornbrook, 1994 Kingston, 2001 Lightbody, 2002 Newbury, 2001 Steinberg, 2000 Tinetti, 1994 VanHaastregt, 2000 Vetter, 1992 Wagner, 1994 Whitehead, 2003	I	Good	A
2	General medical or geriatric assessments and interventions that are not targeted at known fall risk factors do not appear to reduce fall rates or occurrence.	Coleman, 1999	I	Fair	B
3	The effective multifactorial/multicomponent interventions included the following components: environmental adaptation and/or modification (9 studies out of 11); balance, strength, and gait training (7 out of 11); assistive devices; reducing psychoactive medications; reviewing and reducing other medications; managing vision problems; managing orthostasis; and addressing cardiovascular and other medical problems.	Campbell, 1999 Chang, 2004 Clemson, 2004 Close, 1999 Davison, 2005 Day, 2002 Gillespie, 2003 Nikolaus, 2003 Steinberg, 2000 Tinetti, 1994 Wagner, 1994 Whitehead, 2003	I	Good	A
4	Risk factor assessment without direct intervention of the identified risk factors does not appear to be effective.	Gallagher, 1996 Hogan, 2001 Hornbrook, 1994 Kingston, 2001 Lightbody, 2002 Newbury, 2001 Rubenstein, 1990 VanHaastregt, 2000 Vetter, 1992	I	Good	E

*LE = level of evidence; QE = quality of evidence; SR = strength of recommendation.*

## 2.1. Minimize Medications

*Background.* Medications have consistently been associated with increased risk of falls. Reasons for this include both direct effects (e.g., lowering of blood pressure, sedation) and side effects (e.g., fatigue, confusion, ataxia, dizziness). The strongest risk associations occur with psychotropic medications and polypharmacy (defined as more than an arbitrary number of different prescription medications, usually four or more). As a result, many multifactorial fall prevention programs have included medication reduction and simplification. All studied programs that have included such strategies have shown significant efficacy in fall prevention.

### Recommendations:

18. Psychoactive medications (including sedative hypnotics, anxiolytics, antidepressants) and antipsychotics (including new antidepressants or antipsychotics) should be minimized or withdrawn, with appropriate tapering if indicated. [B]
19. A reduction in the total number of medications or dose of individual medications should be pursued. All medications should be reviewed, and minimized or withdrawn. [B]

*Rationale.* There is one published randomized controlled trial of medication manipulation as a separate intervention (as part of a 2 x 2 factorial design) to reduce falls. In addition, reduction of medications has been a prominent component of fall-reducing interventions in a large number of effective community-based and long-term care multifactorial/multicomponent studies.

Most of the trials of multifactorial interventions do not provide sufficiently detailed information to allow estimation of benefit attributable to medication minimization. Seven studies of multifactorial interventions have included medication modification. Of these, three focused on psychoactive agents and four on other types of medications. All demonstrated benefit overall.

The strongest evidence supports withdrawal of psychotropic medication, both as a single intervention and as a component of multifactorial/multicomponent intervention. If discontinuation of a particular high-risk medication is not possible due to medical conditions, dose reduction should be considered.

### *Evidence Statements.*

For all settings, including the community, long-term care, rehabilitation facilities, or hospital, there is a consistent association between psychotropic medication use (neuroleptics, sedative-hypnotics, anxiolytics, and antidepressants) and falls.

***Observational studies: medication as a risk factor***

While some clinicians believe that selective serotonin reuptake inhibitors (SSRIs) are generally safer to use in older adults than tricyclic antidepressants in terms of fall prevention, the data have not supported this. In fact, evidence is building that SSRIs increase fall risk as much as the older tricyclic antidepressants. (Leipzig, 1999; Arfken, 2001, Ensrud, 2002)

**Leipzig et al., 1999**, carried out systematic reviews of the effect of medications on falls, and 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. No randomized controlled trials were identified in this systematic review. Results were based on the pooling of data from cohort, case-control and cross-sectional studies.

**Ensrud et al., 2003**, confirmed that the use of benzodiazepines, antidepressants, and anticonvulsant medication was associated with an increased risk of frequent falls in a large sample (N=8127) of community-dwelling older women. During this three-year study, most participants visited the clinic at least four times and the other participants were followed by home visits or questionnaires to determine whether current use of central nervous system-active medications increases the risk for subsequent falls. Those taking medications (8% benzodiazepines, 6% antidepressants, 6% anticonvulsants, 5% narcotics) were at increased risk of frequent falls. Benzodiazepine use (long-acting only) was associated with 34% greater likelihood for falls and antidepressant use was associated with 54% increased risk of frequent falls (marginal significance for one fall). Subjects taking anticonvulsants had 75% increased risk for one or more falls and were twice as likely to have frequent falls. There was no difference in risk of falls between narcotic and non-narcotic users.

***Medication minimization alone and as a component of multifactorial intervention***

**Campbell et al., 1999**. This randomized controlled trial investigated two interventions, withdrawal of psychotropic medication and a home-based exercise program, in older people taking psychotropic medication. Patients were randomly assigned to one of four groups in a 2 x 2 design: a) gradual withdrawal of medication over 14 weeks versus continuing to take medication; and b) a home-based exercise program versus no exercise. After 44 weeks, the withdrawal of psychotropic medication significantly reduced the risk of falling by 66%. No interaction effect

was found between the two interventions. However, 47% of participants who ceased psychotropic use during the study had resumed taking their medication one month after completion of the study. The authors emphasized that support services, including counseling, relaxation therapy and sleep promotion resources, need to be considered for patients attempting to terminate psychotropic medications.

Although there have been no randomized controlled trials of medication manipulation as the sole intervention (other than in the Campbell 1999 study described above), reduction of medications has been a prominent component of effective multifactorial/multicomponent fall-reducing interventions in community-based and long-term care studies (Close, 1999; Tinetti, 1994; Wagner, 1994; Ray, 1997; Clemson 2004; Healey 2004, Jensen 2002). While it is not possible to assess the relative value of medication reduction alone in the effectiveness of these controlled interventions, virtually all of the multifactorial fall-reduction programs that included medication minimization were significantly effective in reducing falls. Furthermore, several multifactorial/multicomponent studies that did not include medication reduction were not effective.

**Tinetti et al., 1994**, included medication reduction and non-pharmacological strategies in a multifactorial randomized controlled trial. They found that the number of subjects taking four or more medications declined by 23% relative to the control group after one year. The multiple intervention program also resulted in a significant reduction in time to first fall and in the proportion of subjects who fell during the study period compared to the control group.

#### Evidence Table

	<b>Evidence</b>	<b>Source</b>	<b>LE</b>	<b>QE</b>	<b>SR</b>
1	Consistent association has been found between psychotropic medication use (i.e., neuroleptics, sedative-hypnotics, anxiolytics, and antidepressants) and falls.	Arfken, 2001 Ensrud, 2002 Leipzig, 1999	III	-	C
2	Reduction of psychotropic medication as a single intervention reduces rate of falls.	Campbell, 1999	I	Fair	I

3	Assessment, adjustment, and discontinuation of medication regimens as part of multifactorial intervention reduces falls in old persons living in the community.	Campbell, 1999 Clemson, 2004 Close, 1999 Davison, 2005 Healey, 2004 Tinetti, 1994 Wagner, 1994	I	Fair	B
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*LE = level of evidence; QE = quality of evidence; SR = strength of recommendation.*

## 2.2. Initiate an Individually-Tailored Exercise Program

*Background.* Exercise programs are a commonly used fall prevention strategy. There are a number of models of exercise delivery, such as group exercise and individualized home exercise programs. A range of exercise types have been investigated that can be used in isolation or in combination within a specific exercise program, including balance exercises, strength training, flexibility (muscle and joint stretching techniques), Tai Chi, and cardiovascular, endurance, and fitness training.

Numerous research studies have evaluated the types and quantity of exercise that help to reduce falls among older adults. Having certain physical attributes such as weak legs, poor muscle strength, poor balance and stability, and limited mobility have been found to negatively impact gait and increase the risk of falling. Since strength, muscle mass, gait, balance and stability are all closely interlinked, many of the exercise intervention programs have included strengthening exercise as well as balance and stability training. Even among frail older adults who are relatively weak, strength training programs appear to increase muscle strength, core balance and gait.

Exercise, in the form of strength training, and balance, gait, and coordination training, should be included as part of a multifactorial/multicomponent intervention to prevent falls in older persons, and may be considered as a single intervention.

### Recommendations.

1. Exercise should be included as a component of multifactorial interventions for fall prevention in community-residing older persons. [A]
2. An exercise program that targets strength, gait and balance, such as Tai Chi or physical therapy, is recommended as an effective intervention to reduce falls [A]
3. Exercise may be performed in groups or as individual (home) exercises, as both are effective in preventing falls. [B]

4. Exercise programs should take into account the physical capabilities and health profile of the older person, (i.e., be tailored) and be prescribed by qualified health professionals or fitness instructors. [I]
5. The exercise program should include regular review, progression and adjustment of the exercise prescription as appropriate. [I]

*Rationale and Evidence Statements.* A large body of evidence supports the recommendation that exercise, in the form of resistance (strength) training, and balance, gait and co-ordination training, is effective in reducing falls. The reduction in fall rate resulting from exercise is modest (approximately 16%). The best estimate of number needed to treat to prevent one fall is 16 people. (Chang, 2004).

Twenty-four studies have been conducted in community-dwelling populations evaluating exercise as a single intervention. Thirteen studies found that the exercise program was effective in reducing falls. In most of these positive trials, the duration of the exercise program was longer than 12 weeks with variable intensity ranging from once a week to 90 minutes three times per week.

Exercise may be more effective when applied alongside other interventions. Exercise programs were associated with a reduction in falls in both multifactorial and multicomponent studies. (Campbell, 1999; Steinberg, 2000; Tinetti, 1994; Clemson, 2004; Day, 2002). The Hogan et al. (2001) multifactorial intervention included exercise and demonstrated that compared to the control group, the intervention group had significantly more time between falls. In two other studies that combined exercise with other interventions, fall risk factors were reduced but the intervention did not prevent falls. (Whitehead, 2003; Lord, 2005)

Exercise may be considered as a single intervention to reduce falls in selected groups (Gardner, 2000). Initiating exercise programs should be done with caution as some studies have shown that exercise may increase the rate of falls in persons with limited mobility who are not used to exercising. Exercise is an important component of multifactorial fall prevention programs, and future research should address the possibility that, in some populations, exercise may be as effective as multifactorial fall prevention programs.

Recommendations limited to specific types of exercise cannot be made with complete confidence, but general principles may be distilled from the literature, despite the fact that many

reports fail to provide adequate details of their interventions. Further research is needed to identify the most effective components of interventions. (Gardner, 2000)

Endurance (aerobic) training has not been widely tested as a falls prevention strategy. There is insufficient evidence to support the inclusion of endurance exercise in fall prevention exercise programs, although the broader health benefits of endurance training should be considered.

Some trials included a specific Tai Chi program (Gardner, 2000; Li, 2005; Liu-Ambrose, 2004; Lord, 2003; Suzuki, 2004; Wolf, 1996) as part of the intervention. Some of these have showed significant reduction in falls in addition to other benefits in gait, balance, and reduction in fear of falling. Other forms of balance training have demonstrated similar results.

Recommendations concerning other settings and special populations, particularly long-term settings, are subject to considerable uncertainty.

To be of maximum benefit, future trials should standardize the populations from which they recruit, describe the interventions tested, and ensure adequate power and adherence. Studies to compare variations in exercise type and prescription will necessitate large sample sizes and should investigate whether alternative approaches are more effective, cost effective and/or acceptable than resistance, balance, gait and coordination training.

#### Evidence Table

	<b>Evidence</b>	<b>Source</b>	<b>LE</b>	<b>QE</b>	<b>SR</b>
1	Exercise should be included as a component of multifactorial interventions designed to reduce falls.	Tinetti, 1994 Day, 2002 Whitehead, 2003	I	Good	A
2	A multimodal exercise program should include a combination of strength, gait, and balance training.	Gillespie, 2003 Chang, 2004 Gardner, 2000	I	Good	A
3	Tai Chi may be effective in reducing falls.	Gardner, 2000 Li, 2005 Liu-Ambrose, 2004 Lord, 2003 Suzuki, 2004 Wolf, 1996	I	Fair	A

4	There is insufficient evidence to support the inclusion of endurance exercise in fall prevention exercise programs.				I
5	Exercise may be performed in groups or as individual (home) exercises.	(See table, Appendix C3)	I	Fair	B

*LE = level of evidence; QE = quality of evidence; SR = strength of recommendation.*

### 2.3. Treat Vision Impairment

*Background.* Aging is often associated with changes in visual acuity, development of cataracts, macular degeneration, glaucoma, and other conditions that would suggest an impact on risk of falling. Although correction of these conditions should intuitively improve fall risk, there is not enough data to support this intervention alone.

Patients should be asked to identify and describe any vision-related problems and concerns. If they report problems or concerns, their vision should be formally assessed, and any remediable visual abnormalities should be treated, particularly cataracts.

Recommendations.

6. In older women in whom cataract surgery is indicated, surgery should be expedited as it reduces the risk of falling. [B]
7. There is insufficient evidence to recommend for or against the inclusion of vision interventions within multifactorial fall prevention interventions. [I]
8. There is insufficient evidence to recommend vision assessment and intervention as a single intervention for the purpose of reducing falls. [D]
9. An older person should be advised not to wear multifocal lenses while walking, particularly on stairs. [C]

*Rationale.* A systematic review (Gillespie, 2003) found no evidence that referral for correction of vision in community-dwelling older people was effective in reducing the number of people falling. However this conclusion was based on a single randomized controlled trial. (Day, 2002)

Two randomized controlled trials assessing the effect of a cataract operation and waiting list time for surgery showed reductions in rate of falling for immediate versus delayed cataract surgery. However, these studies did not address the larger question of the benefits of screening for cataracts in a general population.

Three studies included vision correction as part of a multifactorial assessment and intervention. The results were mixed. Combined interventions, which included vision correction, reduced the rate of falls, but it is difficult to ascertain whether the reduction is attributable to the vision correction.

One randomized trial looking at a vision assessment and follow-up intervention alone indicated that vision assessment and intervention actually increased risk of falling. This may be related to the effects of adjusting to new glasses. (Cumming, 2007)

### *Evidence Statements*

#### *Vision intervention alone*

**Harwood et al., 2005**, studied 306 frail community-residing women over the age of 70 years with cataract. The intervention group was referred for cataract surgery at one month versus a referral at 12 months for the control group. Over the 12 months monitoring period, there was a 40% decrease in recurrent falls risk and a 34% reduction in fall rate with intervention ( $P=0.03$ ). In terms of general health status, first cataract surgery improved activity levels, anxiety, depression, confidence, visual disability, and handicap compared with controls. Four participants in the operated group sustained fractures (3%) compared with 12 (8%) in the control group ( $p = 0.04$ ).

**Foss et al., 2006**, randomized 239 older (>70 years) community-domiciled women to a second cataract surgery or to a waiting list. The second eye cataract surgery reduced the rate of falling and improved visual function (especially stereopsis). The rate of falling was reduced by 32% in the operated group compared with the waiting list group, but the difference was not statistically significant.

**Cumming et al, 2007**, randomized 616 community-living older people to receive either a comprehensive vision examination followed by eyeglass provision and other indicated eye care or usual care. Surprisingly, after the 12-month follow-up period, the intervention group had significantly more falls than the controls. The authors speculated that this unexpected result may have arisen from problems adjusting to new eyeglasses, the most common intervention. The intervention group was also slightly less frail, and therefore may have been more active.

*Vision as a component of multifactorial interventions*

**Clemson et al., 2004**, studied a multifactorial community program that included components designed to encourage regular visual screening and to help older persons adapt to low vision. Other intervention components included lower limb exercises, medication management, and education to improve safety in the home and community. Among the persons (N=310) who suffered a fall within the previous 12 months, or who had a fear of falling, interventions were associated with a significant 31% decrease in falls compared to the controls. The influence of vision training was not specified.

**Day et al., 2002**, assessed the effectiveness of vision testing and eye care education in healthy community-residing older people (age >70). The intervention was evaluated alone (N=139), in combination with home hazard assessment (N=137), or with all three combined (N=137). Vision intervention alone did not have an impact on fall reduction. Visual acuity remained unchanged in the intervention groups. When combined with both home assessment and exercise, the annual fall rate was reduced by 14%.

**Dyer et al., 2004**, demonstrated a modest but non-significant reduction in falls rates in the intervention group (N=102) receiving a comprehensive program to reduce falls. Optician assessment was included in the multifactorial program.

## Evidence Table

	<b>Evidence</b>	<b>Source</b>	<b>LE</b>	<b>QE</b>	<b>SR</b>
1	Fall reduction after cataract surgery	Harwood, 2005 Foss, 2006	I	Moderate Poor	B
2	Vision testing and intervention	Day, 2002 Cumming, 2007	I	Zero benefit Harmful	D
3	It is unclear whether vision is an essential component of multifactorial intervention. Only 4 out of 11 effective multifactorial studies provided details of vision interventions; the remaining 7 referred for vision assessment.	Clemson, 2004 Day, 2002 Davison, 2005 Wagner, 1994	I	Poor	I

*LE = level of evidence; QE = quality of evidence; SR = strength of recommendation*

## 2.4. Manage Postural Hypotension

*Background.* Postural hypotension is associated with an increased risk of falls. It results in loss of balance due to low blood pressure and consequent cerebral hypoperfusion. Postural hypotension most commonly occurs as a result of dehydration, concomitant medications and autonomic neuropathy. Many multifactorial fall prevention programs have included medication reduction and simplification to modify postural blood pressure. Some have also included specific strategies for management of postural hypotension such as hydration, elastic stockings, abdominal binders and medications (i.e., fludrocortisone and midodrine).

Managing postural hypotension should be included as a component of multifactorial intervention in community-living older persons.

Recommendation.

29. Assessment and treatment of postural hypotension should be included as components of multifactorial interventions to prevent falls in older persons. [B]

*Rationale.* Multifactorial studies which incorporated assessment and management of postural hypotension, including modification and simplification of medications, have shown benefit for fall prevention.

*Evidence Statements.* Three randomized controlled trials have demonstrated a benefit associated with treatment of postural hypotension in addition to interventions for other traditional risk factors such as medication reduction, optimization of fluids, and behavioral intervention (Tinetti, 1994; Close, 1999; Davison, 2005). No adequate prospective study has been published that permits selection of a specific treatment for postural hypotension. Also, no randomized controlled trials have been carried out that examines the benefit of treatment of postural hypotension as a single intervention for fall prevention.

Evidence Table.

	<b>Evidence</b>	<b>Source</b>	<b>LE</b>	<b>QE</b>	<b>SR</b>
1	Multifactorial intervention strategies which included management of orthostatic hypotension reduced falls in community-dwelling older persons.	Tinetti, 1994 Close, 1999 Davison, 2005	I	Fair	B

*LE = level of evidence; QE = quality of evidence; SR = strength of recommendation.*

## **b. Older Persons Living in Long-Term Facilities**

Falling is an even more frequent occurrence among ambulatory residents of long-term care facilities than among older persons residing in the community. About half of ambulatory long-term care residents experience at least one fall each year. The risk factors associated with falling among persons residing in this setting are similar to factors identified among community-living older adults and include impairments in strength, balance, gait, vision, and cognition; use of multiple medications, especially psychoactive medications; and environmental hazards.

Trials in long-term care facilities have addressed both single interventions administered alone as well multiple interventions administered together as described in the next section. (Oliver, 2007) Single interventions have included use of hip protectors, fall alarm devices, removal of physical restraints, medication review, and supplementation with calcium and vitamin D. Interventions that were studied only with observational methods or historical controls are excluded from this guideline. Only randomized controlled trials or cluster randomized trial results were used to develop the guideline.

Interpreting the evidence from randomized controlled trials in the long-term-care setting is complicated by several factors. First, long-term care facilities range from care homes in which residents are independent in many activities to skilled nursing facilities in which most residents are dependent in most of their activities of daily living. Second, the structure of care and terminology used to describe facilities varies among different countries. Third, many of these trials do not identify the cognitive or physical functioning level of participants. Finally, the content of the interventions are either not described in detail or vary from study to study.

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Multicomponent Interventions

## **BACKGROUND**

Multicomponent interventions, in which the same set of interventions addressing more than a single category is offered to everyone included in the trial, are the most commonly studied

strategies in long-term care settings. “Targeted” or “tailored” multifactorial interventions have also been tested. Staff training and feedback, environmental adaptations, balance and gait training, strength training, training in the use of appropriate assistive devices, and decrease in psychotropic medications are interventions that have frequently been included in multicomponent intervention and multifactorial trials in the long-term care setting.

## **RECOMMENDATION**

39. Multifactorial/multicomponent interventions should be considered in long-term care to reduce falls. [C]

## **RATIONALE**

The approach to intervention to reduce falls in long-term care settings differs from the approach in the community, both in content and in implementation strategies.

Models of intervention in long-term care settings differ from those in the community, both in content and in implementation. The available literature varies in the quality of studies and methodological design. Many different types and numbers of interventions occur from study to study. Also, most studies employ complex interventions, making it more difficult to reach a clear conclusion regarding efficacy. While some studies are negative, several have shown efficacy, and there are implications that a well-designed intervention may be beneficial. Medication review has been studied as part of a multicomponent intervention to reduce falls in long-term care settings. The evidence is inconclusive as to whether assessment, adjustment, and discontinuation of medication regimens result in fewer falls in older persons living in such facilities. (Dyer, 2004; Jensen, 2002; Ray, 1997) There is no randomized controlled trial of medication review and minimization as a single intervention in this population, and most multiple intervention trials did not include enough detail to demonstrate benefit of medication adjustment or minimization in long-term care.

Six of the eight studies of multicomponent interventions in the long-term care setting included environmental components. Three studies were ineffective (Jensen, 2002; Kerse, 2004; Dyer, 2004) and three effective (Becker, 2003; Jensen, 2003; Ray 1997). At this time, we can only conclude that evidence for effectiveness in environmental interventions is uncertain in this

population. Two randomized controlled trials incorporating multifactorial interventions and achieving significant reductions in falls both incorporated environmental assessment and modifications as one of the intervention components. Becker (2003) reported using a 76-item checklist, with the most common modifications including changes to lighting, chair and bed heights, reduced clutter in residents' rooms, installation of extra rails in bathrooms, and maintenance of walking aids. Similarly, Jensen (2002) undertook modifications such as removal of loose carpets, bedding adjustments, provision of rails and improved lighting. Neither of these studies provided sub-analyses on the effectiveness of the environmental modifications alone.

The education of long-term care staff has resulted in mixed results, but probably contributes to reduction of falls in some large studies. There is some evidence to support the effectiveness of training the health care team in awareness of fall risk factors and prevention strategies, although several multifactorial studies failed to show significant reduction in falls.

## **EVIDENCE STATEMENTS**

Additions to the evidence base since the last guideline make findings in relation to long-term care more uncertain, with some new studies demonstrating benefit, and others finding none.

## **SYSTEMATIC REVIEW**

**Oliver et al., 2007**, evaluated the evidence for strategies to prevent falls or fractures in eight studies of multifaceted interventions among residents in long-term care homes. One of the studies reported results among participants with, and without, cognitive impairment.

Components utilized in the multiple intervention strategies included various combinations of risk assessment, hip protectors, removal of restraints, exercise and/or physical therapy, nursing education and training, equipment and environmental modification, fall alarm devices, and medication review. The meta-analysis found no significant effect of intervention on falls (rate ratio, 0.80), fallers (relative risk, 0.92), or fractures (relative risk, 0.91), although some individual studies showed strongly positive results.

**Jensen et al., 2002**, carried out a cluster randomized, controlled, non-blinded trial enrolling 439 older persons (>65 years) living in nine residential care facilities in Sweden. The 11-week multifactorial intervention program incorporated general as well as resident-specific tailored

strategies including staff education, environmental modification, exercise, provision of hip protectors and assistive devices, medication review, and post-fall problem-solving conferences. During the 34-week follow-up, the incidence of falls decreased 12% (from 56% to 44%; risk ratio, 0.78) associated with the interventions compared to controls. There was also a significant reduction in femoral fractures (risk ratio, 0.23).

**Becker et al., 2003**, evaluated the effectiveness of a multifaceted, non-pharmaceutical intervention on incidence of falls and fallers in a prospective, cluster randomized trial (N=981, age >60 years) comparing an intervention group from three long-term facilities to controls from three other facilities in Germany. The intervention included education for residents and staff on fall prevention, advice on environmental adaptations, written educational materials, progressive balance and resistance training, and hip protectors. The percentage of fallers in the intervention group (36.9%) was lower than that in the control group (52.3%; relative risk, 0.75) and the incidence density rate of frequent fallers also declined over two years (relative risk, 0.56).

**Ray et al., 1997**, evaluated an intervention program in high-risk nursing home residents in seven pairs of nursing homes. One facility in each pair was randomly assigned to intervention (N=482) and the other facility served as the control (N=261). Review of psychotropic drug use was included in the comprehensive structured assessment along with specific safety recommendations targeting environmental and personal safety, wheelchair use, and transferring and ambulation. In the year following the intervention, the facilities that carried out the intervention had a 19.1% reduction in the mean proportion of recurrent fallers compared to control facilities. There was no significant difference in injurious falls.

**Shaw et al., 2003**, is the only multifactorial trial that specifically enrolled participants with cognitive impairment and dementia. The participants (N=274; age>65) in this randomized controlled trial, 80% of whom resided in a long-term care setting, were randomized to assessment and intervention or to conventional care after presenting to the emergency department after a fall. Intervention was not effective in reducing falls in the year following the intervention (relative risk, 0.92). (See Appendix B.) Dyer et al., 2004, carried out a cluster randomized controlled trial involving 196 residents (age >60) of 20 residential care homes to determine the effect of risk factor modification and balance exercise on fall rates. The multifactorial intervention program included three months of gait and balance training,

medication review, podiatry and optometry The intervention group demonstrated significantly reduced medication use after 3 months. Although this group had a mean of 2.2 falls per resident per year compared to 4.0 falls in the control group, this difference did not reach statistical significance (P=0.2)

**Kerse et al., 2004**, conducted a cluster randomized controlled trial in 14 facilities (N=628). Low-intensity interventions applied in the intervention group included staff and resident education, environmental hazard assessment in rooms and public areas and continued follow-up for 6 months. Significantly more fallers and multiple fallers were reported in the intervention group. There was no significant difference in injurious fall incidence between patients in intervention groups versus control groups. Fall prevention intervention did not reduce falls or injury from falls, and may be worse than usual care in persons who are independent.

	<b>Evidence</b>	<b>Source</b>	<b>LE</b>	<b>QE</b>	<b>SR</b>
1	Effectiveness of multicomponent studies in long-term care is uncertain. Three of the eight trials of multiple component interventions were effective in long-term care institutions.	Becker, 2003 Dyer, 2004 Jensen, 2002 Kerse, 2004 McMurdo, 2000 Ray, 1997 Rubenstein, 1990 Shaw, 2003	I	Fair	C

*LE = level of evidence; QE = quality of evidence; SR = strength of recommendation.*

### 3.1 Exercise

## BACKGROUND

While exercise may provide certain benefits for long-term care patients, particularly in terms of quality-of-life parameters such as depression, mobility, appetite, behaviors, and sleep, there are currently no randomized clinical trials to recommend for or against the use of individually-tailored exercise programs to prevent falls in long-term care settings. Confounding variables, i.e., differences in frailty levels, cognitive function, prior falls history, and the small size of many studies mitigate against clearly defined conclusions.

## RECOMMENDATION

40. Exercise programs should be considered for a variety of benefits to reduce falls in older persons living in long-term care settings (with caution regarding risk of injury); however their effect on fall risk in these settings is yet unproven (C);

## Evidence Statements

**Rosendahl et al., 2008.** In a multicenter Swedish RCT of long-term care (LTC), 158 men (27%) and women, ages 65, (mean age 84) participated. The subjects were randomized to either a high-intensity functional tailored exercise program led by 2 physiotherapists per group of 3-9 participants, and consisting of five 45-minute sessions every 2 weeks for 13 weeks (29 sessions) with 6 month follow-up, or seated social activities. Exercises were weight-bearing, progressive, tasks integrated into ADL. The intervention did not significantly reduce the rate of falls or the proportion of participants who sustained a fall either during intervention or at the 6-month follow-up.

**Faber et al., 2006** conducted a multicenter RCT in the Netherlands that was single blinded with two levels of block-wise randomization and included 208 frail (49%) and pre-frail (51%) male and female residents of 15 LTC homes (mean age 85). Two exercise interventions, a functional walking (FW) program (n = 54) and the In Balance (IB) intervention (n=70) were compared to a control group (n=84). FW consisted of 20 weeks of an exercise program of 10 exercises relating to balance, mobility, and transfer training. The IB program included Tai Chi principles, and seven therapeutic elements of Tai Chi (ankle ROM, proprioception, sensation, co-contractions, slow continuous motions, trunk rotation, weight shifting). There was a 52-week follow-up. Frailty was found to be a strong effect modifier, with interventions having opposite effects in the frail and pre-frail groups; Both FW and IB programs were effective in reducing fall risk by 61% and improving POMA and Physical Performance Scores in the pre-frail elderly group but not in the frail elderly. Benefits were evident within 11 weeks. The risk of becoming a faller was significantly increased by the intervention in the pre-frail group, without any significant changes in physical performance measures.

**McMurdo et al., 2000,** reported a 6-month RCT of exercise in nine residential LTC facilities in the UK, which enrolled 133 men and women  $\geq 70$  years (mean age, 84 years) with a 7-17 month follow-up of falls monitoring (FOPANU study). The intervention consisted of 6 months of an

exercise program (2 x week, 30 minutes) incorporating seated exercise of progressive intensity addressing balance, strength, and joint flexibility. Control subjects took part in seated social activities. No differences were found between groups for the number of falls. However, the drop-out rate was very high with only 68% completing the 6-month intervention and 64% completing the follow-up, and no significant differences were found between groups except for reduced prevalence of postural hypertension (39 to 9%), and reduction in poor visual acuity (63 to 46%) in the intervention group.

**Norwalk et al., 2001**, carried out an RCT of two individualized, exercise programs in LTC in two senior housing communities in the US. The 24-month study enrolled 110 men and women, age  $\geq 65$  (mean age 84.7). The two interventions were a) FNBF (Fit NB Free) program (n=37), with individualized strength training and conditioning, 3 x week; and b) LL/TC (Living and Learning/Tai Chi) (n=38) consisting of behavioral, psychotherapeutic methods to reduce fear of falling 1 x month and Tai Chi classes 3 x week. Control subjects participated in social and music programs. No significant differences between groups were found. In the FNBF, falls rate was 72% while in the LL/TC it was 58%. Falls in the control were 75%. The fallers were significantly different at baseline and follow up. These subjects had a greater decline in MMSE, IADLs, greater increase in walking time, and decrease in ADLs. Adherence was low, with only 55.8% for the FNBF program, which was still significantly better than LL/TC at 24.2%. Potential benefits were masked by variability of participation (overall adherence = 40%).

**Schoenfelder and Rubenstein, 2004**. This exercise study in LTC was carried out in 10 facilities in the US. The RCT enrolled matched pairs of men and women (N = 81), 42 of whom were randomized to intervention and 39 to the control group (age  $\geq 65$ , mean age 84.1). The 3-month intervention consisted of individually tailored, progressive ankle strengthening followed by supervised walking for up to 10 minutes, 3 x week for 15-20 minute sessions followed by a 6 month follow-up. The control group read books or socialized. The assistive device groups showed maintenance or improvement overtime with the semi-tandem stance which remained significant at 6 months (3 months after supervised exercise ended). This group also maintained the same level of fear of falling or experienced some improvement.

**Shimada et al., 2004**, undertook an RCT in Japan of 32 physically disabled men and women, mean age 82.4 (range 66-98) in a LTC facility. One group (n=18) received an intervention

(treadmill exercise) while the control group (n = 14) carried out usual exercise. The intervention consisted of 6 months of gait training on a treadmill, using handrails, with 6 months follow up. The program was divided into eight phases, with the maximum walking speed measured at the beginning of each phase, and 50-70% of maximum set as training speed. Perturbation stimuli (decelerations) increased in magnitude up to 100%. The controls received physical therapy for pain, TENS, stretching, low and high resistance training, gait training on level surfaces, outdoor walking, balance training, stairs, and group exercise for lower limb function. Fifteen of the intervention subjects and 11 controls completed the study. No significant differences between groups were found although the intervention group showed improvements for one-leg standing time, functional reach, walking, and perturbed walking (33.3% fall rate compared to 54.5% fall rate for controls), and longer time to first fall.

**Wolf et al., 2003.** This 48-week RCT of Tai Chi in 20 congregate living facilities in the US enrolled 311 transitionally frail men and women (mean age 80.9; range 70-97) with at least 1 fall in the prior year. The intervention was an intense Tai Chi exercise program with an instructor, at 2 sessions per week progressing from 60 minutes to 90 minutes. Subjects in the control group received a Wellness education program for 1 hour/week. The fallers (1 or more falls) had a 47.6% fall rate with intervention while the control group had a 60.3% fall rate. This difference was not significant. Previous fall-related fractures and education were the only variables that modified the effect of the Tai Chi group significantly. Tai Chi subjects without previous fall fractures, or with no high school diploma, had significantly lower fall rates than control subjects. Participants with no high school degree were significantly less physically active at baseline. Tai Chi subjects with significantly lower risk of falling had better SIP psychosocial scores and 4-12 months of intervention. The subjects who attended their sessions had a marginally significant lower risk of falling.

	<b>Evidence</b>	<b>Source</b>	<b>LE</b>	<b>QE</b>	<b>SR</b>
1	Effectiveness of exercise program studies in long-term care.	Faber, 2006 McMurdo, 2000 Norwalk, 2001 Schoenfelder and Rubenstein, 2004. Shimada, 2004	I	Fair	C

	Exercise in frail elderly groups may increase risk of falls.	Wolf, 2003 Faber, 2006			
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*LE = level of evidence; QE = quality of evidence; SR = strength of recommendation.*

### 3.2 Vitamin D

#### Recommendation

41. Vitamin D supplements of at least 800 IU per day should be provided to older persons residing in long-term care settings with proven or suspected vitamin D insufficiency. [A]
42. Vitamin D supplements of at least 800 IU per day should be considered in older persons residing in long-term care settings who have abnormal gait or balance or who are otherwise at increased risk for falls. [B]

#### Rationale

The use of combined calcium and vitamin D3 supplementation has been found to reduce fracture rates in older people in long-term care. Two studies from a meta-analysis (Bischoff-Ferrari, 2004) as well as one recent randomized controlled trial support the use of vitamin D supplementation to prevent falls in long-term care residents.

#### Evidence Statements

**Flicker et al., 2005**, conducted a two-year multicenter randomized controlled trial in 60 assisted living facilities and 89 nursing homes in Australia. Participants (N=625; mean age, 83.4 years) had serum 25-hydroxyvitamin D levels between 25 and 90 nmol/L. Vitamin D (ergocalciferol, initially 10,000 IU given once weekly, then 1,000 IU daily) was administered to test subjects. All participants also received 600 mg calcium carbonate per day. Vitamin D supplementation was associated with an incident rate ratio for falling of 0.73. The odds ratio for ever falling was 0.82 and for ever fracturing was 0.69. Subjects who reported taking at least half the prescribed capsules (n=540) demonstrated an incident rate ratio for falls of 0.63, for ever falling of 0.70, and an odds ratio for ever fracturing of 0.68.

**Broe et al., 2007**, administered one of four doses of vitamin D (200 IU, 400 IU, 600 IU, or 800 IU) or placebo to 124 long-term nursing home residents (average age, 89 years) in a five-month, randomized, multiple-dose study. Outcomes measured were number of fallers and number of falls assessed using a facility tracking database. The proportion of fallers was 44% in the placebo group, 58% in the 200 IU group, 60% in the 400 IU group, 60% in the 600 IU group, and 20% in the 800 IU group. Residents in the highest-dose group also had a 72% lower adjusted-incidence rate ratio of falls than participants receiving placebo (rate ratio, 0.28).

	<b>Evidence</b>	<b>Source</b>	<b>LE</b>	<b>QE</b>	<b>SR</b>
1	Effectiveness of vitamin D supplementation in long-term care settings.	Broe, 2007 Flicker, 2005	I	Good	A
2	Vitamin D supplementation for older persons with abnormal gait or balance.	Bishoff ferrari, 2004	I	Fair	B

*LE = level of evidence; QE = quality of evidence; SR = strength of recommendation.*

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### **c. OLDER PERSONS WITH COGNITIVE IMPAIRMENT**

#### **Background**

Older people with cognitive impairment and dementia are at increased risk for falls, with an annual incidence of around 60% (twice that of cognitively normal older people). (Tinetti, 1988; Van Dijk, 1999). Mobility problems experienced by elderly people with dementia are associated with falls, fractures and admission to long-term care.

Multifactorial assessment and intervention after a fall or single intervention in patients with cognitive impairment or dementia have not been shown to reduce falls

#### **Recommendations**

43. There is insufficient evidence to recommend for or against multifactorial or single interventions to prevent falls in older persons with known dementia living in the community or in long-term care facilities. [I]

## Rationale

Cognitive impairment is an independent risk factor for falls. Nevertheless, older persons with cognitive impairment have been excluded from most of the successful falls prevention randomized controlled trials in the community setting. The only study that specifically investigated cognitive impairment in the community demonstrated lack of efficacy.

Based on the studies that have been conducted in long-term care facilities in older persons with cognitive impairment, the evidence is inconclusive. More studies with adequate sample size, sensitive and validated measurements, and higher specificity for the types of intervention targeting subgroups of patients with different degrees of cognitive impairment are required to allow for evidence-based recommendations.

## Evidence Statements

**Hauer et al., 2006.** This systematic review cites 11 randomized controlled trials that evaluated the effect of physical activity (exercise) on fall prevention in older persons with cognitive impairment. The review found conflicting evidence regarding the effect of physical training on motor performance and falls in older people with cognitive impairment. However, there was a large heterogeneity regarding methodology, sample size, type of intervention, study outcomes, and analyses, which hampered the evaluation of the effectiveness of training. The investigators concluded that randomized controlled trials reveal only limited effectiveness of physical training or exercise in patients with cognitive impairment.

**Jensen, 2003,** evaluated a multicomponent intervention program comprising staff education, environmental adjustment, exercise, drug review, aids, hip protectors, and post-fall problem-solving conferences. All consenting residents (N=402) were divided into a group of either lower or higher cognition based on the results of a mini-mental state examination (MMSE) (score=19 was the dividing point). The lower MMSE group was older and more functionally impaired and had a higher risk of falling (64% versus 36%) than the higher MMSE group. A significant intervention effect on falls appeared in the higher MMSE group but not in the lower MMSE group (adjusted incidence rates ratio of falls P=.016 and P=.121; adjusted hazard ratio P<.001 and P=.420, respectively).

**Shaw et al., 2003**, conducted a randomized controlled trial to determine the effectiveness of a tailored multicomponent intervention after multifactorial clinical assessment in older patients with cognitive impairment and dementia presenting to the emergency department after a fall. Interventions included optical correction, medical assessment, physiotherapy, occupational therapy and foot care. Of the 274 patients with cognitive impairment and dementia, 130 were randomized to assessment and intervention and 144 were randomized to assessment followed by conventional care. Intention-to-treat analysis showed no significant difference between intervention and control groups in the proportion of patients who fell during a one-year follow-up (74% and 80%; relative risk, 0.92.) No significant differences were found between groups for secondary outcome measures.

### Evidence Table

	<b>Evidence</b>	<b>Source</b>	<b>LE</b>	<b>QE</b>	<b>SR</b>
	There is insufficient evidence to recommend for or against single or multifactorial interventions in community-living older adults with known cognitive impairment.	Shaw, 2003 Hauer, 2006 Jensen, 2003	I	Poor	I

*LE = level of evidence; QE = quality of evidence; SR = strength of recommendation.*

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## ACKNOWLEDGMENTS

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The American Geriatrics Society (AGS) and British Geriatrics Society (BGS) Panel on the Clinical Practice Guideline for the Prevention of Falls in Older Persons includes:

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The American College of Emergency Physicians, the American Medical Association, the American Occupational Therapy Association, and the American Physical Therapy Association.

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*Peer Review*

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APPENDIX A

Table A1a: Multifactorial Interventions Studies - Effective

<b>Intervention components</b>	<b>Tinetti 1994</b>	<b>Clemson 2004</b>	<b>Davison 2005</b>	<b>Day 2002</b>	<b>Campbell 1999</b>	<b>Whitehead 2003</b>	<b>Wagner 1994</b>	<b>Steinberg 2000</b>	<b>Close 1999</b>	<b>Hogan 2001</b>	<b>Newbury 2001</b>	<b>Nikolaus 2003</b>
<b>Environmental adaptation</b>	X	X	X	X		X	X	X	X			X
<b>Balance training</b>	X	X	X	X	X	X		X				
<b>Strength training</b>	X			X	X							
<b>Gait training</b>	X	X	X									
<b>Assistive devices</b>	X	X	X									X
<b>Reduction in psychotropics</b>	X	X	X		X							
<b>Reduction in other medications</b>	X	X	X				X					
<b>Add medications as indicated</b>												
<b>Vision</b>		X	X	X			X					
<b>Address orthostasis</b>	X		X									
<b>Other cardiovascular Tx</b>			X						X			



<b>Assistive devices</b>										
<b>Reduction in medications</b>										
<b>Vision</b>										
<b>Address orthostasis</b>										
<b>Other cardiovascular Tx</b>										
<b>General medical evaluation/Tx</b>				X						
<b>Self management</b>			X	X	X			X		
<b>Physical activity level</b>										
<b>RF assessment with advice and referral, no direct intervention</b>	X	X	X		X	X	X		X	X

Table A2: Studies Evaluating Exercise Interventions

	Single Multiple	Target / high risk	N	Effective	Component Type(s) of program							1-Individual 2-group 3-home
					Walking	Gait/ balance	Strength	Tai Chi/3D	Flexibility	Functional	Endurance	
Tinetti et al., 1994	Multiple	Yes		YES		X						1
Day et al., 2002	Multiple	No	1090	YES		x	x		x			3
Barnett et al., 2003	Single	Yes	163	YES		x	x	x		x	x	2
Buchner, 1997	Single	Yes	105	YES			x				x	2
Hauer et al., 2001	Single	Yes	57	YES		x	x		x		x	2
Robertson et al., 2001a	Single	Yes	450	YES	x	x	x		x	x	x	1
Skelton et al., 2005	Single	Yes	81	YES		x	x		x			3
Weerdesteyn, 2007	Single	Yes		YES		x						2
Li et al., 2005	Single	No	256	YES				x (TC)				2
Lord et al., 2003	Single	No	551	YES		x	x	x(dance)	x			2
Means et al., 2005	Single	No		YES								
Suzuki et al., 2004	Single	No	52	YES		x	x	x (TC)				3
Voukelatos, 2006	Single	No	684	YES				x				2
Woo, 2007 (a) Tai-Chi	Single	No		YES				x				2
Campbell et al., 2005	Multiple	Yes	391	NO	x	x	x					2+3
Lord et al., 2005	Multiple	Yes	620	NO		x	x					2
Steinberg et al., 2000	Multiple	No	252	NO		x	x					3
Latham et al., 2003a	Single	Yes	243	NO			x					1
Nitz et al., 2004	Single	Yes	73	NO		x						2
Rubenstein et al., 2000	Single	Yes	59	NO	x	x	x		x			2
Wolf, 2003	Single	Yes		NO				x				2
Liu-Ambrose et al., 2004a	Single	No	98	NO			x			x		2
Liu-Ambrose et al., 2004b	Single	No		NO		x				x		2
Lord et al., 1995	Single	No	197	NO		x	x		x			2
Morgan et al., 2004	Single	No	294	NO	x	x	x		x			2
Wolf, 1996 (a) Tai Chi	Single	No		NO				x				2
Wolf, 1996 (b) balance	Single	No		NO	x							?
Woo, 2007 (b) Balance	Single	No	180	NO			x					2
Whitehead et al., 2003	Multiple	Yes	140	HARMFUL						x		1

## Appendix B: Evidence Grading System

<b>Table -1: Quality of Evidence (QE)</b>	
<b>I</b>	At least one properly done RCT
<b>II-1</b>	Well-designed controlled trial without randomization
<b>II-2</b>	Well-designed cohort or case-control analytic study, preferably from more than one source
<b>II-3</b>	Multiple time series evidence with/without intervention, dramatic results of uncontrolled experiment
<b>III</b>	Opinion of respected authorities, descriptive studies, case reports, and expert committees
<b>Table -2: Overall Quality</b>	
<b>Good</b>	High grade evidence (I or II-1) directly linked to health outcome
<b>Fair</b>	High grade evidence (I or II-1) linked to intermediate outcome; <i>or</i> Moderate grade evidence (II-2 or II-3) directly linked to health outcome
<b>Poor</b>	Level III evidence or no linkage of evidence to health outcome

<b>Table -3: Net Effect of the Intervention</b>	
<b>Substantial</b>	More than a small relative impact on a frequent condition with a substantial burden of suffering; <i>or</i> A large impact on an infrequent condition with a significant impact on the individual patient level.

<b>Moderate</b>	A small relative impact on a frequent condition with a substantial burden of suffering; <i>or</i> A moderate impact on an infrequent condition with a significant impact on the individual patient level.
<b>Small</b>	A negligible relative impact on a frequent condition with a substantial burden of suffering; <i>or</i> A small impact on an infrequent condition with a significant impact on the individual patient level.
<b>Zero or Negative</b>	Negative impact on patients; <i>or</i> No relative impact on either a frequent condition with a substantial burden of suffering; or an infrequent condition with a significant impact on the individual patient level.

<b>Table 4. Strength of Recommendation Rating System</b>	
<b>A</b>	A strong recommendation that the clinicians provide the intervention to eligible patients. <i>Good evidence was found that the intervention improves important health outcomes; the conclusion is made that benefits substantially outweigh harm.</i>
<b>B</b>	A recommendation that clinicians provide this intervention to eligible patients. <i>At least fair evidence was found that the intervention improves health outcomes; the conclusion is made that benefits outweigh harm.</i>
<b>C</b>	No recommendation for or against the routine provision of the intervention is made. <i>At least fair evidence was found that the intervention can improve health outcomes, but benefits and harms are too closely balanced to justify a general recommendation.</i>
<b>D</b>	Recommendation is made against routinely providing the intervention to asymptomatic patients. <i>At least fair evidence was found that the intervention is ineffective or the conclusion is made that harms outweigh benefits.</i>
<b>I</b>	Evidence is insufficient to recommend for or against routinely providing the intervention. <i>Evidence shows that the effectiveness of the intervention lacking, is of poor quality, or is conflicting; the conclusion is that the balance of benefits and harms cannot be determined.</i>

Based on the U.S. Preventive Services Task Force rating system (Harris et al, 2001)

## APPENDIX B

## Evidence Grading System

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*Based on the U.S. Preventive Services Task Force rating system (Harris et al, 2001)*

## APPENDIX C

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