

FALLS FREE:

Promoting a National Falls
Prevention Action Plan

Research Review Papers



THE NATIONAL
COUNCIL ON
THE AGING



About The National Council on the Aging

Who We Are

Founded in 1950, The National Council on the Aging (NCOA) is the nation's first charitable organization dedicated to promoting the health, independence, and continuing contributions of older Americans. NCOA is a 3,200 member national network of organizations and individuals including senior centers, adult day service centers, area agencies on aging, faith congregations, senior housing facilities, employment services, and other consumer organizations.

What We Do

To accomplish organizational objectives, the following core competencies guide our activities:

- **NCOA is a national voice and powerful advocate** for public policies, societal attitudes, and business practices that promote vital aging. A founding member of the Leadership Council of Aging Organizations, NCOA often leads campaigns to preserve funding for the Older Americans Act. We currently chair and lead the Access to Benefits Coalition to help lower income Medicare beneficiaries find prescription savings. We regularly do public awareness studies such as the Myths and Realities of Aging™ that have helped shape the attitudes of millions.
- **NCOA is an innovator**, developing new knowledge, testing creative ideas, and translating research into effective programs and services that help community service organizations

serve seniors in hundreds of communities. NCOA is the leader in identifying and disseminating best practices and evidence-based programming in community-based physical activity, chronic disease management and health promotion activities. In its long history, NCOA has also shaped many innovative aging programs, including Meals on Wheels and Foster Grandparents.

- **NCOA is an activator**, turning creative ideas into programs and services that help community services organizations organize and deliver essential services to seniors. This includes Family Friends and its Center for Healthy Aging. NCOA also administers two federal Programs (Senior Community Service Employment Service and Senior Environmental Program) and the Maturity Works partnership to provide employment and training opportunities for mature adults through offices nationwide.
- **NCOA develops decision support tools** such as BenefitsCheckUp® and the Long-term Care Counselor™, enabling consumers to make optimal decisions and maximize all available resources and opportunities, whether they are looking for prescription savings or understanding their risk of needing long-term care.
- **NCOA creates partnerships** that bring together a wide variety of voluntary, philanthropic, and public organizations to spark innovative solutions and achieve specific results. Each year, for example, NCOA and the American Society on Aging partner to bring a joint annual conference to 4,000 professionals in the field.



The Archstone Foundation

The Archstone Foundation is a philanthropic leader committed to addressing the issues of Older Americans.

About the Archstone Foundation

The Archstone Foundation is a private non-profit grantmaking organization founded in 1985, whose mission is to contribute toward the preparation of society in meeting the needs of an aging population. It has awarded more than \$50 million in grants since its inception. The Archstone Foundation is currently focusing the majority of its resources to address the following four issue areas, with an emphasis on funding California-based initiatives:

- Elder Abuse Prevention
- Fall Prevention
- End-of-Life Issues
- Responsive grantmaking to address emerging needs within society's aging population.

The Archstone Foundation and Fall Prevention

Fall prevention is an exceptionally important issue for the Archstone Foundation because falls are an enormous threat to the health and well-being of older adults. It is estimated that one in three adults age 65 and older fall each year. While most falls result in minimal injury, more than 20 to 30 percent of adults age 65 and older suffer serious injury from falls, particularly hip fractures and head injury. Of those hospitalized for a hip fracture 40% never return home or live independently again, and 25% will die within one year.

The loss of independence that follows a serious fall may lead to institutionalization, contributing to escalating health care costs and an incalculable human cost. Yet many falls can be prevented. The Archstone Foundation is a major supporter of the Falls Free Summit as part of its work to help prevent falls among older adults.

The Archstone Foundation strives for lasting change and working in partnership with others. To learn more about the Archstone Foundation and the work of its grantees visit www.archstone.org.



Home Safety Council

Our Mission

The Home Safety Council (HSC) is a 501(c)(3) nonprofit organization dedicated to helping prevent the nearly 21 million medical visits that result on average each year from unintentional injuries in the home. Through national programs and partners across America, the Home Safety Council works to educate and empower families to take actions that help keep them safer in and around their homes.

About the Home Safety Council

Established in 1993, the Home Safety Council serves as a national resource for home safety education and information. We believe that *a safe home is in your hands* and that's why our daily commitment is to provide families with the knowledge to implement safety practices in their home. Through relationships with educators, policy makers, safety communities, researchers and media, the Home Safety Council delivers timely information and recommendations for the public. This valuable information could spare them and their loved ones from a serious home-related injury. To learn more about the Council's programs, partnerships and resources, visit the Home Safety Council at www.homesafetycouncil.org.

Why Home Safety?

Unintentional home injury is a major public health problem in the United States. According to the Council's *The State of Home Safety in America*™ research report, each year on average preventable injuries in the home:

- Result in nearly 20,000 deaths
- Cause nearly 21 million medical visits
- Are the fifth leading cause of death overall
- Are 2.5 times more likely to cause injury than car crashes
- Cost our nation \$380 billion
- Are largely preventable when home safety practices are put into action at home

How We Promote Our Mission

We work hard to share information through our programs, partners, and resources to keep families safe at home. Our body of work includes:

- School and community outreach to educate kids and their parents from coast-to-coast
- Research and data collection on unintentional injuries in the home to help target educational programs
- Online safety resources to provide the public with easy access to free information and comprehensive tools designed to improve understanding of unintentional home injuries and offer effective ways families/households can safeguard their loved ones
- Corporate outreach to assist companies of all sizes in developing effective methods to share home injury prevention information with their employees, families and customers
- Grassroots outreach teaming HSC with partner organizations to extend safety messages into local communities
- Seasonal consumer awareness campaigns that deliver timely and "calendar relevant" safety tips to the public through media and web-based outreach
- Risk group outreach to target groups with the highest incidence of home injury and develop customized educational programs tailored to their needs
- Children's educational programs to teach home safety lessons to elementary age kids in the classroom and on the Internet through specially-designed lesson plans, activities and games
- Advocacy and public affairs initiatives to support home safety research, and promote healthy and safer communities
- Awards and recognition for corporations and individuals who champion the cause

The Home Safety Council believes that education is the first step to a safer home and that's why our mission of education and empowerment is so important to the health and well-being of families everywhere.

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Foreword

The enclosed review papers were commissioned in support of the National Council on the Aging's Falls Free Initiative, funded by the Archstone Foundation and the Home Safety Council. The primary purpose of these papers is to familiarize Falls Free National Summit participants with the most current fall prevention research and public health data. These papers, prepared by nationally recognized experts, include discussions of implications and recommendations across four primary risk factors: physical mobility, medications management, home safety and environmental safety.

NCOA wishes to thank the authors for donating their time and expertise to this important work:

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In addition, the reader will find an excerpt from the *Prevention of Falls and Injuries Among the Elderly*, A Special Report from the Office of the Provincial Health Officer, Ministry of Health Planning, British Columbia, January 2004. Our thanks to Victoria Scott, Ph.D., R.N. for allowing us to present selected materials as an overview of other relevant risk factors, points of intervention and the multifactorial concept thought to be a crucial component of interventions effective in reducing the rates of falls in older adults. The full report may be found at <http://www.injuryresearch.bc.ca/>.

These papers may not be reproduced without the express permission of the National Council on the Aging. NCOA will formally publish these review papers as a supplement to the National Action Plan, with a projected release date of March 2005.

Falls Among Older Adults—Risk Factors and Prevention Strategies

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Falls among older adults are a major health problem. This *White Paper on Falls Among Older Adults* provides an overview of the impact of fatal and nonfatal fall injuries, describes fall risk and protective factors, outlines what we know about effective prevention strategies, and highlights key areas that need to be addressed. This paper demonstrates that we currently know many ways to reduce falls and fall injuries that disproportionately affect the lives of older adults. We now must move ahead to implement these strategies in community-based programs.

More than a third of older adults fall each year¹⁻², and fall-related injuries cause significant mortality, disability, loss of independence, and early admission to nursing-homes.³ Fall rates increase sharply with advancing age.⁴⁻⁵ Of those who fall, 20 to 30 percent suffer moderate to severe injuries that reduce mobility and independence and increase the risk of premature death.⁶ Currently, about 36 million Americans (one in eight) are age 65 or older. The U.S. population is aging rapidly, and by 2020 this ratio will decrease to one in six.⁷ As our population ages, the number of fall injuries can be expected to increase.

Among older adults, falls are the leading cause of injury deaths. In 2002, falls caused about 12,800, or 38 percent, of all unintentional injury deaths.⁸ Fatalities, however, reflect only the tip of the iceberg. Falls also are the most common cause of non-fatal injuries and of hospital admissions for trauma. In 2002, 1.6 million seniors were treated in U.S. hospital emergency departments (EDs), and 388,000 of those treated were hospitalized for their injuries.⁹ Or, put another way, every hour one older adult died and 183 were treated in EDs for fall-related injuries. This paper summarizes the epidemiology of older adult falls and describes our current state of knowledge about effective prevention strategies.

Falls and Fall-Related Injuries

Fatal falls

Table 1 shows fatal fall rates for men and women by 5-year age groups. Among older adults, fall-related death rates in 2001 increased sharply with increasing age; the greatest increase occurred after age 74.⁹ This pattern was similar for men and women although, the fatality rate for men was higher than for women in each age category. Even after adjusting for differences in the age distributions, the overall fatality rate was 57 percent higher for men. The underlying causes for this disparity are unclear. Men may have sustained more severe injuries than women because they fell from greater heights, such as from ladders. Or, men may have had more underlying chronic conditions than women of

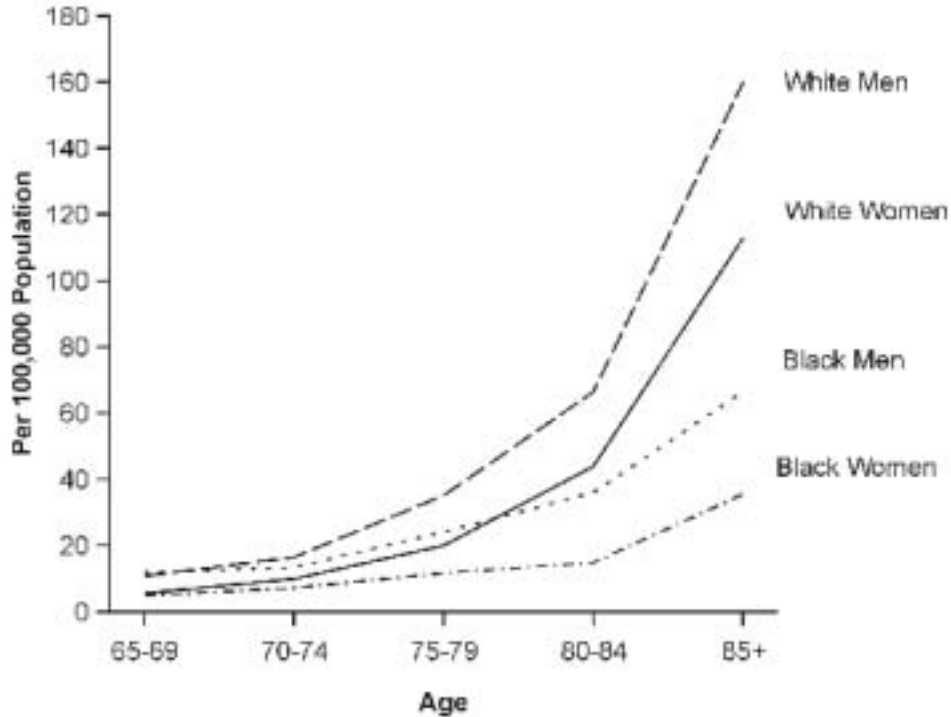
comparable age, been in poorer health and therefore been less able to survive a fall-related injury.

Table 1. Fatal Fall Rates by Age and Sex, United States, 2001		
Age Group	Per 100,000 Population	
	Men	Women
65-69	10.6	5.4
70-74	16.0	9.5
75-79	34.0	19.1
80-84	63.9	41.4
85+	153.2	106.4
Overall, 65+	36.8	30.1
Overall, 65+, adjusted for age	42.0	26.8

Source: National Center for Health Statistics, 2001

Figure 1 shows fatal fall rates for 2001 for men and women by age and race. There was very little difference in the rates for whites and blacks from age 65 to 74. After age 75, fatality rates were highest among white men, followed by white women, black men, and black women. By age 85, the rate for white men was 2.4 times the rate for black men and the rate for white women was 3.2 times the rate for black women.⁹ In addition to race, ethnic differences have been noted. A recent study of ethnic disparities in fatal fall rates found that non-Hispanic adults consistently had higher fatal fall rates than Hispanic adults.¹⁰

Figure 1. Fatal Fall Rates for Men and Women by Age and Race, United States, 2001

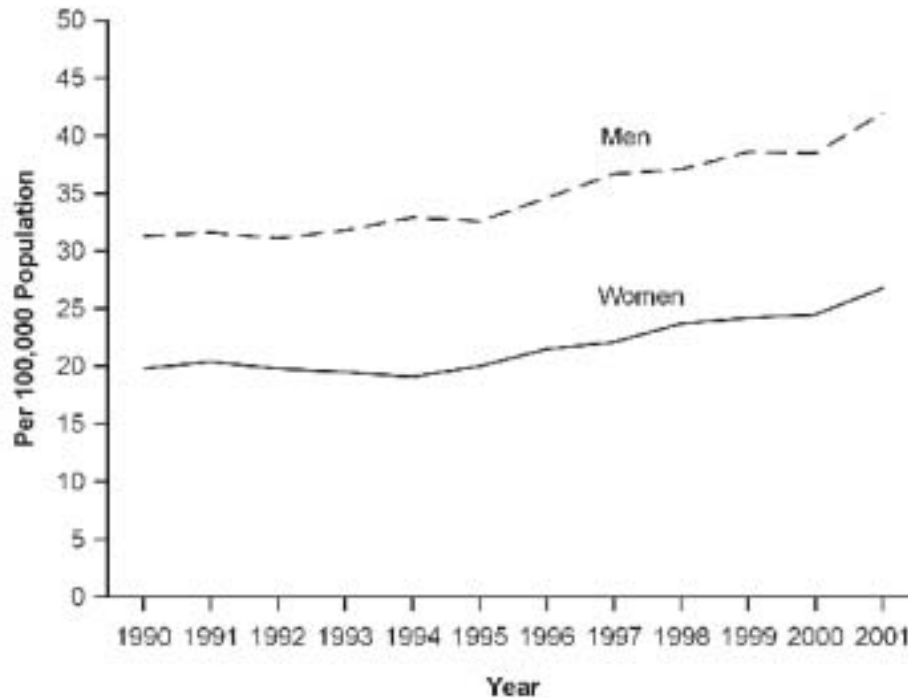


Source: National Center for Health Statistics, 2001

Fatal Fall Trends

From 1990 to 2002, the number of people age 65 and older in the U.S. increased 13 percent, from 31.2 million to 35.3 million⁷ while the number of fatal falls increased 94 percent, from 6,601 to 12,837.⁹ Figure 2 shows the trend in age-adjusted fatal fall rates for men and women from 1990 to 2001 (the most recent year for which age-specific rates are available). After adjusting for the growing population of adults 65 years of age and older, rates for both men and women increased about 35 percent over this time period. Rates were consistently higher for men. The rise in fatal fall rates reflects the 39 percent increase in the number of people over age 85, the “oldest old,” the fastest growing segment of the older population and the most susceptible to falling.

Figure 2. Age Adjusted Fatal Fall Rates for Men and Women Age 65+, United States, 1990–2001



Source: National Center for Health Statistics, 1990–2001

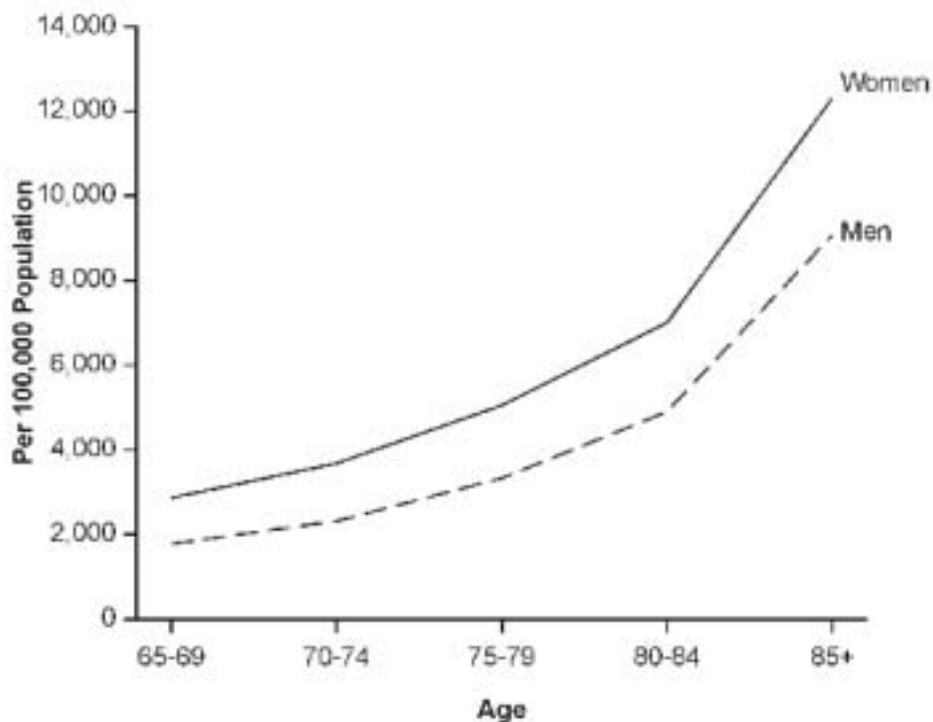
Nonfatal falls

Not only the leading cause of unintentional injury death among older adults, falls also are a major cause of severe nonfatal injuries and the most common cause of hospital admissions for traumatic injuries. In 2001, older adults were hospitalized four times more often for falls than for other injuries, and approximately 1.6 million older adults were treated in U.S. hospital EDs for unintentional fall-related injuries. Fall injury rates were 72 percent higher for women than for men (1337.3 vs. 739.4 per 100,000). About 388,000 patients treated for fall injuries, or one in four, were subsequently hospitalized. Twice as many women were hospitalized as men (278,600 vs. 109,200).⁹

Ten to twenty percent of falls cause serious injuries such as fractures or head traumas.⁶ Falls are the underlying cause of up to half of fatal traumatic brain injuries (TBI)¹¹ and the leading cause of hospital admissions for TB.¹² Figure 3 shows nonfatal fall injury rates for men and women by 5-year age groups. Injury rates increased sharply with age and were four to five times higher for people 85 and older than for those ages 65 to 74. Unlike fatal falls, nonfatal fall injury rates were consistently higher for women.⁹ To some extent, this may reflect gender differences in levels of physical activity. Muscle weakness and loss of lower-body strength, often caused by inactivity, are well known risk factors for falling.¹³ Data on older adults from the 1982–1984 National Health and

Nutrition Examination Survey (NHANES I) Follow up Survey established that women were less physically active than men.¹⁴ Differences in physical activity levels may influence the circumstances or events contributing to women's higher injury rate, as well as help explain their lower mortality.

Figure 3. Nonfatal Injury Rates for Men and Women by Age, United States, 2001



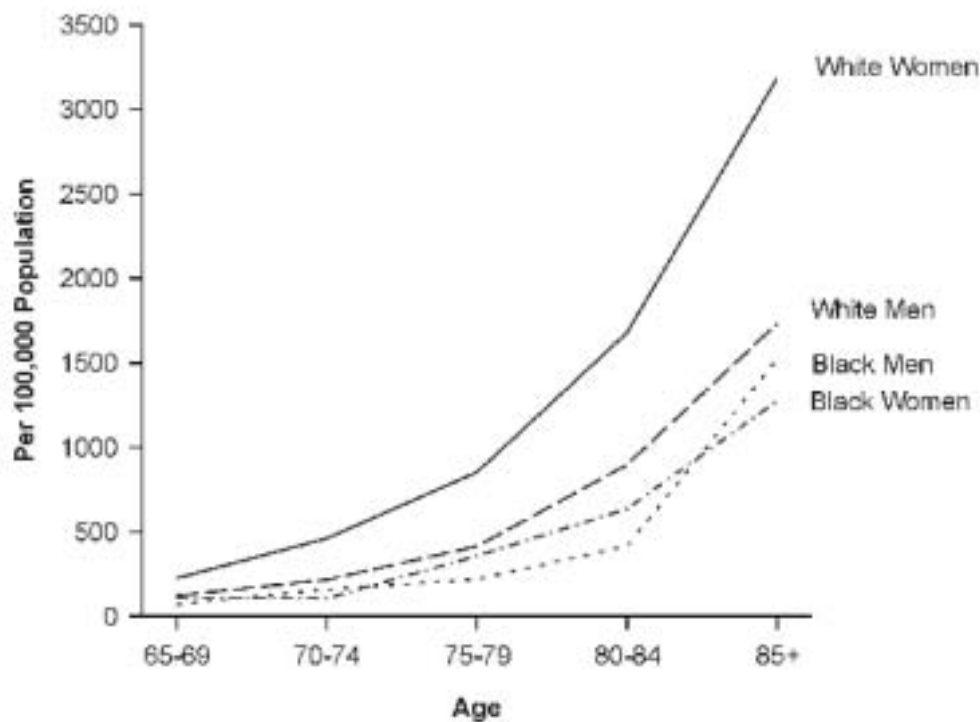
Source: National Center for Health Statistics, 2001

Fall-Related fractures

Fractures are among the most prevalent fall injuries. Each year between 360,000 and 480,000 older adults sustain fall-related fractures.¹⁵ Osteoporosis, a metabolic disease that causes bones to become brittle, greatly increases the chances a person who falls will suffer a fracture, especially a fracture of the vertebrae, forearm, wrist or hip. One study found that women with osteoporosis were three times more likely to sustain hip fractures compared to women without this disease.¹⁶ Osteoporosis is widespread among older women. A 1992 study found that almost 60 percent of women ages 70 to 79 and 84 percent of women over age 80 had osteoporosis.¹⁷

The most serious and disabling osteoporotic fracture is hip fracture. The majority of hip fractures, over 95%, are caused by falls. In 2001, there were about 327,000 hospital admissions for hip fracture; 248,000 (76%) among women. Figure 4 shows hip fracture admission rates for men and women by age and race. White women had the highest admission rates, appreciably higher than for white men. The rates for black men and women were compared and were not statistically different.

Figure 4. Hip Fracture Admission Rates for Men and Women by Age and Race, United States, 2001



Source: National Center for Health Statistics, 2001

Figure 5 shows the trends in hip fracture rates for men and women from 1990 to 2001. During this period, the hip fracture hospitalization rates increased for both men (437.5 to 537.3 per 100,000) and women (1104.5 to 1196.6 per 100,000). These trends were statistically significant ($p < .05$). Reasons for this increase probably parallel those of other fall injuries. In addition, a reduction in physical activity may contribute to the prevalence of osteoporosis, especially among the oldest segment of the population.

Figure 5. Hip Fracture Admission Rates for Men and Women Age 65+, United States, 1990–2001



Source: National Center for Health Statistics, 1990–2001

The potential outcomes of hip fracture are extremely serious. Mortality following hip fracture is high—up to 20 percent of patients die within a year following their fracture.¹⁸ Those who survive often experience significant disability and reduced quality of life.¹⁹⁻²⁰ After being hospitalized for about one week, many hip fracture patients are discharged to nursing homes²¹, and as many as a quarter of formerly independent older adults remain institutionalized for at least a year.²² One study found that 12 percent of older adults who fell subsequently required long-term nursing home care.²³ Without effective interventions and given our aging population, by 2040 the number of hip fractures is projected to exceed 500,000.²⁴

In addition to physical injuries, falls can have significant psychological and social consequences. Many people who fall, whether or not they sustain injuries, develop a fear of falling. This fear can cause them to limit their activities, which in turn leads to reduced mobility and physical fitness and subsequent increased fall risk.²⁵ Fear of falling is strongly associated with future falls even among people who have not fallen recently and has been found to lead to deteriorating health, a decline in physical and social functioning, and nursing home admission.²⁶

Costs of Fall Injuries

Fall-related injuries create a significant financial burden. The total cost of all fall injuries for people age 65 or older in 1994 was \$27.3 billion (in current dollars) and by 2020 is expected to reach \$43.8 billion (in current dollars).²⁷ A study of people ages 72 and older found that the average health care cost of a fall injury was \$19,440 (including hospital, nursing home, emergency room, and home health care, but not physician services).²⁸

In 1989, the direct medical costs for osteoporotic fractures exceeded \$6 billion.²⁹ A study published in 1994 estimated that total direct medical costs for osteoporotic fractures among postmenopausal women in the next 10 years would exceed \$45.2 billion.³⁰ Of all osteoporotic fractures, hip fractures are the most costly. In the U.S., hospitalization accounts for 44 percent of direct health care costs for hip fracture patients.³¹ In 1991, Medicare costs for this injury were estimated to be \$2.9 billion.¹⁵ Assuming 5 percent inflation and a growing number of hip fractures, the total annual cost of these injuries is projected to reach \$240 billion by the year 2040.²⁴ These costs do not account for the long-term consequences of these injuries, such as disability, functional limitations, decreased productivity, and reduced quality of life.

Fall Risk Factors

Fall risk factors are often categorized as personal or environmental. Personal risk factors include characteristics of the individual such as age, functional abilities, and chronic conditions. Environmental factors are those associated with the external environment. For older adults living in community settings, environment risk factors most often concern fall hazards in and around their home and include tripping hazards such as throw rugs and clutter in walkways, lack of stair railings or grab bars, slippery surfaces, unstable furniture, and poor lighting.³²⁻³⁴

Risk factors also can be classified as either nonmodifiable or modifiable. Examples of the first category include older age, a past history of falls, and being female.^{10,35} Other factors potentially amenable to change include lower-body weakness³⁶, problems with gait and balance^{13,36}, taking four or more medications or any psychoactive medications³⁷⁻³⁹, and vision impairment.⁴⁰ Having certain chronic diseases such as Parkinson's Disease, a history of stroke, and arthritis also increase fall risk.⁴¹ Although these latter factors are not modifiable, identifying and treating the symptoms of these diseases (e.g., reducing arthritis pain and increasing mobility) may reduce the risk of falling.

Risk factors may increase a person's risk of falling (e.g., lower-body weakness, tripping hazards), or of falling and being injured (e.g., being female, being visually impaired, having Parkinson's disease). Osteoporosis, while not a risk factor for falling, increases the likelihood of a fracture in the event of a fall.¹⁶ The risk of falling increases with the number of risk factors present⁴², and the occurrence of many risk factors increases with age. Data from the National Health Interview Survey showed that, from ages 65 to 85, the prevalence of reported functional limitations increased from 3 to 20 percent⁴³, and the prevalence of visual impairments increased from 12 to 26 percent among men and from 15 to 34 percent among women.⁴⁴ Approaches for preventing

functional decline and subsequently reducing fall risk include increasing physical activity, treating chronic conditions, correcting vision, and treating osteoporosis.⁴⁵

Fall Prevention Strategies

In recent years, a number of systematic reviews have evaluated intervention strategies to determine what works.⁴⁶⁻⁵⁰ The RAND Report concluded that fall prevention programs as a group effectively reduced the risk of falling by 11 percent and the monthly rate of falling by 23 percent.⁴⁸ Interventions that focused on high-risk individuals (e.g., those who had fallen and were at increased risk of falling again) were more likely to be effective than were those that targeted an unselected group of seniors.

Clinical Assessment and Risk Reduction

Based on a meta-analysis of randomized controlled trials, the RAND Report concluded that the most effective intervention strategies used clinical assessment combined with individualized fall risk reduction and patient follow-up.⁴⁸ For example, one effective study included a home visit by an occupational therapist who provided advice and education about home safety and assisted with some environmental modifications (e.g., removed loose rugs and provided minor equipment).⁵¹ When analyzed as a group, interventions using clinical assessment and risk reduction lowered the risk of falling by 18 percent and reduced the average number of falls by 43 percent.

The American Geriatrics Society Panel on Falls Prevention has recommended that doctors identify high risk patients (those who have had two falls in the past year, had one fall with an injury, or who have gait and/or balance problems) and administer a comprehensive clinical assessment to identify specific risk factors.¹³ Such an assessment includes testing gait, balance, and neurological function, reviewing all medications, and asking about the circumstances of the fall. Following this assessment, the physician develops a tailored medical management approach, suggests appropriate intervention strategies, and/or refers the patient to appropriate specialists (e.g., physical therapists, gerontologists).

Exercise

After clinical assessment with risk factor reduction, the most effective single intervention was exercise. Overall, exercise interventions reduced the risk of falls by 12 percent and the number of falls by 19 percent.⁴⁸ Exercise was effective in reducing falls when used alone and when included as part of a multi-component intervention.

Different types of exercise have been studied and found to be effective. These have included Tai Chi⁵², balance and gait training, and strength building.^{38,53-54} A program of muscle strengthening and balance retraining prescribed at home by a trained health professional was effective in three trials.⁵⁴⁻⁵⁶ Exercise interventions have employed a variety of approaches including group classes⁵⁷⁻⁶⁰, and individualized in-home programs.^{54,56}

Medication Management

It has been clearly established that psychoactive medications, specifically benzodiazepines, antidepressants, and sedatives/hypnotics, increase the risk of falling.^{37-39,61-62} Large numbers of seniors use these types of medications. A 1993 paper by Cumming and Klineberg noted that 20 percent of community-dwelling older adults were taking one or more psychoactive medications.⁶³

The evidence indicates that reviewing and modifying medications can reduce fall rates. It is useful for physicians to regularly review all patients' medications and eliminate those not absolutely necessary. Reducing the number and types of medications used, particularly tranquilizers, sleeping pills, and anti-anxiety drugs, appears to be an effective fall prevention strategy when used alone or as part of a multi-component intervention.^{37,54}

Home Modification

Although studies have not demonstrated that home modification alone will reduce falls, environmental factors do play a part in about half of all home falls.⁶⁴ Home assessment and modification may be effective in reducing falls when conducted by trained professionals such as occupational therapists and when focused on those at high risk. A number of multi-component interventions that included home modification were effective, particularly among individuals with a history of previous falls.^{1,58,65-67} Prevention strategies included removing tripping hazards, using non-slip mats in the bathtub and on shower floors, installing grab bars next to the toilet and in the tub or shower, putting handrails on both sides of stairways, and improving home lighting.

Hip Protectors

Although reduced bone mass is a significant risk factor, hip fracture generally entails falling sideways onto the hip.^{16,68} Specialized hip pads have been developed that reduce the force of impact on the hip joint when a fall occurs.⁶⁹ They usually are sewn into undergarments.

The majority of research using hip protectors has been conducted in nursing home and residential care facilities. Hip protectors were effective among nursing home residents who were at high risk of falling although adherence generally was only fair.⁷⁰ To date, only one randomized controlled trial has assessed the effectiveness of hip protectors among high-risk community-dwelling women. This study found that those who fell while wearing a hip protector were significantly less likely to sustain a hip fracture than those who fell while not wearing one.⁷¹ Although these studies seem promising, more research is needed to improve adherence and to evaluate the effectiveness of hip protectors among various populations of older adults.

Multi-component Strategies

Because falls are frequently caused by an interaction between personal and environmental factors, effective interventions have generally included components to address multiple risk factors.⁷² Effective multi-component interventions may incorporate risk factor screening; tailored exercise or physical therapy to improve gait, balance and strength; medication management; and other elements such as education about fall risk

factors, referrals to health care providers for treatment of chronic conditions that may contribute to fall risk, and having vision assessed and corrected.^{51,58,67,73-74}

Two current randomized controlled trials funded by CDC are evaluating multi-component community-based fall prevention programs. The No More Falls! Study, being conducted by the California State Health Department, integrates fall prevention into an existing community-based public health program for older adults. This intervention includes education about fall risk factors, referrals to community exercise programs to increase strength and balance, medication review, and home modification to reduce home hazards. The Wisconsin Department of Health, in collaboration with the University of Wisconsin, is assessing the effectiveness of a comprehensive approach to preventing falls among high-risk seniors. This intervention includes health assessments in the participants' homes combined with tailored risk reduction strategies such as individualized strength and balance exercises. These studies will provide valuable information about the effectiveness of two different intervention strategies in community settings.

The AGS Panel has recommended intervention approaches based on the needs of various populations. For people living in the community, the AGS Panel has suggested that prevention strategies include gait training, exercise including balance training, reviewing, reducing and/or modifying medications, treating postural hypotension, reducing home hazards, and treating cardiovascular disorders including cardiac arrhythmias. For patients in nursing homes or assisted living settings, the Panel has recommended multi-component interventions that include staff education programs, gait training, advice on using assistive devices appropriately, and reviewing and modifying medications, especially psychoactive medications.¹³

Conclusion

Falls and fall-related injuries represent an enormous burden to individuals, society, and to our health care system. Because the U.S. population is aging, this problem will increase unless we take preventive action. We need to refine, promote, and implement prevention strategies that we know work. The CDC is currently conducting a project to move effective interventions into practice. The project has identified randomized controlled studies of scientifically-based effective fall interventions and entered key information about the studies into a database system using a standardized format. This database will provide the foundation for the *Compendium of Effective Fall Prevention Interventions*, a document that will contain concise summaries of each study as well as details about the interventions. This document will give public health practitioners and others the detailed information needed to implement these interventions in fall prevention programs.

While we know much about what works to prevent falls, we need more information in order to tailor intervention strategies for populations with differing characteristics and risk factors. For example, we know that exercise reduces falls, but we need research to identify what specific types of exercises are most effective and for what audiences. In addition, we need to conduct research to learn ways to successfully disseminate effective interventions, to translate these intervention strategies into

programs, to encourage implementation in community settings, and to promote widespread adoption at the local level.

Judy A. Stevens, Ph.D., is an epidemiologist at the National Center for Injury Prevention and Control, Centers for Disease Control and Prevention, Atlanta, GA.

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The Role of Exercise in Reducing Falls and Fall-Related Injuries in Older Adults

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Over the course of the past twenty years, researchers have investigated the efficacy of different categories of intervention strategies designed to reduce the risk factors that contribute to falls and the actual incidence of falls and fall-related injuries in the older adult population. These different categories of strategies have been implemented with different target populations and in different settings (e.g., healthy and frail community-residing older adults, frail nursing-home residents). The goal of this paper is to describe the different exercise-based intervention strategies that have been shown to be effective in reducing fall incidence rates and fall-related injuries among community-residing older adults. This paper will examine the efficacy of exercise as a stand-alone intervention strategy or as a core component of a multifactorial risk factor assessment and management approach.

Overview of Research Findings

A number of research studies conducted over the last two decades have examined the benefits of exercise, either as a stand-alone intervention strategy or as a component of a multifactorial intervention strategy, in reducing fall risk and fall incidence rates in the older adult population.¹⁻⁴ The many different types of exercise interventions have ranged from single exercise (e.g., resistance exercises, walking, tai chi) to multicomponent exercise programs (e.g., aerobic endurance, flexibility, strength, and balance training). While some exercise interventions have adopted a more general approach, others have included exercises that specifically target balance and gait impairments and other physical factors known to be associated with heightened fall risk, such as muscle weakness or reduced flexibility.⁵⁻⁸ In addition to different types of exercise, the method of delivery (i.e., group-based versus one-to-one) and intervention setting (i.e., community-based facility versus home) have also differed across studies. Finally, the type of provider (e.g., physical or occupational therapists, nurses, physical activity instructors) who implements the exercise intervention also has varied across studies.

Multicomponent Exercise Interventions

The multi-center FICSIT (Frailty and Injuries: Cooperative Studies on Intervention Techniques) randomized controlled trials represented the first systematic and large-scale attempt to investigate the efficacy of exercise (both targeted and non-targeted) on a

number of difference performance measures related to frailty as well as fall incidence rates among older adults. Five of the seven intervention sites that incorporated exercise provided services to community-residing older adults, while the two remaining sites served frail nursing-home residents. Although the interventions varied with respect to the type of exercise used and the intensity, frequency, and duration of the intervention, the combined multi-site outcomes demonstrated a significant reduction in the risk of falling for the interventions that included exercise as a component of the intervention (13% reduction). The risk of falling was further reduced (24% reduction) if the exercise intervention included specific balance and gait activities.⁹

In recent years, individualized exercise programs that have targeted specific physical impairments identified during an initial assessment have also produced significantly lower fall incidence rates. These programs have generally been designed and supervised by physical or occupational therapists in the home setting.¹⁰⁻¹¹ For example, Campbell et al. reported only modest improvements in physical function, but their intervention nevertheless demonstrated a significant reduction in the rate of falling in a group of older women (80 years and older) identified at high risk for falling. Participants received an individualized exercise program designed and initially taught by a physical therapist. Participants in the exercise group subsequently received instruction to perform the moderate intensity exercise program three times per week for six months unsupervised. Instructors further encouraged participants to engage in brisk walking an additional three times per week. During the intervention period, regular telephone follow-up was conducted to maintain the participants' level of motivation. Participants who agreed to maintain the exercise program for an additional year (71% of original group) continued to experience reduced fall rates over the course of the second year when compared to the non-exercising control group.

A more recent study compared the effectiveness of three different types of interventions in reducing fall incidence rates - group-based exercise, home hazard management, and vision improvement strategies - in a group of relatively healthy older adults (70 years and older).¹² The 15-week group exercise intervention, supplemented with a home exercise program, proved the most beneficial single fall reduction strategy with an estimated reduction in fall incidence rates of 6.9% over the 18-month study period. A combination of all three strategies, however, resulted in a further reduction in estimated fall rates (14%).

Practical Implications

Although studies have varied by the actual components included in the exercise intervention, the evidence strongly suggests that exercise programs, whether group-based or individualized, that focus on improving balance and gait as well as other risk factors associated with heightened fall risk (e.g., muscle weakness, joint pain/instability) likely provide the most effective results. Given that the duration of the various exercise interventions also varied considerably, the amount of exercise needed to reduce fall incidence rates among older adults at different levels of risk remains unclear. One additional practical implication emerging from the present findings relates to exercise intensity (i.e., length and frequency of exercise sessions, exercise difficulty). To appreciably lower fall risk, interventions need to provide moderate intensity exercise for older adults at a low to moderate risk for falls but progress from low to moderate

intensity exercise for high-risk groups who are severely de conditioned. Exercise interventions should be considered inadequately intense if they do not lead to significant improvements in intermediate variables such as balance, strength, or endurance because these variables contribute most to reduced fall risk and/or fall incidence rates.¹³⁻¹⁴

Alternative Forms of Exercise –Tai Chi

In recent years, an Eastern form of exercise known as tai chi has emerged as a viable stand-alone exercise intervention that not only provides numerous health benefits but also appears effective in lowering fall incidence rates among certain groups of older adults.¹⁵⁻¹⁶ Wolf and colleagues were the first to demonstrate tai chi's effectiveness in reducing both fear-of-falling and fall incidence rates (as much as 47%) over a four-month follow-up period in a group of community residing older women at moderate risk for falls who participated in a 15-week group and home-based tai chi program. Li et al. recently provided additional support for the use of tai chi as a fall prevention strategy in a group of sedentary, community-residing older adults who participated in a six-month program.¹⁶ In addition to demonstrating significant improvements in multiple measures of balance, physical performance, and fear-of-falling, the group receiving the tai chi intervention experienced significantly fewer falls of any kind as well as injurious falls during the six-month follow-up period, compared to a group who received a low intensity flexibility program. The authors of this most recent study attributed the effectiveness of tai chi in reducing the number of falls as well as fall injury rates to its emphasis on controlled movements, postural alignment, and increased range of motion in the joints and muscles of the lower body. In contrast to the evidence that supports it as an effective fall prevention strategy for relatively healthy, albeit sedentary community-residing older adults, tai chi appears less effective as a stand-alone fall-prevention strategy in groups of older adults who are frail or transitioning into frailty.¹⁷

Practical Implication

Certainly the incorporation of tai chi programs into large-scale community-based fall prevention initiatives has a number of advantages. It costs little and requires no equipment, and it can be performed in groups or individually in the home. It requires only sufficient space to allow for movement in group-based settings. Although easy to initiate in community-based settings, however, programming must give careful consideration to the form of tai chi selected and the qualifications of the instructor hired to lead the class. The Li et al. study selected the Yang style of tai chi and reduced it to 24 different movements that emphasized multi-directional weight –shifting, multi-segmental (arms, trunk, legs) coordinative movements, awareness of body alignment, and synchronized breathing.¹⁶ In the earlier study conducted by Wolf et al., a simplified form of tai chi consisting of 10 exercise forms that “emphasized all components of movement that typically become limited with aging” (p. 490) was used.¹⁵ Movement components emphasized the gradual reduction in base of support, increased body and trunk rotation, and reciprocal arm movements.

Not all styles of tai chi may be appropriate for use with older adults. First, providers may need to manipulate the number and type of movement forms selected, for

reasons of safety and ease of learning. Second, appropriate use may depend on the qualifications of the tai chi instructor who leads such programs. An experienced tai chi instructor who demonstrates a good understanding of the aging process and has the ability to adapt certain tai chi forms to accommodate common age-associated neuromuscular and orthopedic conditions will more likely have success than tai chi instructors, albeit very experienced ones, who have less knowledge about the aging process.

Issues to be Addressed

A number of important issues warrant further investigation based on the mixed findings emerging from a large number of studies that have included exercise as a stand-alone intervention strategy. These include (a) identifying the minimum dosage (i.e., frequency, intensity, and duration) of exercise (including tai chi) needed to significantly lower fall incidence rates and fall-related injuries among older adults at different levels of risk; (b) directly comparing the relative benefits of different types of exercise interventions – at this time there is no evidence that one type of exercise is superior to another type; (c) investigating the cost effectiveness and cost savings associated with different types of intervention strategies – only limited evidence currently exists relative to this issue; (d) identifying the type of intervention strategy that has greatest effect for older adults with cognitive impairment and dementia; and (e) addressing the degree to which the ethnicity, socioeconomic, and/or geographic location (urban versus rural) of the participants being targeted influence the effectiveness and acceptability of a given exercise intervention.

Multifactorial Intervention Strategies with Exercise as a Core Component

Given that not all older adults fall for the same reason, and are in fact most likely to fall as a result of the presence of multiple fall risk factors, multifactorial risk factor assessment and intervention strategies first identify and then minimize the risk factors identified through a systematic follow-up process. The most common fall risk factors that studies exploring this type of intervention strategy have targeted include gait and balance impairments, muscle weakness, difficulties moving from bed to chair, number and type of medications, cardiovascular risk factors, and environmental hazards in the home.

Current studies have examined the efficacy of multifactorial fall risk assessments and management interventions in community-residing older adults at different levels of fall risk and have found them the most effective strategy for reducing falls in older adults.¹ Unfortunately, this type of intervention strategy is more resource intensive and generally requires a multidisciplinary team of providers comprising emergency room physicians and nurses, general practitioners, physical and occupational therapists, pharmacists, psychiatrists, and social workers. Once medical personnel identify the risk factors, they then refer the individual to the appropriate services for specific treatment and follow-up.

A landmark study of a multifactorial intervention conducted by Tinetti and colleagues reported that fewer participants in the intervention group fell during the one-year follow-up period (31 percent) and also found significantly increased time to the first

fall for this same group.¹⁸ Close et al. also demonstrated a significant reduction in falls in the year following discharge from a hospital emergency department in a group of older adults who received a post-fall multifactorial fall risk assessment and appropriate referral and follow-up.¹⁹ Only 32 percent of the intervention group versus 52 percent in the control group who received usual care reported at least one fall during the follow-up period.

Although effective in reducing fall incidence rates when implemented with older adults with normal cognition, a multifactorial intervention approach has proven less effective when examined in older groups with cognitive impairment and dementia.²⁰ A recently published study found no significant difference in fall incidence rates, or any of the other fall-related measures collected (e.g., time to first fall, injury rates, hospital admission, mortality), between a group receiving the multifactorial assessment and intervention and a usual care group during the one-year follow-up period. The authors recommended more research to determine how best to intervene in this group of older adults who are twice as likely to fall as their cognitively unimpaired peers.²¹

Issues to be Addressed

Multifactorial risk factor assessment and intervention strategies, usually including targeted exercise as a core component, hold promise for significantly lowering fall incidence rates and fall-related injuries, particularly when targeting high-risk older adults with normal cognition. The successful implementation of these programs will require a multidisciplinary team approach as well as the time and resources needed to identify all the individual risk factors contributing to heightened fall risk. Implementation also will require a clear set of operating procedures to ensure that the older adult receives the appropriate services and treatment in a timely manner, with progress monitored over the long term. Finally, success will require a clear set of criteria for targeting older adults most likely to benefit from this type of intervention strategy.

The very limited research evidence that currently exists also suggests that these types of multifactorial intervention strategies have greatest cost effectiveness when they target older adults identified at high risk for falls.²² Definitive conclusions relative to this issue, however, will depend on additional research. Fall prevention guidelines jointly developed by the American Geriatrics Society, the British Geriatrics Society, and the American Academy of Orthopedic Surgeons, identify older adults who have experienced repeated falls, who reside in a nursing home, who are prone to fall-related injuries, or who have just sustained a fall requiring medical attention as at high risk.²³

Recommendations

Although many issues remain to be addressed, the current research findings indicate that different types of stand-alone exercise interventions or multifactorial intervention approaches that include exercise as a core component have the potential to significantly reduce many of the risk factors that contribute to falls and, in the case of community-residing older adults, the actual number and rate of falls. What is less clear is how best to match the type and dose of exercise to the specific needs of older adults at different levels of risk. A set of five recommendations follows:

1. *Type of Exercise.* While no definitive evidence exists to support one type of exercise more than another, the most effective exercise interventions include activities that specifically target balance and gait, as well as other risk factors known to substantially increase the risk of falling (e.g., muscle weakness), are performed at or progress toward a level of moderate intensity in progressively more challenging practice environments. Good evidence now exists for the use of tai chi as an alternative stand-alone exercise intervention for community-residing older adults at low to moderate risk for falls. Interventions incorporating more simplified forms of tai chi and a smaller number of movement sequences that emphasize the types of movements most affected by the aging process appear to be effective in reducing falls. Further, experienced instructors with good knowledge of common age-associated performance limitations should implement this type of exercise intervention.
2. *Level of Fall Risk and Type of Intervention Strategy Prescribed.* Multifactorial risk factor assessment and intervention strategies likely have the greatest effect in reducing fall rates and fall-related injuries in older adults at high risk for falls or with a history of falls. No evidence has yet identified the component or components of the multifactorial approach that most effectively reduces fall rates. Some evidence suggests that they provide the most cost effective approaches for high-risk older adults. In contrast, well-designed stand-alone exercise programs, either group-based or individualized, appear just as effective as multifactorial programs in reducing fall incidence rates and are more cost effective for older adults at a low to moderate risk for falls.
3. *Compliance.* To achieve long-term benefits, exercise interventions must be designed in such a way that older adults find them acceptable, and they must also foster high levels of compliance. Compliance appears to improve if group-based exercise programs provide strong social support and if the design of individualized home exercise programs fosters the development of self-regulatory skills (e.g., goal setting), self-monitoring of progress and self-reinforcement.²⁴ The older adult's initial level of frailty and overall risk for falls appears to further influence long-term success of unsupervised home exercise programs.² Achieving long-term compliance in this higher risk group may require the addition of regular telephone or in-home visits by an appropriately trained volunteer or a more supervised group-based intervention when possible.
4. *Judging an Intervention's Effectiveness.* The effectiveness of any exercise intervention should not solely rest on whether fall incidence rates are appreciably lowered in the targeted group. Judgment concerning effectiveness should consider additional outcome measures such as the number of fall-related injuries; utilization of health care services; intermediate physical performance measures such as strength, balance, and gait; and psychosocial measures such as fear-of-falling, depression, and perceived quality of life. Given that a successful exercise intervention will likely lead to higher levels of physical activity, so too will it increase the risk for falls due to increased exposure to environmental hazards. In order to recognize this potentially

offsetting phenomenon, the calculation of fall incidence rates should adjust for physical activity levels.⁸ By adjusting for increased exposure to risk, Rubenstein et al. demonstrated significantly lower fall incidence rates in a group of fall-prone older adult men who completed a 12-week group-exercise program compared to a no-exercise control group. Evaluation of an intervention also should include assessment of cost/benefit ratios, with a lower ratio considered more successful.

5. *The Influence of Ethnicity, Socioeconomic Status, and Geographical Location.* Little if any research to date has examined the effectiveness and acceptability of exercise as an intervention strategy for reducing falls among older adult groups who are ethnically diverse, of different socioeconomic status, and/or geographically isolated. This noticeable gap in the literature needs attention to determine how best to develop and implement a national action plan for reducing falls among older adults. Each of these variables may pose important barriers to implementation and therefore deserve immediate attention. Recently conducted focus group research makes it clear that cultural background influences the older adults' perception of what is an acceptable type and frequency of physical activity.²⁵ Location of residence (urban versus rural) and sufficiency of economic resources to gain access to available programs also will likely shape the content of exercise interventions and methods of delivery to the target population.

Summary

A review of the existing research makes it clear that exercise provides an essential component of any program designed to reduce falls and fall-related injuries in older adults. Remaining issues include deciding what additional components, if any, to add to a fall risk reduction program to meet the needs of the specific targeted group (low, moderate, high risk). While community-residing older adults at low to moderate risk for falls will derive substantial benefits from a targeted stand-alone exercise program (group-based or at-home) that addresses the intrinsic risk factors known to heighten fall risk, older adults at high risk for falls will derive greater fall protection from multifactorial risk factor assessment and management intervention approaches. Although a number of research studies have demonstrated reductions in the risk factors associated with falls, fall incidence rates, and fall-related injuries from interventions that incorporated exercise as the primary component, Gillespie, in a recent editorial, stated that these reductions are modest at best.²⁶ She therefore recommends that service providers “set conservative and achievable targets” and that programs that incorporate the more labor intensive and expensive intervention strategies (i.e. multifactorial risk assessment and management) carefully target older adults who are most likely to benefit [p. 653]).

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The Role of Medication Modification in Fall Prevention

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As described elsewhere in the white papers for the *Falls Free: Promoting a National Falls Prevention Action Plan National Summit*, falls represent a devastating and costly, yet preventable, public health problem among people over age 65. Numerous factors increase the risk of falling and fall-related injuries among older adults, but none is as potentially preventable or reversible as medication use.¹ Older persons use approximately 30 percent of all prescription and over-the-counter medications sold in the U.S. On average, community-dwelling seniors use 4.5 prescription medications and two over-the-counter medicines every day and take 26 different prescription drugs annually.² Approximately 30 percent of these community-dwelling seniors fall each year. In addition to the sheer number of medications, the types of medications prescribed to older adults often result in side effects, adverse effects and toxic effects that increase the likelihood of falling.

Falls can cause physical and psychosocial impairments, such as fractures of the hip, spine, and forearm, fear of falling with subsequent restriction in activities and potential nursing home admission. No one risk factor alone predisposes an older person to fall. Typically, the interplay of multiple risk factors—both intrinsic and extrinsic—contributes to a fall event. In addition to medications, multiple chronic conditions, sensory impairments, environmental hazards, history of previous falls, gait and balance abnormalities and cognitive deficits are all major risk factors for falls.

Increasing awareness about fall risk factors and strategies to prevent falls is critical. Everyone working with older adults must identify those individuals most at risk for falls and intervene when necessary. All falls prevention strategies should include interventions that address medication use, such as modifications to medication regimens, no matter what practice setting. This recommendation follows guidelines developed by the American Geriatrics Society³, the American Medical Directors Association⁴, and the Quality Indicators for the Management and Prevention of Falls and Mobility Problems in Vulnerable Elders, which is a component of the Quality Indicators for Assessing Care of the Vulnerable Elders or ACOVE initiative.⁵

The risk of falling increases with the number of prescription and over-the-counter medications taken. In addition, numerous epidemiological studies have identified specific therapeutic classes of medications that increase the risk that an older person will fall. As shown in Table 1, these classes of medications are problematic because they often cause side effects and adverse effects that predispose older persons to fall. Many geriatricians believe that any symptom in an older person should be considered a drug side effect until proven otherwise.⁶

The side effects or adverse effects leading to falls include blurred or impaired vision, hypotension leading to dizziness and lightheadedness, sedation, decreased

alertness, confusion and impaired judgment, delirium, compromised neuromuscular function and anxiety. Fortunately, clinical investigation of cause and subsequent modification to the medication regimen can frequently reverse these effects.

In general, older persons have greater risk of the adverse effects of medications because of the physiologic changes that occur with aging. These changes affect the *pharmacokinetics*—the absorption, distribution, metabolism and elimination—of medications. Pharmacokinetics involve what the body does to the drug. Specific examples of these changes include decreased lean body mass and increased body fat that cause fat-soluble medications to be distributed more extensively and to remain longer in the body of an older person than in a younger person. Declining kidney function can result in an accumulation of medications that are renally excreted, leading to possible toxic drug levels. Decreased liver function can decrease the metabolism of certain medications and also lead to potentially toxic medication levels in many older adults. Diazepam (Valium®) provides an excellent example of a medication that pharmacokinetic changes affect; the liver metabolizes it very slowly and the kidneys excrete it slowly in the body of an older person compared to a younger person. These changes cause diazepam—even one dose of the medication—to remain in an older body for very long periods of time, producing a highly sedative effect.

Age can also alter the *pharmacodynamics* or the interaction between a medication and its target site that results in either a therapeutic or adverse response. Pharmacodynamics involves what the drug does to the body, not what the body does to the drug. Pharmacodynamic changes increase an older person's sensitivity to a potential adverse effect. Medications that affect the central nervous system, such as psychotropic medications, frequently are susceptible to these pharmacodynamic changes. Because of these changes with age, many geriatric practitioners frequently use a rule of thumb “to start low and go slow” when dosing medications for older adults.

Overview of the Research

What specific medications or medication classes have been shown to increase the risk of falling and fall-related injuries among older persons and why? Table 1 summarizes the various classes of medications described below and the mechanisms by which these medications increase the risk of falling in older adults.

Benzodiazepines

Benzodiazepines are commonly prescribed to older adults across all settings of care. Up to 15 percent of community-dwelling older adults receive prescriptions for these medications to treat anxiety, insomnia, and seizure disorders.⁷ These medications are frequently used as sedative-hypnotics. Various studies have shown benzodiazepines associated with a 48 percent greater risk of experiencing falls and fractures in older persons.¹ Long acting benzodiazepines such as diazepam (Valium®), flurazepam (Dalmane®) and clonazepam (Klonopin®) and even the short acting benzodiazepines such as alprazolam (Xanax®), temazepam (Restoril®) and lorazepam (Ativan®) commonly create "hangover" effects from nighttime use. These effects, which include

sedation, impaired balance, decreased neuromuscular function, and decreased central processing or alertness in older adults, can cause or contribute to a fall event.

Other studies have shown that the risk of fall-related fractures from benzodiazepine use is associated with the dose, not the medication's long or short acting characteristics⁸, and that the greatest risk occurs within 15 days of a new prescription and decreases with an increase in time from prescription fill date.⁹ This research indicates that it is critical for physicians to prescribe the lowest therapeutic dose possible and for health care providers to educate and alert patients and caregivers about the risk of falling and fracture within the early days of benzodiazepine use.

Antidepressants

Studies also have shown that antidepressants increase the risk of falling, by potentially causing orthostatic hypotension and dizziness, sedation, decreased alertness and blurred vision. "Older generation" antidepressants such as the tricyclics or TCAs, including amitriptyline (Elavil®) and imipramine (Tofranil®), are particularly problematic. Research has found that antidepressants (most research has examined tricyclic antidepressants) increase the risk of experiencing a fall by 66 percent.¹ New users of antidepressants have higher rates of falls than nonusers, and higher doses of antidepressants are associated with higher rates of falls. In addition, older persons taking the new generation of antidepressants, known as selective serotonin reuptake inhibitors (SSRIs), such as fluoxetine (Prozac®), paroxetine (Paxil®) and sertraline (Zoloft®), have a greater risk of falls¹⁰ and hip fracture¹¹ than older adults not taking these medications. Because this class of medications has a generally more favorable side effect profile, however, it is frequently the choice for the treatment of depression in older adults compared to the TCAs.

Antipsychotics

Research has shown that antipsychotics, used in the treatment of schizophrenia, bipolar disorder and other psychotic conditions, which include chlorpromazine (Thorazine®), trifluoperazine (Stelazine®) and haloperidol (Haldol®), significantly increase the risk of falling. The prevalence of antipsychotic use is high in older populations, particularly for those persons residing in institutional settings; recent estimates show that the prevalence of use is approximately 26 percent in nursing homes and 13 percent in assisted living facilities.¹²⁻¹³ The newer "atypical antipsychotics," such as risperidone (Risperidol®) and olanzapine (Zyprexa®), also have an association with increased risk of falls in older adults compared to nonusers. The side effects of these medications include postural hypotension, dizziness, blurred vision and sedation.

Antihypertensive Medications

Certain medications that treat high blood pressure by acting upon the central nervous system, such as clonidine (Catapres®), may contribute to falling through orthostatic hypotension and dizziness, fatigue, decreased mental alertness and sedation. Diuretics, also used to treat hypertension, may contribute to falls by causing sedation, fluid depletion, electrolyte disturbances or an urgency to rush to the bathroom. Of all the antihypertensives studied, only diuretics appear to significantly increase the risk of

falling.¹ Older persons taking more than one antihypertensive drug have an increased risk of falling compared with those taking just one.¹⁴⁻¹⁵

Anticholinergic Medications

Many medications are potentially inappropriate for use in elderly patients due to their anticholinergic effects. Medications with anticholinergic properties inhibit or block the action of acetylcholine at a number of different receptor sites in the body. Common anticholinergic side effects that can result in falls and fractures include: blurred vision; drowsiness or sedation; rapid heart rate; confusion, disorientation; memory impairment; dizziness when standing from bed or chair; nervousness, agitation, or anxiety; weakness; and hallucinations and delirium.

The following commonly used medications have anticholinergic effects: anti-nausea and antidizziness medications, anti-Parkinson's medications, antidepressants, antihistamines, muscle relaxants, anti-diarrheal medications, urinary and gastrointestinal antispasmodics, antiarrhythmics and antipsychotics. Anticholinergic adverse effects may be more likely or severe if the patient receives several medications with anticholinergic effects. Older persons should be observed for these adverse effects so problems can be avoided, managed, or reversed.

Cardiac Medications

Cardiac medications include digoxin (Lanoxin®), drugs to treat arrhythmias, calcium channel blockers (Procardia®, Adalat®, Cardizem®) and nitroglycerin (Nitrostat®). The mechanisms by which these drugs are thought to increase the risk of falling include hypotension and dizziness, muscle weakness, confusion and fatigue. Both digoxin and type IA antiarrhythmic agents (Procan® and quinidine) have associations with significant increases in the risk of one or more falls in older adults.¹

Analgesics

Analgesics, a class of medications that includes narcotic pain relievers such as codeine and propoxyphene (Darvon®, Darvocet N-100®), as well as non-steroidal anti-inflammatory agents (NSAIDs) such as ibuprofen (Motrin®, Advil®), naproxen (Aleve®, Naprosyn®) and ketoprofen (Orudis®), may contribute to falls. This effect usually occurs due to side effects common to these medications: decreased alertness, impaired neuromuscular function, dizziness, sedation, confusion, declines in hearing and blurred vision. One study concluded that the association between NSAID use and falling might reflect confounding by disease state, particularly lower extremity arthritis.⁷

Propoxyphene has been identified by geriatric experts as potentially inappropriate for use by adults aged 65 and older due to its opioid-related adverse effects and questionable efficacy.¹⁶⁻¹⁷ Propoxyphene's central nervous system-related side effects of dizziness, sedation and lightheadedness may increase the risk of falls; research has identified propoxyphene use as a risk factor for hip fractures.¹⁸⁻¹⁹ In addition, several studies have demonstrated that propoxyphene is no more effective than acetaminophen, aspirin, codeine, or ibuprofen in reducing pain and may even be inferior.²⁰⁻²¹ Propoxyphene's lack of advantage over other analgesics in clinical efficacy, together with its potential for

opioid-related adverse effects, has resulted in widespread recommendations against its use in the elderly population.

Alcohol

Although research has not shown an association, alcohol may potentially increase the risk of falls in elderly persons. Because of altered pharmacokinetics in older persons, blood alcohol levels tend to be higher than the levels in younger persons who consume the same amounts of alcohol. In addition, chronic heavy alcohol use has long-term neurologic and possible osteoporotic effects that may increase the risk of fall injury events. Failure to find an association between alcohol use and falling may reflect underreporting of alcohol use or early mortality resulting from alcohol consumption. Alcohol can increase the sedative and negative neuromuscular side effects of many medications, including commonly used over-the-counter medications such as diphenhydramine or Benadryl™, so mixing alcohol with medications can potentially contribute to a fall.

Multiple Medications

Although extensive research exists on medication use, falls and fractures, few studies have yet assessed whether and to what extent various *combinations* of medications have significant associations with increased risk for falling among older persons. One study did reveal that patients taking combinations of NSAIDs, cardiac, and psychotropic drugs have an increased risk of falling compared with those not taking this combination.²² However, several studies have shown that the risk of falls increases with the number of medications take concurrently; taking three or more medications of any type has been shown to increase the risk of falling and of recurrent falls than older persons taking fewer medications.^{1,23}

Table 1

MEDICATIONS AND THEIR MECHANISMS THAT INCREASE RISK OF FALLS AND FRACTURES		
MEDICATION CLASS	MEDICATION INCLUDED IN CLASS	MECHANISM
Benzodiazepines - Long and Short Acting	flurazepam (Dalmane®), diazepam (Valium®), alprazolam (Xanax®), lorazepam (Ativan®)	sedation, dizziness, decrease in neuromuscular function, cognitive impairment
Antidepressants	tricyclic antidepressants (amitriptyline-Elavil®, imipramine-Tofranil®) selective serotonin reuptake inhibitors or SSRIs (fluoxetine-Prozac®, paroxetine-Paxil®, sertraline-Zoloft®)	postural hypotension, sedation, blurred vision, confusion, ataxia

Antipsychotics	chlorpromazine (Thorazine®), haloperidol (Haldol®) respiridone (Respiridol®), olanzapine (Zyprexa®)	postural hypotension, dizziness, blurred vision, sedation
Antihypertensives		
Centrally Acting Antihypertensives	clonidine (Catapres®), methyldopa (Aldomet®), reserpine, minoxidil (Loniten®)	postural hypotension, sedation
Beta Blockers	propranolol (Inderal®), nadolol (Corgard®), atenolol (Tenormin®), metoprolol (Lopressor®),	postural hypotension, sedation
ACE Inhibitors	Captopril (Capoten®), enalapril (Vasotec), lisinopril (Zestril®)	postural hypotension
Thiazide Diuretics	Hydrochlorothiazide/HCTZ (Hydrioduril®), metolazone (Zaroxlyn), chlorthalidone (Hygroton)	postural hypotension, lethargy
Loop Diuretics	Furosemide (Lasix®), bumetanide (Bumex®)	postural hypotension, decreased alertness, fatigue
Cardiac Medications		
Cardiac Glycosides	digoxin (Lanoxin®)	lethargy, confusion
Antiarrhythmics	procainamide (Procan®), quinidine, tocainamide, flecainide	hypotension, arrhythmias
Calcium Channel Blockers	diltiazem (Cardizem®), nifedipine (Procardia®, Adalat®), verapamil (Calan®)	postural hypotension
Nitrates	nitroglycerin (Nitrostat®), isosorbide dinitrate (Isordil®)	postural hypotension, syncope
Analgesics		
Non-steroidal Antiinflammatory Agents (NSAIDs)	Ibuprofen (Motril®, Advil®), naproxen (Aleve®, Naprosyn®) Diflunisal (Dolobid®), diclofenac (Voltaren®)	sedation, dizziness, cognitive dysfunction
Opioid Analgesics	codeine and derivatives, propoxyphene (Darvon®, Darvocet N-100®), meperidine (Demerol®)	sedation, confusion, ataxia, blurred vision

Anticonvulsants	barbiturates, phenytoin (Dilantin®), valproic acid (Depakote®), carbamazepine (Tegretol®)	ataxia, cognitive impairment, sedation
Antihistamines	diphenhydramine (Benadryl®), chlorpheniramine (Chlortrimeton®)	hypotension, sedation, confusion
Gastro-intestinal-Histamine Antagonists	cimetidine (tagamet®), ranitidine (Zantac®), famotidine (Pepcid®)	confusion, ataxia; cimetidine decreases the clearance of many drugs including diazepam, propranolol and tricyclic antidepressants

The Role of Medication Modification in Falls Prevention Strategies

Physicians, pharmacists and other health care providers should use knowledge of medications and medication classes that have associations with an increased risk of falling to guide prescribing decisions and modify existing medication regimens. Questions to consider when identifying if medications contributed to a fall include the following:

- Were the medications administered prior to or after the fall?
- If prior to the fall, how close to it were the medications first administered?

Frequently, eliminating a medication, changing the dosage or switching to an alternative medication that does not compromise therapeutic effect will reduce the chance that a fall will occur or recur in an older person.

Practice guidelines that focus on falls prevention all include specific interventions aimed at reducing the potential increased risk posed by medication use. Table 2 provides a summary of these interventions by guideline.

Table 2

<u>Source</u>	<u>Recommended Interventions</u>	
American Medical Directors Association, Falls and Falls Risk, 1998⁴	<p>Potential Fallers</p> <ul style="list-style-type: none"> ▪ Review medications that could predispose to falls; especially diuretics, cardiovascular medications, anti-hypertensives, antipsychotics, antianxiety agents, sleeping medications, antidepressants ▪ Reduce dosages or eliminate 	<p>After a Fall</p> <ul style="list-style-type: none"> ▪ Review for presence of medications that could predispose to falls; adjust dosage or stop medication as indicated ▪ Review for recent changes in medication regimen

	such medications
American Geriatrics Society, British Geriatrics Society, American Academy of Orthopedic Surgeons Panel on Falls Prevention. Guideline for the prevention of falls in older persons, 2001³	Patients who have fallen should have their medications reviewed and altered or stopped as appropriate in light of risk for future falls. Particular attention to medication reduction should be given to older persons taking four or more medications and to those taking psychotropic medications.
Quality Indicators for the Management and Prevention of Falls and Mobility Problems in Vulnerable Elders & Quality Indicators for Appropriate Medication Use in Vulnerable Elders: Quality Indicators for Assessing Care of the Vulnerable Elders (ACOVE)⁵	<p>Intervention: Medication Review</p> <ul style="list-style-type: none"> ▪ Conduct a medication review on at least an annual basis ▪ All prescribed medications should have a clearly defined indication ▪ Avoid tricyclic antidepressants ▪ Monitor diuretic and warfarin therapy ▪ New medications should have clearly defined indications ▪ Educate patients about side effects of new medications ▪ Avoid medications with anticholinergic properties ▪ Patient should have an up-to-date medication list

Recommendations

As described above, using multiple medications and certain classes of medications increases the risk that a fall will occur. Interventions to address medication risk must include:

- An initial review of the medication regimen, paying particular attention to new medications and any side effects, adverse effects, and toxic effects that may increase the risk of falling;
- Recommendations for changes in medication therapy, e.g., dose reduction, elimination of a medication or medications, and switch to a medication that poses less risk;
- Education of older adults and their caregivers about their medications, side effects that might increase the risk of falling, and guidance about when to report those side effects; and
- Follow-up to assess recurrence of falls and the impact of medication adjustment.

For these interventions to be most effective, they must be included as part of a program that addresses multiple risk factors for falls as most falls can be attributed to multiple causes. Multifaceted interventions have consistently shown a decline in fall

rates, particularly when targeting persons at risk and incorporating several intervention approaches including medication reviews. The multi-disciplinary team should include a pharmacist or other health care provider with expertise in geriatric pharmacotherapy to specifically address medication issues, while other members of the team assess and intervene on the other factors associated with increased risk of falling.

The *Stepping On* program provides an example of a multifactorial intervention conducted by health care professionals with skills in geriatric medicine that has shown to decrease the rate of falls in community-dwelling older adults. The *Stepping On* program aims to improve fall efficacy, encourage behavioral change and reduce falls. Key aspects of the program include improving lower-limb balance and strength, improving home and community environmental and behavioral safety, encouraging regular visual screening, making adaptations to low vision and conducting medication reviews. The medication reviews involve identifying medications risks and exploring strategies to reduce risk of falls from medication side effects or misuse. The intervention also includes behavioral sleep alternatives to taking sedative hypnotics such as benzodiazepines. This program was shown to be effective in reducing falls by 31 percent in community-dwelling older adults who had experienced a fall in the previous 12 months or were concerned about falling.²⁴

In addition, to prevent a fall event, seniors themselves need an awareness of their fall risk factors and knowing what to do about their own risks. Health care providers must proactively educate seniors about risk factors for falls. For example, providers should instruct seniors who experience dizziness or syncope when moving from a lying or sitting position to standing (often a consequence of antihypertensive medications) to rise slowly from the lying or sitting position to allow for their blood pressure to adjust. Older persons should report any side effects they experience so that their health care providers can assess medications and make changes if necessary. Seniors should carry a list of all current prescription and over-the counter medicines so their physicians know every medication they are taking.

Summary

Professionals across the continuum of care need awareness of all risk factors for falls and the ability to identify seniors most at risk for a fall. Changes in cognitive and physical function, dizziness or lightheadedness, balance difficulties, confusion and sedation provide red flags to alert service providers to refer seniors who experience these problems to health professionals for a comprehensive assessment. Medication use may cause these changes and require interventions aimed at medication modification, such as a dosage reduction, elimination of a medication or use of an alternative, to reduce the risk of falls.

At the time of this writing, Kathleen A. Cameron, RPh, MPH was the executive director of the Research and Education Foundation, American Society of Consultant Pharmacists, Alexandria, VA.

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The Role of the Environment in Fall Prevention at Home and in the Community

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Older persons strongly prefer to stay in their own homes and communities and never move. Unfortunately, however, the settings where they live often have numerous hazards, dangerous areas and lack supportive features, all of which can contribute to accidents, reduce activities, and foster unnecessary dependence. Since persons with functional limitations have an increased risk of falling, we need to address both their current needs and to insure that future housing and communities provide greater safety, accessibility and support.

Falls not only have devastating consequences for older adults in terms of morbidity and mortality, but also are associated with high acute and long-term care costs. A number of studies have reported that 30 to 60 percent of community-dwelling older adults fall each year. The fall incidence rates for this population range from 0.2 to 1.6 falls per person per year, with a mean of about 0.7 falls per year.¹ In 1994, fall injuries among people 65 and older had a total direct cost of \$20.2 billion.² Research indicates that falls result from a complex interaction between intrinsic (e.g., age-related physiological changes) and extrinsic factors (e.g., environmental hazards). In addition, studies have found that multi-factorial intervention programs that include environmental modifications can effectively prevent over one-third of falls among older adults, thereby improving their independent functioning and enhancing their quality of life.

This paper provides an overview of fall incidence among community-dwelling older adults in terms of frequency and location, as well as environmental risk factors associated with falls at home and in community settings. It analyzes the role of home modification and community intervention strategies in preventing falls. Finally, it discusses challenges and barriers related to the environment, along with recommendations for better integrating the environment as a component of fall prevention strategies.

Where and How People Fall

Falls and fall-related injuries, potentially preventable public health problems, have been the leading cause of injury deaths among older adults. In 2001, approximately 1.6 million elders received treatment in hospital emergency departments for fall-related injuries and 373,000 were hospitalized.³ In addition, more than 11,600 people aged 65 and older died from fall-related injuries.² Peek-Asa and Zwerling also reported that falls

– specifically, complications from fall-related hip fractures – account for approximately 25 percent of injury deaths among those aged 65 years and older, and 34 percent of injury deaths among those aged 85 years or older.⁴

Data compiled from the 1997 and 1998 National Health Interview Surveys indicate that the majority (55%) of fall injuries among older people occurred inside the house.⁵ Older adults, particularly the oldest old, become less mobile and spend more of their time inside their dwelling units, which may account for the greater number of injuries in the home. An additional 23 percent of injuries occurred outside but near the house and the remaining 22 percent occurred away from the home.

Studies indicate that the home environment is implicated in 35 to 40 percent of older persons' falls.⁶ Tripping or slipping while walking forward most commonly causes falls, followed by falling during transfer and falling on stairs or steps.⁷⁻⁸ Objects in one's path such as low chairs, loose mats or flooring, and electrical cords may trigger falls due to trips and slips.⁹ Gill, Williams and Tinetti reported that of older persons who fell at home, those who resided in dwelling units that had no stairs fell in the following areas: hallways (10%), bathrooms (13%), kitchens (19%), bedrooms (30%), and living rooms (31%).¹⁰ Falls that occur while transferring often occur while moving from a chair or bed.⁸ Gallagher and Brunt (1994) also noted that a study by University of Victoria researchers found that 65 percent of falls among seniors occurred outdoors while walking on a familiar route.¹¹ The variety of places both inside the home and outside in the community where people fall indicates the complexity of environmental interventions as a strategy to prevent falls.

Environmental Risk Factors Associated with Falls

Risk factors associated with falls include intrinsic factors (e.g., age-related physiological changes, impairments to the sensory-nervous system, disorders of the musculoskeletal system, specific acute and chronic diseases) as well as extrinsic factors (e.g., environmental hazards and obstacles interfering with safe mobility).¹²⁻¹³

The majority of falls result from a complex interaction between such intrinsic and extrinsic factors, and in general, the relationship between falls and environmental factors is complex and individual specific.¹⁴ Some of the most common environmental factors affecting the risk of falling include: 1) poor or inadequate lighting; 2) changes in floor surface or slippery surfaces (e.g., wet or polished floors, and non-slip-resistant bathtub surfaces); 3) high-gloss floors and/or walking surfaces; 4) problems associated with stairs (e.g., lack of handrails); 5) inappropriate chair or cabinet heights; 6) clutter, storage problems, and tripping hazards such as furniture or throw rugs; 7) poor sidewalk and pavement conditions, and 8) pets and pet-related objects.^{9,13-15}

Prevention of Falls at Home

The great majority of dwelling units in which the elderly live can be characterized as “Peter Pan” housing, designed for persons who never grow old. David Oliver, President and Executive Director of Home Safety Council, has pointed out, “We take our homes

for granted . . . we don't make things safer because for the most part, we don't even know the problem exists."¹⁶ Such housing contains three basic types of problems: hazards, problem areas and lack of supportive features.

Problems in the Home

Hazards that may lead to or contribute to falls very commonly exist in homes of the elderly.¹⁷ Carter and colleagues found, for example, that 80 percent of the homes investigated had at least one hazard and 39 percent had five or more hazards. Such hazards include clutter, electrical cords that cross pathways, slippery throw rugs and loose carpets.¹⁸ Likewise, most homes contain physical problems and barriers. The three biggest problem areas for older persons are: 1) outside steps to the entrance, 2) inside stairs to a second floor, and 3) unsafe bathrooms. Such problem areas are more likely to exist in dwelling units of the elderly because they live in the oldest parts of the housing stock and their diminished capacities make activities such as climbing stairs and bathing difficult. Older persons with mobility and functional limitations report the following three greatest unmet needs for supportive features: 1) handrails/grab bars, 2) ramps, and 3) easy-access bathrooms.¹⁹ The absence of such features can cause residents to unnecessarily restrict activities, create safety problems and make it more difficult for caregivers to provide assistance.

The Role of Home Modification and Multi-factorial Interventions in Fall Prevention

Home modification (HM) refers to converting or adapting the environment in order to make performing tasks easier, reduce accidents and support independent living. HM attempts to reestablish an equilibrium between a person whose capabilities have declined and the demands of the environment.²⁰ Sometimes the environment itself may change over time as a home becomes older and the resident does not have the resources to fix problems such as steps in poor repair. On the other hand, changes in a person's capability in climbing stairs may require additional features such as handrails on stairs.

HM, ranging from low-cost to more expensive adaptations, includes removing hazards (e.g., clutter, throw rugs), adding special features or assistive devices (e.g., grab bars, ramps), moving furnishings, changing where activities occur (e.g., sleeping on the first instead of second floor) and renovations (e.g., installing a roll-in shower). In some cases, modifying the home may also require repairs such as improved wiring to eliminate the need for extension cords or fixing loose stair treads. HM involves a willingness of the resident to alter the home environment and often changes the way activities are carried out.

There is considerable evidence that HM has an important role to play in fall prevention. A number of studies have indicated the efficacy of HM in improving independence, safety, caregiving and functioning. For example, a study of older persons in a controlled intervention with assessment by an occupational therapist found that home care services and HM significantly reduced home health costs and delayed institutionalization of those in the treatment group.²¹ The Community and Home Injury

Prevention Program for Seniors (CHIPPS) in San Francisco combining home assessment and minor HM strategies (average cost of \$93 in materials and \$50-100 in labor) reported reducing the fall incidence rate by almost 60 percent among relatively healthy seniors.²² Close et al. (1999) reported that persons identified in the emergency room as having fallen who were provided with detailed assessments (i.e., medical, functional, environmental), counseling about safety, and HM reported significantly reduced numbers of falls compared with those in a control group.²³ Similarly, in a controlled trial that included home assessment, home visits by an occupational therapist, and minor HM, 36 percent fewer of the intervention group fell than in the control group. The effect occurred, however, only for those who had fallen in the prior year. The researchers attributed the results to the role of the occupational therapist (who helped assess the home for hazards, supervised the completion of HM and encouraged compliance) rather than HM alone.²⁴ Salkeld and colleagues (2000) found that a single factor home hazard reduction program was likely to be the most cost effective for older people who had a history of falls, again suggesting that programs focus on persons at high risk of falling.²⁵

Several other studies, however, have found weaker relationships between the presence of environmental hazards and falls, indicating the difficulty of isolating extrinsic factors such as the presence of scatter rugs or worn carpet from intrinsic factors such as balance, strength and reaction time.²⁶ In this respect, Gill, Williams and Tinetti reported that the association between environmental hazards and nonsyncopal falls was not firmly established.¹⁰ Based on a meta-analysis of controlled trials of fall prevention undertaken by RAND researchers, Rubenstein and colleagues suggested that the most potent interventions combine multiple components that include risk assessment, exercise, and environmental assessment/modification strategies.¹ The overall impact of such interventions is additive. Accordingly, RAND's meta-analysis²⁷ and other studies^{2,28} provide overall consensus that rather than focusing solely on HM, the best approach includes HM in a multi-factorial strategy of fall prevention. Studies, however, have yet to determine the level of intensity or scales of the HM interventions, as most have focused only on hazard assessment.

Multi-Factorial Interventions In Practice

The No More Falls program in California provides an excellent example of a multifaceted fall risk screening and health promotion project. It offers the intervention group: 1) a comprehensive health assessment modified to include fall risk identification; 2) an individualized fall prevention action plan of activities to reduce identified fall risk factors; 3) individual counseling and education about care plan goals and activities; and 4) a home hazard assessment checklist for client self-appraisal and the offer to have program staff conduct a home visit to evaluate, assess and abate hazards. The initial pilot study showed that program participants were 20% less likely than controls to fall one year after completing the program.²² Similarly, findings from a study by Yates and Dunnagan found that low-cost, home-based fall risk reduction programs for community-dwelling older adults were effective in reducing fall-related risk factors when the programs provide the intervention group with fall risk education, exercise programming, nutritional counseling and/or referral and environmental hazard education.²⁹

In general, single-intervention programs such as modification of the home environment, staff education or fall prevention education for older adults without other

key components of multi-factorial intervention (e.g., risk assessment, exercise) have been less effective in reducing falls.^{4,28,30-31}

The Process of HM and Its Challenges

The process of HM includes information and referral, assessment, financing, implementation and follow-up. Effectiveness of the HM interventions requires consumer involvement in the decisions and professional knowledge about the products and service availability.

In general, an individual's acknowledgement of and receptivity to the need for HM is the first step in the process. According to the Consumer Decision Model, an individual balances four factors – perceived susceptibility, perceived severity, perceived efficacy and perceived cost – when deciding whether to obtain HMs.³² The decision to make changes to the home depends on the degree to which a person feels susceptible to a fall or fall related injury, as well as how severe s/he considers the consequences. If the changes are affordable and the person believes that the modifications will make a difference, then the changes are more likely to occur.

Information and Referral

A variety of individuals and agencies that come into contact with older persons are in good positions to provide them with information to raise their awareness about falls, identify environmental problems and provide referrals to service providers. Individuals and their caregivers, including family members and home health aides, may recognize that a person is falling or tripping in the home environment, or restricting activities to avoid accidents. Physicians or other health care providers who assess individual health conditions that may contribute to falls (e.g., poor balance) can also inquire about problems in the home. Case managers in aging service programs or discharge planners who prepare people to return home from a hospital or rehabilitation unit can play especially important roles by considering the home environment. In addition, emergency responders (e.g., paramedics) who see people in their homes after a fall may be able to identify where a fall has occurred and recommend that the person seek HM. Unfortunately, many of these potential referral sources may not view the environment as their purview, are unaware of the role that the home environment plays in falls, lack protocols to identify environmental problems, and/or do not have information about where to refer people. Just as important, HM providers can recommend that their clients who have fallen also seek help from injury prevention or other fall prevention programs.

Types of Home Assessments and Who Should Carry Them Out

Home assessments include safety and hazard checklists, analyses of supportive features in the environment and functional evaluations of the person in the home environment.²⁶ Checklists are inexpensive, and generally a variety of persons can use them to identify home hazards (e.g., loose floor coverings, cluttered pathways), although research indicates laypersons are less adept than a skilled nurse in identifying trip/slip hazards and readily removable objects.³³ Checklists do not, however, provide much information about how a person interacts with the environment nor generally help older people set

priorities about what to change. Moreover, when a hazard cannot be removed or a needed supportive feature cannot be added, older people may need advice from a professional such as an occupational therapist on how to live more safely with the problem.²⁴ Functional assessments are better suited to identify the need for supportive features (e.g., grab bars, hand rails).

Comprehensive in-home functional assessments in which a professional analyzes how an older person carries out an activity (e.g., getting in and out of the shower) set the 'gold standard' to address the needs of persons at high risk of falling who may need complex modifications tailored to their specific needs. They, however, cost more to administer than checklists and require professionally trained staff such as nurses and occupational therapists. Situations that involve structural changes (e.g., installing a roll-in shower) or equipment attached to the house itself (e.g., a stair glide), often require a professional from the building industry (e.g., a contractor, remodeler, or handyman) to estimate costs and make the changes. Team approaches involving an individual and/or family member, a health care provider and a building industry installer are especially useful in complex cases involving structural changes or expensive equipment.³⁴

Consumer Awareness, Involvement and Direction

Client acceptance in making HMs hinges not only on awareness of problems but also on such factors as participation in setting priorities, the ease of making adaptations, cost of HM and the fit of the changes with the home and life style of the resident. Some older persons resist changes because of denial of a problem, a strong sense about what is proper in their home setting or a desire to keep unsafe items that have meaning such as throw rug in the hallway. Strategies that allow residents to keep valued items by, for example, securing throw rugs with Velcro to make them safer, will likely succeed more than efforts to convince residents to remove them. Attractive features (e.g., grab bars of materials and colors that fit into the décor) will also likely meet with more approval than ones that appear institutional. Even though tenants have the right to make modifications under the Fair Housing Amendments Act of 1988, they may still be concerned that making structural changes will create problems with their landlords. In such situations, assistive devices such as temporary grab bars may be more acceptable than permanent types attached to the wall that may have to be removed later at the tenant's expense.

Costs and Financing of HM

Affordability may prevent persons from obtaining needed HM. According to Pynoos and Nishita, more than 75% of persons with home accessibility features pay for them out of pocket.³⁵ Available public and private options to help finance HMs include Community Development Block Grants, grant programs administered by the Department of Veterans Affairs and the Administration on Aging, Medicaid and Medicaid Waivers, state loan programs and private financing (e.g., home equity loans, long term care insurance). Unfortunately, Medicare and Medicaid pay for very few HMs.

HM programs lack stable sources of funding, are subject to budget limitations and often have low caps on expenditures. Even though public and private sources of financing HMs exist, they do not provide comprehensive services and have different eligibility requirements. Therefore, costs remain a serious impediment to obtaining HMs, especially for those with low income or who need expensive modifications.

Consequently, programs tend to focus on low-cost solutions such as home hazard abatement or assistive devices instead of adding more costly features that might require structural changes. A recent AARP survey reported that lack of funding is a major reason why people do not undertake HM.³⁶

Accessing the HM Service System

Lack of consumer access to HM providers is another major reason that people do not make HMs.³⁶ Without assistance, residents will less likely add features such as grab bars, handrails, and ramps. Overall, the HM delivery system can be characterized as fragmented, full of gaps and limited in terms of what it can provide. Although some providers have skill in both assessment and the provision of services, many lack expert knowledge of the needs of older persons and the most effective types of HM. In order to upgrade skills of HM providers, several programs have emerged in the last several years through the organizations such as Rebuilding Together³⁷, the National Association of Home Builders³⁸, and the University of Southern California's National Resource Center on Supportive Housing and Home Modification.³⁹

Follow-up and Reassessment

Follow-up and reassessment are critical and often overlooked components of the HM process. They are essential to insure that HM have been implemented correctly and are working as planned. Too often, adequate follow-up is lacking which can have negative consequences. Studies report, for example, that many assistive devices and special features malfunction, do not feel safe to older persons or are a poor fit between the equipment and person or home environment. For example, Gitlin and colleagues found in a study of bathroom modifications that the majority of clients had one or more difficulties with their equipment. The problems involved both the provider (e.g., incorrect equipment delivered, equipment installed incorrectly) and the inability of the person to safely and effectively use the equipment.⁴⁰ Unfortunately, the original pricing of HM generally does not factor in the costs for follow-up. Moreover, it is extremely difficult to obtain reimbursement for visits by professionals such as occupational therapists, especially once the work is completed.

Prevention of Falls in the Community

Falls in the community can occur in public and private outdoor spaces as well as in the built environment. In general, outdoor community hazards include uneven pavement or surfaces and/or pavement cracks, tree roots, slippery footing, obstacles in walkways (e.g., bike racks, bus shelters, flower boxes and garbage cans), snow or ice on walks or steps, uneven steps, building mats, door sills, unsafe stairs and poor lighting or contrasts. Hazards related to the built environment include poorly designed or maintained buildings; lack of features such as handrails, grab bars, curb cuts, and ramps; and inadequate lighting or glare from surfaces.⁴¹ Such problems can be related to poor enforcement of codes or safety regulations as well as inadequate building codes.

At the community level, Braun reported that the elderly population perceived poor sidewalk and pavement maintenance (e.g., sidewalks, streets and pavement not clear of

ice and snow, cracked or irregular pavement, and inadequate street markings) as likely causes of falls. The study also identified absence of handrails or handrails poorly positioned in public places as potential risk factors for falls among older adults.⁴²

Interventions, Recent Community Efforts, and Challenges

Environmental Modifications in the Community

Two major community strategies aimed at reducing falls include: 1) identifying and eliminating hazardous conditions that interfere with mobility and increase fall risk and 2) adding features (e.g., adequate lighting). Although the identification of community environmental factors in fall prevention is an area of growing importance, few studies have examined the impact of environmental modifications at the community level on reducing fall incidence rates among older adults. Even though man-made environments can be modified to reduce fall risks⁴, manipulation and/or elimination of risk factors at the community level has been limited. Challenges include the unclear relationship between specific environmental hazards and fall risk, and difficulty determining the most effective combination of preventive strategies in environments with multi-sources of stimulation (e.g., uneven surfaces, traffic noise, crowded or obstacle-ridden sidewalks).⁴³

The need for multiple stakeholder involvement increases the complexity of designing, implementing and evaluating a program.⁴³ City planners, road engineers, public work officials, transportation services, businesses and government departments all have stakes in setting public safety standards and building code regulations that affect hazard reduction. As noted earlier, the complex factors that can lead to fall in the community make it difficult to determine what specific environmental changes to make.^{11,41} Consequently, the RAND²⁷ and Cochrane reviews⁴⁴ could not find enough evidence to either support or discount the effectiveness of environmental modification outside the home. Clearly, more studies are needed.

Community Re-Development/Empowerment Approaches

Community development/empowerment approaches that emphasize multidisciplinary and community-wide involvement in preventing falls appear promising. In particular, Gallagher and Scott have pointed out that involving multiple stakeholders and developing successful partnerships among seniors, social service workers, faith based groups, advocacy organizations, business, health professionals, product designers, architects, urban planners, developers, and government officials has the potential to facilitate and enhance the success of prevention initiatives.⁴⁵ Researchers have also emphasized that involving a variety of partners in the planning and implementation stages has the potential to increase local acceptance and commitment, provide access to knowledge and expertise, gain additional resources and increase community capacity. Such initiatives reflect a “bottom up” orientation, as exemplified by fall prevention initiatives that have included a broad range of individuals and organizations in their design and implementation.⁴³ For example, Gallagher and Scott’s *Seniors and Persons with Disabilities Task Force for Environments Which Promote Safety (STEPS)* worked to create safer environments for those at risk for falling by increasing awareness, identifying and reducing community hazards and assisting in the development of risk management

plans to reduce hazards. For nine months, STEPS sponsored a hotline that people could use to report falls and relayed information from the hotline to building managers and appropriate municipal officials. The STEPS study investigated 791 incidents of missteps or falls in public spaces and found that 86.4 percent of the 778 valid reports occurred outdoors – most frequently on sidewalks (44.5%), crosswalks (9.8%), curbs (8.2%), roads (7.7%) and unpaved walkways (6.6%).⁴⁵ Follow-up results indicated that approximately one-third of reported hazards were repaired and many hazards were marked with orange fluorescent paint to draw attention to them.⁴³

In addition, Veterans Affairs Canada and Health Canada currently are collaborating in a joint venture called *Falls Prevention Initiatives*, a community-based falls prevention pilot program in three regions: Atlantic Canada, Ontario and British Columbia/Yukon. This project is designed to identify effective strategies for preventing falls in the community among veterans and seniors.⁴⁶

Building Future Housing and Communities More Appropriately in the First Place

Many of the environmental problems related to falls in residential settings and the community could be better addressed if these settings were designed more appropriately in the first place. Towards this end, several initiatives have taken place to promote better design in both new housing houses and communities. Although they do not have fall prevention as their main purpose, they provide a mechanism to insert fall prevention features into mainstream design and planning. For example, visitability, a concept that emerged out of the disability movement, calls for a package of features (e.g., zero step entrance, wide front door and level route on the main floor, backing for grab bars in the bathroom) to make the first floor of a home accessible for people who use wheel chairs, walkers or similar devices. The focus on visitability occurred because neither the Fair Housing Amendments Act of 1988, which provides basic accessibility standards for multi-unit housing, nor the Americans with Disabilities Act, which applies to common spaces and public buildings, apply to housing with less than four units, leaving out single family housing that comprises the major part of the housing stock. As of 2003, five states and ten cities adopted mandatory visitability ordinances, with many more areas promoting it through incentives (e.g., reduced building fees) and voluntary programs. An even broader concept, universal design (UD) aims to make all products and environments usable by all persons to the greatest extent possible. In terms of housing, UD extends visitability by making the entire house more accessible, adaptable, and safe through the inclusion of such features as supportive grab bars in showers, accessible light switches, non-slip tile on floors and handrails on both sides of stairs. Building codes are beginning to include UD provisions, but primarily on a voluntary and educational basis with builders offering UD features to prospective buyers as extras.

A broader movement now also exists to design communities in new ways that emphasize mixed land use, placing services and shopping in close proximity to residences and encouraging higher density development. These communities have the potential to offer not only greater accessibility but features that promote physical activity (e.g., exercise paths), eliminate hazards and include supportive features (e.g., resting benches placed near walkways) to help prevent falls. Such planning initiatives are

variously referred to as smart growth, walkable communities, elder-friendly communities or livable communities.⁴⁷⁻⁴⁹

Recommendations

Considerable evidence exists that demonstrates the effectiveness of multi-factorial interventions that include risk assessment, exercise and environmental modification for fall prevention. Several strategies would help insure the success of the environmental components of such interventions.

Raise Awareness the Role of HM in Fall Prevention

Many older people overlook the environment in terms of fall prevention and change their behavior (e.g., restrict activities) rather than implement HM. In addition, health and social service professionals as well as policy makers often discount the environment, partly because of lack of knowledge about how to conduct assessments, unfamiliarity with the world of housing and uncertainty about how to effectively alter the environment to help prevent falls. We need to raise awareness about the benefits of HM among the general public and provide education/training to professionals about how to better utilize HM in their practice.

Provide a Wide Array of Potential HM

Environmental interventions in fall prevention tend to focus on home hazard abatement because such changes are relatively inexpensive and easy to implement. Expanding the range of HM to include the addition of features (e.g., handrails, curbless showers) can more effectively prevent falls, make tasks easier and ease caregiving.

Carry out More Comprehensive Assessments

Most assessments involve the use of simple checklists of potential hazards and the presence/absence of useful features (e.g., grab bars). More comprehensive environmental evaluations, including functional assessments in the home, can lead to better solutions, especially for persons at moderate to high risk of falling.

Increase Funding and Develop a More Coordinated System

Funding seriously constrains both the types of assessments that are carried out and the HM provided. Current funding tends to drive solutions towards self-evaluations of the environment and home hazard abatement even though the programs that use professionals (e.g., occupational therapists), coupled with a range of HM, have proven the most effective. Such approaches entail additional reimbursement for assessments, HM and follow-up. Furthermore, no one agency takes full responsibility for HM because funding comes from many disparate programs such as health, long term care, rehabilitation, aging, and housing. Consequently, consumers often find it difficult to pull together the resources needed to address their problems. Targets of opportunity for increasing funds include Medicaid Waivers, Community Development Block Grants and Health Maintenance Organizations (HMOs). HM coalitions at the state and local level have proven useful to identify gaps, increase coverage and coordinate services.

Emphasize Consumer Direction

Many older persons are reluctant to change their homes even to eliminate hazards that can contribute to falls. New methods are needed such as guided assessments, in which professionals, instead of prescribing changes, help older persons make choices about both the risks they are willing to take and their options for modifications.

Pay Attention to the Broader Community Environment

Although planning, retrofitting, and maintaining the community environment have received less attention than the home environment, they offer much promise in terms of preventing falls and encouraging activity among older persons. Such efforts need to bring together a range of stakeholders including public officials, social service and health care providers, planners and builders.

Conclusion

The homes and communities in which older people live contain hazards, dangerous areas, and lack supportive features which can contribute to falls. Research indicates that multi-factorial interventions, including risk assessments, physical activity, and environmental modifications can reduce falls. In order to insure the effectiveness of environmental modifications, we need to focus increasing attention on: raising awareness among consumers and professionals about the role of HM; providing a range of HM; conducting comprehensive assessments; increasing funding; involving consumers in choices; and improving coordination of health, social service and HM providers. In the long run, future community planning should include concepts such as visitability and UD in order to insure that we are building communities with fall prevention in mind.

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Excerpt from: Prevention of Falls and Injuries Among the Elderly

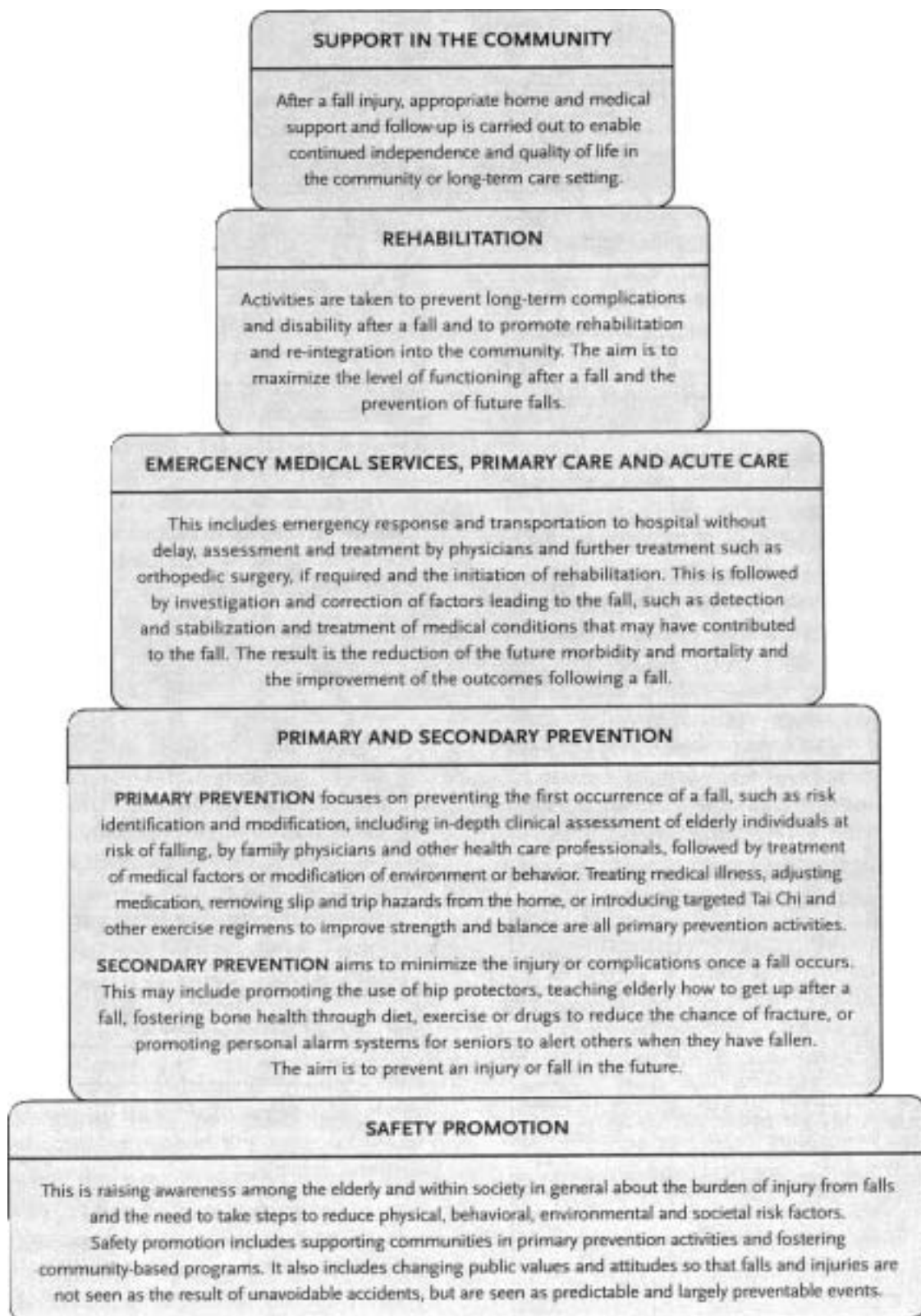
Although the preceding reviews included a variety of risk factors and addressed a multifactorial approach to the issue of fall prevention they primarily focused on specific intervention topics. In an effort to help the reader better appreciate the range of potential risk factors, the advantages of integrating multiple strategies and the value of collaboration at all levels of intervention we have provided an excerpt (with permission) from *Prevention of Falls and Injuries Among the Elderly*, A Special Report from the Office of the Provincial Health Officer, Ministry of Health Planning, British Columbia, January 2004:18-67. The full report may be found at <http://www.injuryresearch.bc.ca/>.

INJURY PREVENTION MODEL - POINTS OF INTERVENTION CONTINUUM

A population health promotion approach to falls takes into account the full spectrum of the factors and their interactions that are known to influence health and the outcome of the injuries. The following diagram (adapted from Peck et al., 2002) identifies the points of intervention along a continuum of health service activities that can reduce incidence and severity of falls among the elderly and improve the outcomes for those who experience falls.

Currently, emergency response and acute medical care for falls receive the most of the available health care funding and attention. While timely, appropriate and effective emergency and acute care are essential elements of the continuum of care, we must ensure, that we are not simply treating the broken hip or the fractured wrist and neglecting to investigate and manage the cause of the fall or to prevent subsequent falls and injuries. To further reduce the burden of injury of falls among the elderly, we must pay more attention and target more resources to the other points of intervention along this continuum, particularly safety promotion, primary prevention and secondary prevention, to prevent the falls and injuries from occurring in the first place.

FALLS INJURY PREVENTION MODEL - POINTS OF INTERVENTION CONTINUUM



RISK FACTORS FOR FALLS

It is clear from the preceding pages that falls among seniors compose a significant burden of injury in British Columbia. By understanding the risk factors that increase the likelihood an elderly person will fall, we can better target prevention programs to reduce the number of falls.

Evidence for risk factors have been derived from more than 60 observational studies. It is common to divide the risk factors into intrinsic risks (related to the health of the individual) and extrinsic (related to the person's environment) (Gillespie et al., 2001).

Researchers in Canada, however, tend to further divide intrinsic and extrinsic factors in to four categories of risk factors that reflect the broad determinants of health:

- biological/medical risk factors,
- behavioural risk factors,
- environmental risk factors, and
- social and economic risk factors.

The separations between these categories are somewhat arbitrary and most fall-related injuries result from overlapping and compounding effects of multiple risk factors. Some risk factors - such as advancing age cannot be changed, but other risk factors such as the amount of exercise one does, or public building standards - can be changed (Scott et al., 2001).

BIOLOGICAL/MEDICAL RISK FACTORS

The natural aging process and the effects of acute and chronic health conditions increase the risk that an elderly person will fall, or sustain an injury in a fall. A review of the research literature indicates the following biological risk factors:

- **Advanced age** - Those over 80 are the most likely to fall and be injured.
- **Gender** - Women tend to fall more often than men and sustain more injuries.
- **Chronic and acute illness** - Chronic diseases, such as Parkinson's disease, arthritis, osteoporosis, heart disease and stroke, bowel and bladder incontinence, blood pressure problems and other diseases, as well as short-term illnesses such as flu and infections can cause increased frailty and physical impairment. For example, research shows that 40 per cent of people who have a stroke will have a fall within a year of their stroke (Lamb et al., 2003). The medications used to treat certain illnesses can also predispose some people to failing, as described in more detail in the section on medications.
- **Physical disability** - The risk of falls increases with some of the physical effects of aging, including: gait disorders; diminished touch and sensation from limbs, muscles

and feet; poor hearing; poor balance; dizziness; postural hypotension; injuries from a previous fall; sore feet and other foot problems.

- **Muscle weakness and diminished physical fitness** - Falls increase with a loss of muscle strength, balance, flexibility and coordination, particularly weak limbs. Risk factors include tiring easily with exertion and the inability to easily accomplish activities of daily living such as feeding oneself, dressing, bathing, getting out bed, toileting and walking.
- **Vision changes** - Reduced vision, poor depth perception, bifocal and multifocal lenses, and ill-fitting glasses or an out-of-date lens prescription may all increase the risk of an elderly person misperceiving a trip hazard, and failing as a result.
- **Cognitive impairments** - Alzheimer's disease and other disorders that diminish alertness or mental capacity increase the risk of falls.

BALANCE AFTER A STROKE

Up to 40 per cent of people who have a stroke have a serious fall within the next year. New research suggests that being unable to balance while getting dressed, or experiencing dizziness and a "spinning sensation", accounts for many of stroke survivors' falls. An analysis of prospective falls among 124 women recovering from a stroke found that women with balance problems while dressing were seven times more likely to fall. Those who experienced "spinning" sensations were five times more likely to fall. The researchers recommended that women recovering from strokes take their time while dressing, and sit down, particularly while putting on pantyhose (Lamb et al., 2003).

STAIRWAYS TO INJURY

Steps and stairs are among the most frequent sites of falls and the leading category for mortality from falls in British Columbia. According to Jake Pauls, a US-based safety consultant who specializes in stairs, one stair-related death occurs for every million hours of use, making stairs more dangerous than cars. Home stairs account for about 87 per cent of all hospital-treated stair-related injuries, where location is known (Pauls, 2001). Problems include:

- **Visibility** - Poor lighting, glare, and lack of contrast in step colour can cause people to misjudge or overstep stairs.
- **Riser height** - Non-standard stair dimensions can cause people to misstep. The 1995 building code of Canada established a 7-inch rise and 11-inch tread for large public buildings. But, this code does not apply to many private or smaller buildings. Pauls notes that adopting a 7/11 code for stairs in all buildings could reduce falls by 25 per cent.

In Canada each year, about 100,000 people are treated in hospital for a stair-related injury of which 5,000 require a hospital admission. Each year, about 500 people in Canada die after falling on stairs (Pauls, 2001).

BEHAVIORAL RISK FACTORS

Behavioral risk factors are as simple as the choice of footwear, attempts to prune a tree or reach an object on a high shelf. These risks can also include life-style factors such as alcohol use, poor diet and lack of exercise, or the use of high-risk medication or multiple medications that predispose some seniors to failing. It can be difficult for seniors, who may feel no different than they felt in younger years, to realize that the seemingly ordinary choices they make and the actions they take may greatly increase their chance of failing.

Based on a review of the research literature (Scott et al., 2001) the most common behavioral risk factors are:

- **Risk-taking behaviors** - Elderly people who do not recognize their changing physical abilities and attempt to do too much can set themselves up for a fall. Clearing snow and ice off a walkway, pruning trees, climbing ladders, climbing a chair or unsteady stool to reach objects or clean surfaces, walking without a mobility aid when one is needed, inappropriate use of a mobility aid, or not using available aids such as hand rails or grab bars, are all risky behaviors for seniors. This is particularly true if seniors' physical abilities are declining or if their bones are weakening from osteoporosis or osteopenia, which can increase the chance of a fracture from a fall.
- **Medication use** - The use of benzodiazepines, tricyclic antidepressants and multiple prescriptions all increase the risk of falls, fall-related injuries and hip fractures. New data from B.C.'s PharmaCare - which suggests that acute illnesses requiring anti-infective medications such as antibiotics are associated with a higher risk of falls - sheds further light on this issue (see medication use and falls in B.C. presented later in this section).
- **Inattention** - Not paying attention to one's surroundings increases the chance of falling, particularly in new surroundings or in transition zones, such as entering doorways or changing elevations from one level to another.
- **Alcohol use** - Seniors who drink alcohol, especially those who drink to intoxication, have a greater risk of falling.
- **Inappropriate footwear** - Loose fitting shoes or slippers, shoes with slippery soles, high heels, shoes with thick soles, or frequent changing of shoe styles (for example, from heels to sandals to runners) can increase the risk of falling.

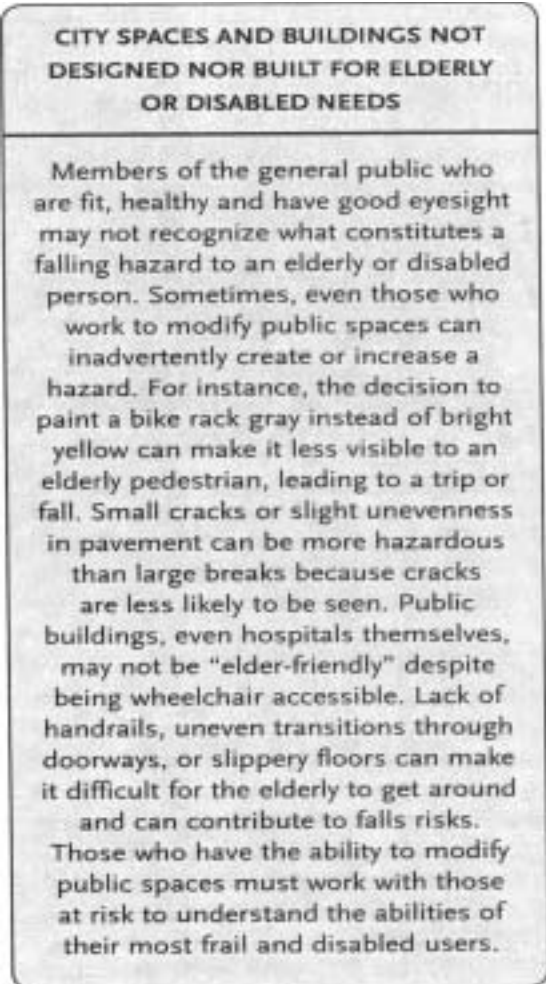


- **Handbags** - Evidence is emerging that heavy, awkward purses and handbags used by elderly women can throw off their balance and make them more susceptible to a fall.
- **Inadequate diet/exercise** - Not eating enough healthy food to keep oneself strong, an inadequate intake of protein or water, or not doing enough physical activity to ward off the loss of muscle mass or loss of bone density can increase the risk of falls and injuries.
- **Fear of failing** - The fear of falling again, as a reaction to a previous fall, can lead to inactivity that puts the person at increased risk of future falls.

ENVIRONMENTAL RISK FACTORS

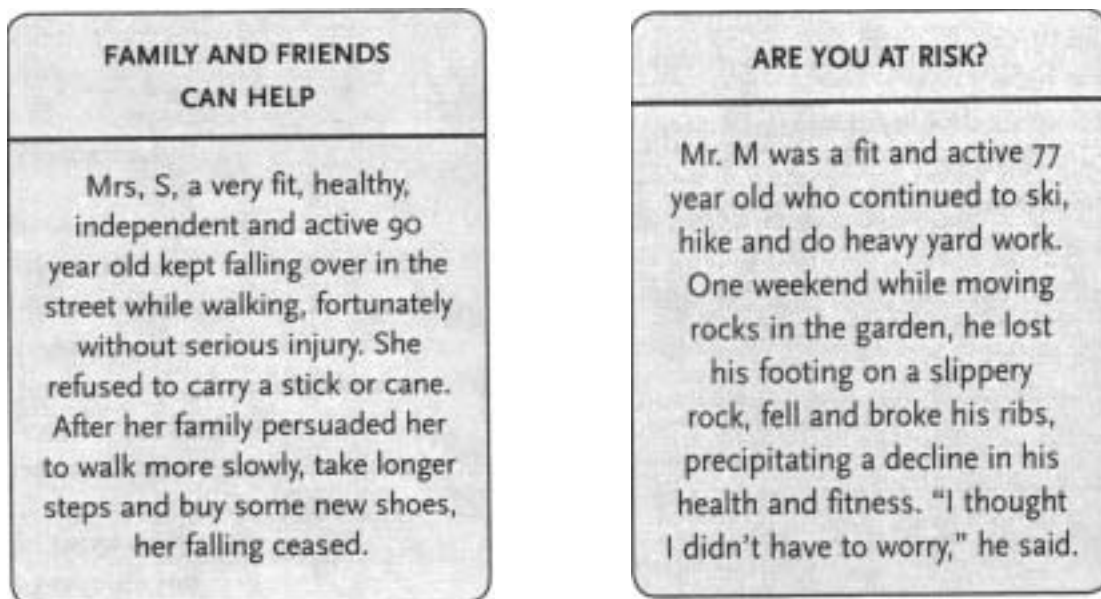
A person's surrounding environment can harbor risks that increase the chance of failing. This includes the furnishing, design or upkeep of homes, as well as risks in the neighborhood or community and risks within public buildings. A review of the research literature (Scott et al., 2001) identifies the following key environmental hazards:

- **Home hazards** - Throw rugs; loose carpets; electrical cords; door sills; pets; cluttered floors; poorly lit or poorly designed stairs; slippery floors; shower stalls or baths; lack of aids such as grab bars or hand rails.
- **Community hazards** - Uneven pavement or surfaces; sidewalk cracks; tree roots; snow or ice on walks or steps; building mats; door sills; unsafe stair design; uneven steps; poorly lit walks and stairways or sharp contrasts; slippery surfaces; poor building design; lack of handrails, grab bars, curb ramps and rest areas; obstacles such as planters, bike racks, bus shelters, garbage cans, flower boxes, pedestrian islands; or leaves that obscure changes in pavement, or become slippery when wet.
- **Institutional hazards** - Poorly designed or maintained buildings; inadequate building codes; poor enforcement of codes or safety regulations; lack of hand rails or grab bars; slippery floors; poor lighting; glare from surfaces; lack of rest areas; beds that are too high; lack of storage for equipment that consequently clutters rooms and hallways.



SOCIAL AND ECONOMIC RISK FACTORS

The study of the social determinants of health has repeatedly shown that one's income, education, housing and social connectedness all bear a strong relationship to one's health, level of disability and longevity. People with low income, low education, inadequate housing, a lack of support networks or lack of access to appropriate health or social services are all at a greater risk for the chronic health conditions that are, in turn, risk factors for falls. The role that social and economic factors play in contributing to falls is poorly understood. However, contributing factors may include illiteracy - resulting in an inability to benefit from printed resources on strategies for preventing falls - or muscle weakness or ill health due to lack of funds for a nutritional diet.



FOCUSING ON WHERE FALLS TAKE PLACE

Falls can occur in the home/community setting among both the well elderly and the frail elderly, as well as in acute care hospitals or in long-term care institutions. Understanding the interaction between the risk factors and the settings where falls take place can help tailor effective prevention strategies designed to reduce the incidence of falls.

FALLS AMONG THE WELL ELDERLY IN THE COMMUNITY

Many British Columbians over the age of 65 are aging well, and continue to be active, fit and healthy. Surveys of the well elderly in other regions (Alder Group 2002, Commonwealth of Australia, 2001) have found that while the well elderly understand the

general risk of falls, they do not perceive themselves to be personally at risk. This feeling of confidence can itself be a risk factor. As noted in the 2001 Australian survey: “Ironically, those who do not identify themselves as being “old” and who have not precluded themselves from their general daily activities are in fact at an elevated risk of failing when compared to the group of older people who appear to have taken the persona of an ‘older person’”. This may be because the latter group, who accept normal age-related declines in physical function, take the necessary precautions for safety (such as using a cane or walker to promote good balance), while the former group may have increased exposure to situations that can cause falls and may take greater risks.

The well elderly may be more apt to engage in risky behaviour because they see no reason to limit the scope of their activities, despite a gradual decline in strength, agility and balance. They may climb ladders to prune a tree or clean out an eaves trough or attempt to clear a walkway of snow or ice. They may pay less attention to environmental hazards because they are not worried about a pet underfoot, an uneven sidewalk or a poorly lit or poorly designed staircase.

They may not even think about the design or safety of the footwear they choose and may be reluctant to start walking slowly, using a cane or wearing a pair of hip protectors.

A survey of Ontario seniors (Alder Group, 2002) found that many of the respondents over-estimated their level of fitness and under-estimated their loss of visual acuity. Since many seniors feel fit and healthy, they may not recognize subtle deteriorations in their strength, coordination and balance that make them less able to catch themselves if they trip or slip. Since they do not perceive themselves to be at risk, they may not take precautions and may be less likely to respond to public education campaigns encouraging awareness and prevention of the risks of failing. The Australian survey of attitudes concluded that one of the greatest challenges is to alert the well elderly to the issue of falls and possible interventions – without inducing a detrimental change in their positive attitude that might itself result in a reduction of healthy activity and a lessening of mobility.

TWO PROGRAMS HELP SENIORS ADAPT LIVING SPACE

The Canada Mortgage and Housing Corporation (CMHC) provides financial assistance to seniors on limited incomes, for home modifications.

The Home Adaptations for Seniors Independence (HASI) program pays for such modifications as installation of handrails and grab bars, lever handles on doors, and easy-to-reach storage.

CMHC also operates the **Residential Rehabilitation Assistance Program** for Persons with Disabilities, for homes requiring extensive modifications such as wider doorways to accommodate a wheelchair. To find out about qualifying for these programs, call CMHC in Vancouver at 604-731-5733.

Veterans may qualify for a home modification program called **Veterans Independence Program**, offered by Veterans Affairs Canada District Offices, or in Vancouver at 604-666-7942.

FALLS AMONG THE FRAIL ELDERLY IN THE COMMUNITY

The highest risk of falling is among people who are mobile but unsteady on their feet (Tinetti et al., 1995). For the frail elderly living in the community, the inter-relationship of all the risk factors - biological, behavioural, environmental, social and economic - can make their entire world seem like a fall waiting to occur.

The use of mobility aids such as walkers, canes, scooters and wheelchairs can reduce the risk of falling, while increasing independence and activity levels. However, when used improperly these aids are also associated with an increased risk of falls. The reasons for this include the use of aids by people with limited abilities, not having a proper assessment to ensure the mobility aid is suited to an individual's specific needs and abilities, or improper use, such as failing to set a brake on a walker or a wheelchair.

A recent Canadian study on seniors' experiences and values concerning assistive devices found that most seniors thought that such devices symbolized loss of independence, disability and inevitable decline (Gallagher et al., 2003). They indicated that the look and appearance of some of the devices contributed to this negative perception. Personal realization of the need for a device tended to occur after a crisis event - such as a fall - or through caregiver, family or health professional recommendation, intervention or referral. A full copy of this report can be viewed at: www.injuryresearch.bc.ca.



At the Provincial Health Officer's regional consultations, physiotherapists and occupational therapists emphasized the importance of careful choice of assistive devices, tailored to the needs of the individual. Advice on the selection of appropriate devices is available from these professionals.

FALLS IN ACUTE CARE HOSPITALS

Research evidence suggests that acute illness and hospitalization may increase the risk of falls (Evans et al., 1998; Gaebler, 1993). Not much is known about the extent and nature of this risk. The analysis of the hospital Discharge Abstract Database for B.C. did not enable us to determine which falls may have occurred within the acute care setting as all institutional settings are clustered together. Furthermore, since most of the research conducted among institutionalized elderly tends to focus on those in long-term care. However, a number of factors been identified suggests that hospitalization and the weeks immediately after discharge may be a high- risk period. The following events are likely to happen during hospitalization, often predisposing elderly people to falls:

- **Acute illness:** Can cause sudden changes in physical health, abilities and functions (Tinetti et al., 1989).
- **Immobility and extended bed rest:** Can diminish coordination, body strength, slow reflexes and mobility, undermine balance and increase body sway, and cause postural hypotension (Deitrick et al., 1948; Taylor et al., 1949; Greenleaf et al., 1984). Staff shortages may make it difficult for elderly to obtain help to get out of bed and start moving and can contribute to reduced mobility and increased risk of falls.
- **Delirium:** Studies show that delirium occurs in up to 50 per cent of elderly patients in hospital and can persist once the patient returns home (Inouye et al., 1993).
- **Psychoactive medications:** Sleeping pills and other anti-anxiety medications are often started during hospitalization to help the elderly person rest in the new surroundings, but can also increase the chance of falling in the hospital and after discharge (Ray et al., 1989; Leipzig et al., 1999).

The rate of falls is substantially increased in the first month after discharge from hospital (Inouye et al., 1993).

Although the quantity and quality of the evidence is limited, a review of the literature on falls in acute care settings highlights a number of patient characteristics that are associated with high rates of falls (Evans et al., 1998). Patients at higher risk include those who are confused, those who have previously fallen, those taking medications such as sedatives or analgesics, those with elimination problems such as incontinence or urinary frequency, and those with mobility deficits. The most common activity at the time of the fall appears to be transferring from a bed to a chair. However, evidence is not yet available to determine if reducing any of these risk factors leads to a reduction in falls.

FALLS AFTER DISCHARGE FROM HOSPITAL

The early weeks after an elderly person is discharged from an acute care hospital are a high-risk time for falls. One study found that acute care patients who were functionally dependent and needed professional help after hospital discharge were significantly more likely to fall compared to those who were independent and not requiring professional help (Mahoney et al., 1994). The rate of falls increased in the first month after discharge from hospital (ibid).

A more recent study of elderly patients discharged from hospital found the fall rate was more than four-fold higher in the first two weeks after hospitalization compared to three months after discharge. In the first month after discharge, 11 per cent of falls resulted in serious injury requiring re-hospitalizations and 15 per cent of all re-hospitalizations for the elderly were related to falls (Mahoney et al., 2000).

More research needs to be done to assess the incidence rate and fill knowledge gaps about the factors that contribute to falls in acute care settings, as well as falls that occur shortly after discharge from hospital. It is also clear that considerably more research is needed to determine the best practices for assessing people at high risk for falling in this setting, and for preventing these falls from occurring.

FALLS IN LONG-TERM CARE INSTITUTIONS

While falls are common in the community, they are even more common in long-term care institutions. In fact, it has been estimated, through systematic review of studies of falls in long-term care settings, that the institutionalized elderly fall three times more often than elderly in the community (Rubenstein et al., 1996). Approximately 30 to 50 per cent of all long-term care residents fall each year and of these, 40 per cent fall twice or more each year (Tinetti, 1987; Aronow & Ahn, 1997; Kiely et al., 1998; Nygaard, 1998). Approximately 10 per cent of these falls result in serious injury and up to 5 per cent result in bone fractures (Butler et al., 1996; Thapa et al., 1998). The risk for sustaining a hip fracture is 10.5 times higher for women who are in facilities than if they were living in the community, and less than 15 per cent of facility residents who sustain a hip fracture regain pre-injury ambulatory status (Folman et al., 1994).

In a 1994 study, it was estimated that there are 1.5 falls per bed per year in long-term care institutions and nursing homes (Rubenstein et al., 1996). A facility with 100 beds, for example, would be expected to have about 150 falls among its residents every year.

The general public may have the impression that the elderly who live in institutions are better protected from the hazards of everyday living that come with increased age. However, there are a number of reasons why the institutionalized elderly 'may be more vulnerable to falling:

- **High level of frailty:** The most dependent and least ambulatory seniors tend to live in institutions.
- **Number of co-morbidities:** It is common for the institutionalized elderly to suffer from a number of disease processes that can increase their risk of falling.
- **Cognitive deficits common:** Alzheimer's disease, senile dementia and other disease processes that undermine mental competency make the long-term care population more prone to falling. Available evidence points to the effects of neurochemical degeneration caused by the dementia process, as well as the role of medications commonly taken by those with dementia, both of which impair balance, gait, judgment and reaction time (Oleske et al., 1995).
- **Inactivity common:** Maintaining muscle strength and physical abilities is difficult in institutional settings lacking the resources for on-site physiotherapists and exercise programmers.

- **Side effects of medications:** The elderly in institutions are often taking numerous medications, including benzodiazepines to help with sleep. These drugs can contribute to increased risk of falls. (Geriatricians can help reduce the number of medications that are prescribed for and taken by seniors.)
- **Care giver/patient ratios:** The elderly population in institutions is a highly dependent population. Poor care giver/ patient ratios can mean that aid from care givers may not be available when the frail elderly patient attempts higher-risk activities which may lead to a fall (for example, getting out of bed on their own).
- **Availability of Physiotherapists and Occupational Therapists:** There may be limited availability of professionals who can assist a facility to design falls prevention programs and carry out assessments of individuals determined to be at risk of failing.

Current practices for recording falls and fall-related injuries in British Columbia's long-term care facilities need to be standardized to enable better data collection on the person, place, time and circumstances of a fall. We also need to be able to compare numbers over time and across institutions. This will enhance the ability to both apply and evaluate fall prevention strategies in the long-term care setting.

Some facilities in B.C. have already initiated their own falls surveillance so that they can assess at regular intervals the circumstances that may have contributed to falls and then initiate a prevention or quality of care improvement program.

Multifactorial intervention: Combining a number of interventions such as any one or all of exercise programs, environment and behavioural modification, medication withdrawal, assistive device use and clinical assessment.

In general, the systematic reviews have found the following evidence-based results:

- The use of thorough, focused clinical assessments can help identify and then reduce the risk of falls, if followed up by targeted intervention, such as exercise or environmental modification (multifactorial interventions).
- Exercise programs can be an effective prevention strategy, but more research is needed to determine if one type of exercise is more effective than others and which exercises are best for seniors with chronic health conditions or disabilities.
- Environmental modification can be effective, particularly if the senior has manual or financial help to modify their environment.
- There is insufficient evidence to conclude whether education alone is an effective intervention, but it does play a role as part of a multifactorial strategy that includes clinical assessment followed by targeted intervention. The benefits of staff education have not been well tested in long-term care.

EDUCATION

Education is an important component of most successful falls prevention strategies. Safety promotion - the first step in the continuum of injury prevention activities - involves raising awareness about the importance of preventing specific injuries such as falls. It also involves changing public values so that people no longer see falls among the elderly as an “accident” that cannot be prevented, and instead understand that falls are highly predictable events that can be minimized by taking specific preventive actions.

Evaluations of education strategies alone, however, are inconclusive. The Cochrane and RAND reviews both conclude that there is insufficient evidence to either support or refute education programs alone in terms of changing behaviors or reducing falling risk among seniors.

The Canadian Best Practices Guide concludes that education strategies may play an important role for seniors as part of a multi-faceted prevention program, by helping them become aware and concerned about the risks of falls, which may then increase their readiness to adopt one or more strategies to reduce falls (Scott et al., 2001).

Effective education may take many forms, including printed materials as handouts, discussion groups or the use of the media. Trained peer volunteers are well received by other seniors as reliable sources of information. Timing is also an important aspect of effective education programs. A senior who has had a recent fall is more likely to be receptive to learning about prevention than someone who has never fallen.

There is a need for research on the benefits of educating those who work with or assist the elderly regarding falls risks and prevention. Evaluation is needed to see if education programs that target nurses, physicians, long-term care staff, home support workers and the families and caregivers of the elderly are effective methods to reduce falls.

CLINICAL INTERVENTIONS

Clinical intervention for falls prevention is primarily based on doing a systematic assessment of an individual by a health practitioner, where the purpose of the assessment is to identify and lessen physiological and psychological factors found to contribute to the risk of falling or sustaining a fall-related injury. Many of the factors identified in a careful evaluation may be amenable to treatment, which could then reduce the likelihood of a fall.

According to the American Geriatric Society (as reported in the RAND review), a falls assessment or evaluation should include: a history of fall circumstances, medications, acute or chronic medical problems, and mobility levels; an examination of vision, gait and balance, and lower extremity joint function; an examination of basic neurological function, including mental status, muscle strength, lower extremity peripheral nerves, proprioception, reflexes, test of cortical and cerebellar function; and extrapyramidal

assessment of basic cardiovascular status including heart rate and rhythm, postural pulse and blood pressure, and if appropriate, heart rate and blood pressure responses to carotid sinus stimulation.

The results of this assessment may then require referral to appropriate specialists, such as a neurologist or geriatrician, or to other health professionals to deal with issues such as the need for assistive devices, home modifications, exercise and diet regimes, and other interventions that could reduce the chance of a subsequent fall (RAND Report, 2003). Other non-medical assessments may help in identifying seniors at risk and assist in making appropriate referrals for follow-up intervention. One RCT study had volunteers administer a questionnaire to seniors about their ability to perform the activities of daily living, followed by regular visits or referrals to health practitioners (Carpenter et al., 1990). It found the intervention group had a significant reduction in falls compared to the control group.

The RAND Review concluded that research evidence supports a focused falls risk assessment with follow-up as the most effective component of a falls prevention program, along with standardized data collection for recording fall incidents.

The Canadian Best Practices Guide came to the same conclusion following a review of the literature and found that clinical assessments proved useful in a variety of settings, and administered by a variety of professionals or trained volunteers. Clinical assessments could be implemented by emergency room nurses and doctors (Baraff et al., 1999; Close et al., 1999), in health centres by either doctors or nurses (Wagner et al., 1994) and in the senior's home either by trained health professionals (Gallagher & Brunt, 1996; Fabacher et al., 1994; Weber et al., 1996) or by trained volunteers (Carpenter et al., 1990; Vefter et al., 1992).

The Canadian Best Practices Guide noted that it was particularly important to do an in-depth assessment following a fall in order to uncover undiagnosed health problems that may contribute to the risk of further falls. Laurence Rubenstein and colleagues, under the auspices of RAND's Assessing the Care of Vulnerable Elders (ACOVE) project, have conducted a literature review regarding potential quality indicators for falls and mobility disorders. Rubenstein and colleagues have created an algorithm that links detection, evaluation, and intervention and shows the relationship of each of the indicators to the overall diagnosis and management (Rubenstein, et al., 2001). Physicians should initially screen their elderly patients with two simple questions: "Have they had a fall?" "Are they experiencing mobility problems?" If the patient reports no problems, there is no need for further intervention. If the patient reports more than two falls, he or she should undergo a fall risk assessment which would examine home hazards, gait and mobility problems, polypharmacy and other medical problems. If the patient reports mobility difficulties, he or she should have a gait and mobility evaluation that looks at balance, strength and endurance, vision problems, pain and joint problems, and sensory problems. The problem is then either treated or the patient is referred to appropriate programs or specialists, such as an exercise program or ophthalmologist.

Some fall risk assessment tools have been tested for reliability and published. A list of validated assessment tools can be found on the B.C. Injury Research and Prevention Unit Web site at www.injuryresearch.bc.ca. Other tools are being developed, such as one now undergoing study in British Columbia, Ontario and Nova Scotia in long-term care facilities. A variation of this tool is also being tested among community seniors who receive home support services in B.C.

Clinical assessment is seen to be a promising avenue for dealing with falls in the community, but there is less evidence so far of its effectiveness among seniors in long-term care institutes. Some of the recurring questions about how to conduct clinical assessments in long-term care homes include the following:

- **Who does it?** - Should the assessment be carried out by a referral to a doctor? Can nurses or therapists in the facility conduct the assessment? Or is the best approach to have components of the assessment conducted by different members of a multidisciplinary team?
- **Who is assessed?** - All new residents? Only those identified at being high risk for falls or all residents who have a fall?
- **How often is it done?** - When should that information be updated? Should it be updated at regular intervals or only when there is a clear change in the patient's physical or cognitive abilities?

MULTIFACTORIAL INTERVENTIONS

Falls are often the result of a complex, interdependent constellation of factors in which multiple causes interact together to produce a fall. For that reason, interventions that address a number of factors at once not only make sense but have been shown in the research evidence to be most effective.

Most multifactorial interventions begin with a thorough clinical assessment of the individual senior's risk factors for falling and then the implementation of interventions based on these assessments, to deal with the medical management of problems, medication risk, behaviour, home modifications, and education.

The RAND Review (2002) concluded that multifactorial interventions that start with a focused clinical assessment followed by appropriate interventions are the prevention strategies that have the greatest support in the research literature.

The Canadian Best Practices Guide (Scott et al., 2001) reviewed seven multifactorial studies and found evidence for their effectiveness. One randomized controlled trial by Tinetti et al. (1994) used nurse practitioners and a physical therapist to conduct in-home base-line assessments of physical, behavioural and environmental risk factors for falling.

Based on the assessments, the participants received three months of focused interventions - dealing with everything from learning transfer skills in the bathroom, medication reviews, treatment of medical problems, home hazard removal, gait training and exercises to promote strength and balance. The group that received the intervention had significantly fewer people who fell (35 per cent intervention versus 47 per cent control) and had a significantly fewer number of falls (94 versus 164).

The Cochrane review also concluded from the available research evidence that prevention strategies were likely to be beneficial if they included multidisciplinary, multifactorial screening and assessment of health and environmental risk factors, followed by appropriate interventions. Screening plus intervention was likely to work equally well for the general population of community-dwelling seniors, for older people with a history of falling, or for people selected because of known risk factors (Gillespie et al., 2001).

**MULTIFACTORIAL INTERVENTIONS
IN EDMONTON**

A symposium was held in March 2002 in Edmonton: "Taking the right step forward: Preventing falls in the Capital Region" (Preddy et al., 2002).

A total of 121 participants from multiple disciplines came together to address falls in youth and older adults. For the older adults, strategies were suggested for Home Dwelling, Supportive Housing, Continuing Care and Acute Care and Rehabilitation.

The participants noted that efforts towards fall prevention must include the following: improved awareness of falls and falls prevention; improved and comprehensive data collection and surveillance systems; more collaboration and multi-stakeholder partnerships; and comprehensive consideration of the four "E's" of injury prevention: education, engineering, enforcement, and evaluation and research. For older adults, medication use and the need for a regional risk assessment tool were priority issues for action.

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