

**PREDICTOR VARIABLES RELATED TO FALLS IN A LONG-TERM CARE
ENVIRONMENT**

By

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A THESIS REPORT

IN

INDUSTRIAL AND SYSTEMS ENGINEERING

Submitted to the Graduate Faculty
of Virginia Polytechnic Institute and State University in
Partial Fulfillment of the Requirements for the Degree of

**MASTER OF SCIENCE IN
INDUSTRIAL AND SYSTEMS ENGINEERING**

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July 30, 2003
Blacksburg, VA

Keywords: fall risk assessment, screening tests, risk factors, older persons, nursing
assessment/standards, aging, long-term care

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ABSTRACT

Although a great deal is known about the etiology of falls in elderly individuals, fall accidents continue to represent a significant burden to elders residing in long-term care facilities. It has been stated that 75% of deaths due to falls in the United States occur in the 13% of the population age 65 and over. The first objective of the study was to identify which fall-predictor variables acknowledged in the research literature are associated with increased fall frequency with the older population. Identifying specific predictor variables related to a high occurrence of falls in long-term care setting can assist in the redesign of tools and programs aimed to recognize fall risk, and prevent fall-related accidents and fatalities in the geriatric population. The second objective of the study was to identify which combination of predictor variables could better predict the frequency of falls.

A history of falls variable was the only predictive variable that differed significantly between groups of residents who had sustained subsequent falls and those who had not. Other variables including age, mental status, day number of stay, elimination, visual impairment, confinement, blood pressure drop, gait and balance, and medication were found to not be statistically significant between groups of fallers and non-fallers. In this setting, the current design of the tool had limited accuracy and

exhibited an inability to effectively discriminate between resident populations at risk of falling and those not at risk of falling. Consequently, the current fall risk assessment tool is not adequate for assessing fall risk in this clinical setting.

ACKNOWLEDGEMENTS

Numerous people have made it possible for this research to be successful. Most of all, I would like to thank the Locomotion Research Laboratory for their financial support for the duration of this research. I would also like to thank the individuals, in the Grado Department of Industrial Systems Engineering here at Virginia Polytechnic Institute and State University, responsible for recruiting me for this funding opportunity.

I would especially like to thank my advisor, Dr. Thurmon E. Lockhart, for his unending support, encouragement, and his ability to empower me to receive more out of this research opportunity than I ever thought I could. I would also like to thank my committee, Dr. Brian Kleiner, and Dr. Karen A. Roberto, for their advice, input, support, encouragement, and most of all, patience. Without all of you, this would not have been possible.

I would also like to thank my friends in the Human Factors Engineering Program for their support, their help, and their advice. Additionally, a special thanks to Lovedia Cole, Theresa Coalson, and everyone else who assisted me through this process.

Most of all, I would like to thank my family for their love, everlasting devotion, and support.

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INTRODUCTION

Falls are among the most common and serious problems facing older adults. Falling is associated with considerable mortality, morbidity, reduced functioning, and premature nursing home admissions (Robbins, Rubenstein, & Josephson, 1989). Falls generally result from an interaction of multiple and diverse risk factors and situations, many of which can be corrected (Fleming & Pendergast, 1993). This interaction is modified by age, disease, and the presence of hazards in the environment (Fleming & Pendergast, 1993). Frequently, older people do not appreciate the seriousness of or report these problems to their physicians and, thus, the problems remain undetected until preventable injury and disability occur (Cumming, Kelsey, & Nevitt, 1990).

Both the incidence of falls and the severity of fall-related complications rise steadily after about age 60. In the age 65-and-over population, approximately 35% to 40% of community dwelling, generally healthy elderly persons fall annually. After age 75, the rates are higher (Rubenstein & Josephson, 2002). Incidence rates of falls in nursing homes and hospitals are almost three times the rates for persons older than 65 years of age living in the community (1.5 falls per bed annually). Complication rates are also considerably higher, with 10% to 25% of institutional falls resulting in fracture, laceration, or the need for hospital care.

Fall-related injuries account for 6% of all medical expenditures for persons age 65 and older in the U.S. (Rubenstein & Powers, 1999). The total cost of all fall injuries for people age 65 or older in 1994 was \$20.2 billion (Englander, Hodson, & Terregrossa, 1996). By 2020, the cost of fall injuries is expected to reach \$32.4 billion (before adjusting for inflation) (Englander et al., 1996).

Approximately 95% of all hip fractures in the U.S. result from falling (Nyberg, Gustafson, Berggren, Brannstrom, & Bucht, 1996). Because the U.S. population is aging, the problem of hip fractures will likely increase substantially over the next four decades. By the year 2040, the number of hip fractures is expected to exceed 500,000 and the annual cost of hip fractures in the U.S. is projected to escalate to over \$16 billion (Cummings, Rubin, & Black, 1990).

Falls are the leading cause of injury deaths among people 65 years and older (Hoyert, Kochanek, & Murphy, 1999). In 1998, about 9,600 people over the age of 65 died from fall-related injuries (NCHS, 2000). Accidents are the fifth leading cause of death in older adults (after cardiovascular, neoplastic, cerebrovascular, and pulmonary causes) and falls constitute two-thirds of these accidental deaths. More directly, 75% of deaths due to falls in the United States occur in the 13% of the population age 65 and over (Josephson, Fabacher, & Rubenstein, 1991). In addition to physical injury, falls can also have psychological and social consequences. Fear of falling and the post-fall anxiety syndrome are recognized as negative consequences of falls. The loss of self-confidence to ambulate safely can result in self-imposed functional limitations (Clark, Lord, & Webster, 1993).

A key concern is not simply the high incidence of falls in elderly persons but rather the combination of high incidence and a high susceptibility to injury. This propensity for fall-related injury in elderly persons stems from a high prevalence of co-morbid diseases (e.g., osteoporosis) and age-related physiological decline (e.g., slower reflexes) that make even a relatively mild fall particularly dangerous. Approximately 5% of elderly people who fall require hospitalization (Lundebjerg, 2001).

Recurrent falls are a common reason for admission of previously independent elder persons to long-term care institutions (Donald & Bulpitt, 1999). One study found that falls were a major reason for 40% of nursing home admissions (Bezon, Echevarria, & Smith, 1999).

Falls can indicate underlying health problems. Nursing home residents are generally frailer than seniors living in the community. They tend to be older, have more cognitive impairments, and have greater limitations in their activities of daily living. They also tend to have more chronic illnesses, be physically dependent, and have a higher prevalence of walking problems (Bedsine, Rubenstein, & Snyder, 1996), all factors associated with falling (Ejaz, Jones, & Rose, 1994).

Injuries associated with fall accidents occurring within the nursing home pose a significant problem, both in terms of human suffering and economic losses. Falls, fall-related injuries, and the resulting adverse clinical, social, and economic consequences are a major public health problem in nursing homes. Falls can lead to disability, loss of independence, and overall increase in health care expenditures. Of the estimated 1.7 million nursing home residents in the United States, approximately one-half fall annually, twice the rate for persons dwelling in the community, and 11% sustain a serious fall-related injury (Ray, Taylor, & Meador, 1997). The tendency to fall is one of the chief problems of elderly residents living in long-term care. The elderly residing in nursing homes are often afraid of falling, with the first fall leading to an acceleration of the aging process, which, in turn leads to total helplessness and a loss of independence (Sehested & Severin-Nielsen, 1977).

Since the 1920s, many scientists have dedicated their professional careers to the study of fall related accidents. These scientists used four principal approaches to better understand slip and fall accidents: biomechanics, tribology, psychophysics, and epidemiology. The biomechanical analysis of walking and slipping has provided information concerning the gait parameters such as the vertical and horizontal forces (during heel strike), shoe angle, and heel velocity under normal and abnormal conditions (Crowinshield, Brand, & Johnston, 1978; Herman, Wirta, Bampton, & Finley, 1976; Lockhart, 2002; Perkins, 1978; Strandberg & Lanshammar, 1981). The tribological approach deals with surface dissipative processes in terms of hydrodynamics of contaminants between the shoe and the floor, and the viscoelastic characteristics of the shoe heel and sole materials (Andres & O'Connor, 1992). The psychophysical approach is the relationship between the perception of a sensation and the physical stimulus, which produce the sensation (Tisserand, 1969, 1985; Gescheider, 1985; Strandberg & Lanshammar, 1985; Harris & Shaw, 1988; Leamon & Li, 1990; Lockhart, Wolstad, Smith, & Ramsey, 2002). The epidemiological approach is concerned with the identification of the incidence, distribution, and potential controls for illness and injuries in a population. There have been wide spread improvements in tribometric techniques to assess shoe/floor interactions, increased knowledge of the biomechanical responses to walking on slippery surfaces, and several journal publications in postural control (Lockhart, 2002; Lockhart et al., 2002).

Even with the greater understanding of the occurrence of slip and fall accidents, falls continue to represent a serious problem for long-term care residents. Falls also represent a substantial and expensive dilemma for institutional care organizations. To

reduce the personal and economic losses associated with slips and falls, academic and geriatric professionals have examined risk factors related to the high occurrence of injuries and fatalities inflicted by slips and falls. The reduction of these personal and economic costs, mainly in a high-risk group such as nursing home residents, takes a clear understanding of the causes of fall-related accidents. The growing number of nursing home residents underscores the need to develop and implement preventive programs for this vulnerable population (Thapa, Gideon, Fought, & Ray, 1995).

A number of studies have identified risk factors for falling. These can be classified as either intrinsic (e.g. lower extremity weakness, poor grip strength, balance disorders, functional and cognitive impairment, visual deficits) or extrinsic [e.g., polypharmacy (i.e., five or more prescription medications) and include environmental factors such as poor lighting, loose carpets, lack of bathroom safety equipment] (Lundebjerg, 2001).

Perhaps as important as identifying risk factors is appreciating the interaction and probable synergism between multiple risk factors. Several studies have shown that the risk of falling increases dramatically as the number of risk factors increases. Tinetti, Speechley, and Ginter (1988) surveyed community-dwelling elderly persons and reported that the percentage of persons falling increased from 27% for those with no or one risk factor to 78% for those with four or more risk factors. Similar results were found among an institutionalized population (Tinetti, Williams, & Mayewski, 1986). Nevitt, Cummings, Kidd, and Black (1989) reported that the percentage of community-dwelling persons with recurrent falls increased from 10% to 69% as the number of risk factors increased from one to four or more.

Research Objectives

Due to the high incidence of fall-induced injuries in nursing home facilities, falls continue to be a serious problem in the long-term health care industry. Specifically these problems are evident in terms of the human suffering and economic losses they pose on nursing home facilities. Furthermore, Tinetti and Speechley (1989) stated that falls are more common in nursing homes, where the average annual incidence of reported falls is 1,600 per 1,000 patients.

The aim of the study was to assist health care professional in their assessment of fall risk and in their management of elderly patients both at risk of falling and those who have fallen. The objective of the study was to determine the factors that most likely contribute to, either individually, or in combination, fall-related incidents. With the use of institutional historical incident data and fall assessment tool scoring data at the institutional level, this study proposed to establish the occurrences of falls and the related predictor variables. The predictor variables consist of several factors: age, mental status, numbers of days at the facility, elimination, history of falls, visual impairment, confinement, blood pressure drop, gait and balance, and medication use. The multiple regression analysis was performed to test the relationship between the predictor variables and the occurrence of fall-related incidents. This analysis identified which risk factors accurately predict fall frequencies while residing in a long- term care facility. The results were then used to assist with future studies in the pursuit to reduce fall accidents in the nursing home environment.

Research Hypothesis

The primary objectives of the research presented in this thesis are encapsulated in the following hypotheses:

Hypothesis 1: Elders with an incident of a fall during the first 90 days of stay at the long term care facility will have a significantly higher age risk indicator than elders with no reported incident of a fall.

Hypothesis 2: Elders with an incident of a fall during the first 90 days of stay at the long term care facility will have a significantly higher mental status risk indicator than elders with no reported incident of a fall.

Hypothesis 3: Elders with an incident of a fall during the first 90 days of stay at the long term care facility will have a significantly higher day number of stay risk indicator than elders with no reported incident of a fall.

Hypothesis 4: Elders with an incident of a fall during the first 90 days of stay at the long term care facility will have a significantly higher elimination risk indicator than elders with no reported incident of a fall.

Hypothesis 5: Elders with an incident of a fall during the first 90 days of stay at the long term care facility will have a significantly higher history of falls risk indicator than elders with no reported incident of a fall.

Hypothesis 6: Elders with an incident of a fall during the first 90 days of stay at the long term care facility will have a significantly higher visual impairment risk indicator than elders with no reported incident of a fall.

Hypothesis 7: Elders with an incident of a fall during the first 90 days of stay at the long term care facility will have a significantly higher confined to chair or bed risk indicator than elders with no reported incident of a fall.

Hypothesis 8: Elders with an incident of a fall during the first 90 days of stay at the long term care facility will have a significantly higher drop in systolic blood pressure risk indicator than elders with no reported incident of a fall.

Hypothesis 9: Elders with an incident of a fall during the first 90 days of stay at the long term care facility will have a significantly higher gait and balance risk indicator than elders with no reported incident of a fall.

Hypothesis 10: Elders with an incident of a fall during the first 90 days of stay at the long term care facility will have a significantly higher medicines risk indicator than elders with no reported incident of a fall.

Hypothesis 11: The predictive equation will better predict fall frequency in a long-term care facility.

Need for the Study

Although it is known that the problem of fall-related incidents exists with older adults, there has been considerable research conducted to determine the exact causes or to manage the problem. This study will attempt to identify and quantify the predictor variables related to the risk of falls among nursing home residents. The driving philosophy behind this study is that the factors related to fall-related incidents must be understood to adopt the systems approach to intervention. To achieve a significant reduction in patient falls and injuries sustained as a result of falls, fall-risk assessment should focus on accurately identifying risk factors that would accurately predict which residents are particularly vulnerable to falling.

Identifying fall-risk variables related to fall frequency could have a positive effect on various aspects of the long-term care facility. Identifying accurate fall-risk predictors not only has an effect on the residents and staff of that particular long-term care facility, but also influences organizations at the state level. The Medical Data Sheets (MDS) required by all long-term care facilities contains a Facility Quality Indicator Profile. This profile contains various quality indicators, such as prevalence of falls and compares the falls statistics to all long-term care facilities across the state. The Commonwealth of Virginia tends to further investigate any quality indicators above 75% of the state percentile rank when conducting their inspections. The accurate identification of predictor variables related to frequency of falls may have a direct effect on the legislature at the state level by addressing other areas of fall risk identification.

LITERATURE REVIEW

A fall is defined as a sudden, unexpected change in position in which the static and fixation mechanisms fail and reflex responses for correcting imbalance are inadequate (Sehested & Severin-Nielsen, 1977). Death or disability resulting from falls and gait instability continue to be major problems among institutionalized elders. These dilemmas represent a major cause of mortality, morbidity, immobility, and premature nursing home placement. After middle age, there is an increase in both the incidence of falls and the severity of complications from falls (Rubenstein, Robbins, Schulman, Rosado, Osterweil, & Josephson, 1988). Primarily due to repeated falls and various other reasons, previously independent elderly persons are being admitted to long-term care institutions (Smallegan, 1983).

The literature on falls is reviewed in this following chapter. The literature investigating the growth of the elder population is discussed in the first section. The next section presents the use of fall assessment tools. Falls that occur in long-term care facilities is discussed in the third section. The fourth section presents the epidemiology of falls with the geriatric population. Finally, various fall risk factors are discussed in the last section.

Elder Population Growth

The Administration on Aging (2000) indicated that, in 1999, there was 34.5 million persons age 65 or older, representing 12.7% of the United States population. The number of older Americans increased by 3.3 million (10%) since 1990 compared to 9.1% for Americans less than 65 years of age. The percentage of Americans age 65 or older has more than tripled from 4.1 percent in 1900 to 12.7 percent in 1999, and the number of

Americans age 65 or older has increased 11 times from 3.1 million to 34.5 million (Administration on Aging, 2000). The older population itself is getting older. In 1999, the number of Americans age 65-74 was 18.2 million, which is eight times larger than in 1900, but the number of Americans age 75-84 was 12.1 million, which is 16 times larger, and the Americans age 85 and older were 4.2 million which is 34 times larger (Administration on Aging, 2000). As illustrated in Figure 1, b the year 2030, there will be about 70 million older adults, which is more than double that of the year 1999. And, people age 65 and over will represent almost 13 percent of the population in the year 2000 and is expected to be 20 percent of the population by 2030 (Administration on Aging, 2000).

The growth of the elder population will have a direct effect on the number of individuals residing in long-term care facilities. Currently, there are more residents of nursing homes than total available hospital beds. In 1997, 1.5 million persons ages 65 and older lived in nursing homes. If current rates continue, by 2030 this number will rise to about 3 million (CDC, 2000).

With the rise in the elderly population and the projected increase in the number of nursing home residents, the current costs related to long-term care could see immense inflation. The average daily charge for private-pay residents increased as the level of care increased. Skilled care had the highest average daily charge of \$136 per day. The average daily charge decreased to \$107 for intermediate care and to \$97 for residential care (CDC, 2000).

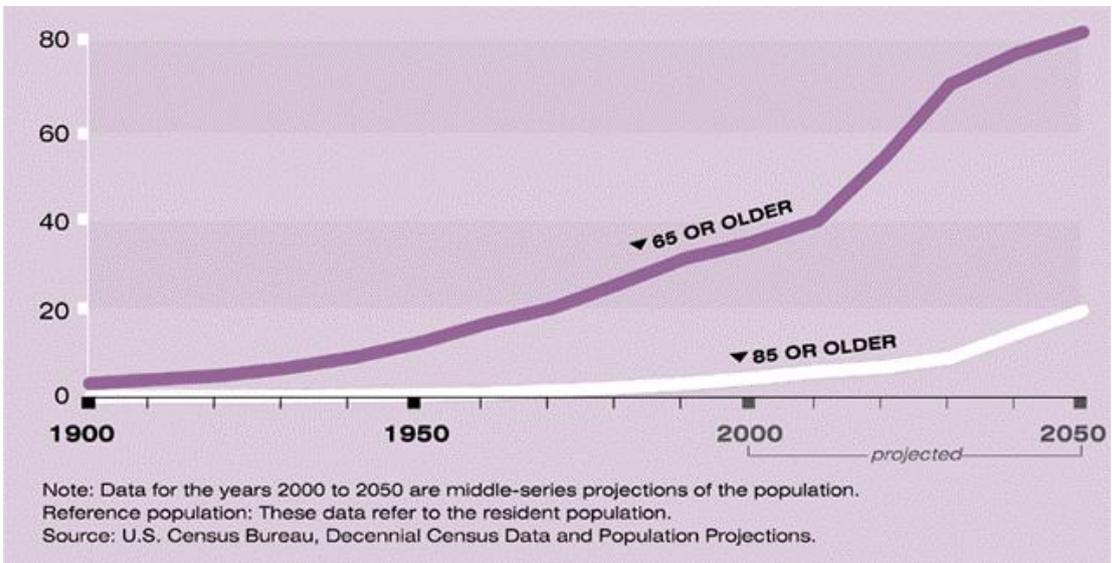


Figure 1 Total number of persons age 65 or older, by age group, 1900 to 2050, in millions (CDC, 2000)

Assessment of Falls

A fall represents a failure of the body to remain upright, but does not always suggest an inadequate postural control system. Due to the complexity of falls and of interpreting falls risk, a multifaceted approach to assessing falls risk is preferred. The four approaches for assessing falls with elders are ecological, biomedical, physiological, and functional (Figure 2).

The ecological approach focuses on the extrinsic aspects of a fall event. Specifically, it is concerned with the interaction between the person and the environment. This approach allows the examiner to assess the effects of environmental factors in fall events.

The biomedical component of the assessment focuses on the medical events that may contribute to falls. The identification of both acute and chronic diseases that contribute to instability is important. For example, drug side effects, dehydration, and blood loss associated with acute illnesses can all cause weakness, lightheadedness, and falls. On the other hand, components of chronic diseases such as Parkinson's disease, brain degeneration, and vestibular disease can also cause instability and falling.

The pathophysiological component of geriatric fall assessment attempts to identify deficits in postural control that contribute to instability. Components of the postural control system that are assessed include sensory, strength, range of motion, biomechanical alignment, flexibility, and central processing.

The last component of the assessment is the functional, which allows for the identification of important routine movements with which the person has difficulty. These movements represent the integrated function of the postural control system. They

signal how the output of the system is affected by the deficits of the postural control system (Guccione, 1993).

The intensity of assessment varies by target population. For example, fall risk assessment as part of routine primary health care visits with relatively low-risk senior populations would involve a brief assessment. In contrast, high-risk groups, such as persons with recurrent falls, those living in a nursing home, persons with injurious falls, or persons presenting to a health care professional after a fall, would require a more comprehensive and detailed assessment. The essential elements of any fall-related assessment include details about the circumstance of the fall (including a witness account), identification of the person's risk factors for falls, any medical co-morbidity, functional status, and environmental risks (Lundebjerg, 2001).

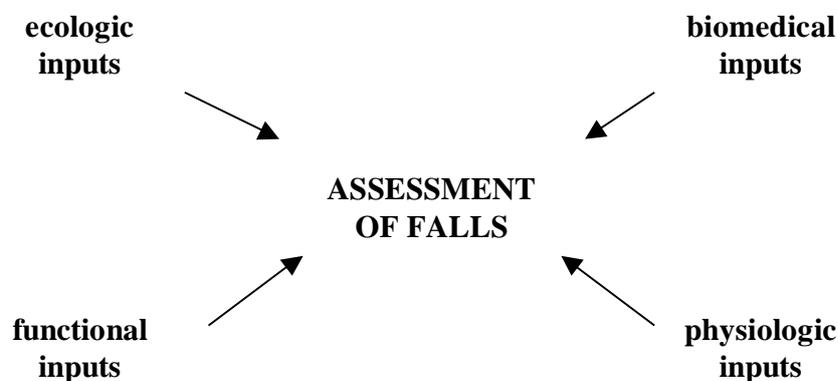


Figure 2 Four approaches to the assessment of falls. (Adapted from Guccione, 1993)

Fall Assessment Tools

Fall assessment tools are targeted at detecting those physical and cognitive impairments, as well as environmental factors that place older adults at risk for falls. These tools represent an effective quantitative method to gather information on fall risks for older adults. Although, no reliability and validity reports of fall assessment tools were found in the literature, the general practice of fall risk assessments and prevention is well documented as a means to prevent falls. Strengths of a fall assessment tool are its ability to detect those individuals at the highest risk of falls, and when used repeatedly on the same individual such instruments are able to detect minor changes in cognitive and functional ability, as well as environmental alterations that put the individual at risk for falls. A limitation is that the use of a fall assessment tool may limit the establishment of preventative measures for all older adults as a high-risk population for falls (Farmer, 2000).

Most falls are precipitated by a combination of both extrinsic factors, which are believed to be contributed by environmental hazards influenced by a situation, and intrinsic factors, which are the result of a medical illness (Commodore, 1995; Steinweg, 1997). There may be simple measures that could reduce the incidence of falls without the need for physical restraints, sedation, excessive supervision, or other measures that undermine an individual's dignity and independence (Oliver, Britton, Seed, Martin, & Hopper, 1997). Various researchers have identified risk factors (measurable resident characteristics) that have a potential to predict falls in the elderly population, thus suggesting preventability (Janke, Reynolds, & Swiech, 1986). However, since the occurrence of falls depends on individual characteristics and institutional characteristics

such as clinical and nursing practice, risk factors may be specific to particular healthcare settings.

Only a few studies have explored how the risk factors interactions and confound patient risk. Mayo, Korner-Bitensky, Becker, and Georges (1989) reviewed cases (falls) and controls (non-falls) considering more than 100 variables. They found that stroke, incontinence, anticonvulsant medications, and topical eye preparations to be significantly related to the risk of falls. Tinetti et al. (1986) hypothesized that the risk of falling increases as the number of chronic disabilities increase. They utilized nine risk factors (mobility score, morale score, mental status score, vision, hearing, postural blood pressure, back examination, post-admission medications, and activities of daily living score) and found that the occurrence of falls was proportionate to the number of these factors that an individual possessed.

The inconsistency in the findings and the multitude of risk factors make it difficult to incorporate them into clinical nursing assessment and practice (Hernandez & Miller, 1986). Various clinical characteristics (over 400 in total on systematic review) are associated with an increases incidence of falls. These clinical characteristics include an individual's visual status, medication regimen, and gait and balance indicators. Downton (1993) found that the interactions between these factors could make it difficult to ascertain the effect this might have on the persons' likelihood of falling. Due to the numerous clinical characteristics that contribute to the risk of falls in elderly persons (Turkoski, Pierce, & Shreck, 1997), it has been recognized that interventions to reduce falls must take a multifactorial approach (Effective Health Care, 1996).

Research on the occurrence of resident falls indicates that the implementation of a falls prevention program can reduce the frequency of falls (Ruckstuhl, Marchionda, & Salmons, 1991). Fall prevention programs consisting of a fall assessment tool is essential to the provision of holistic care for older adults. Since normal and pathological changes, which are common in aging, contribute to falls, assessment of the risk factors is necessary (Farmer, 2000). The assessment of residents to identify those at risk of falling by the use of risk-assessment tools with intervention/prevention strategies has been suggested as a successful means of managing the issue (Downton, 1993; Sweeting, 1994; Cannard, 1996). The development of these tools has taken a multifactorial nature of strategies to reduce falls into account.

The use of risk-assessment tools has been successful in studies claiming the reduction in the incidence of falls (Kinn & Hood, 2001). Cannard (1996) developed a risk assessment tool for use with older adults. The approach is to select individuals at high risk and target prevention strategies. The scale was found to be effective in predicting the likelihood of falling, although no detail was given about how the risk factors, scores, or weightings were determined (Kinn & Hood, 2001). Sweeting (1994) developed a tool, using a number of factors based upon the range and frequency of different causes of falls. Studies have identified a 60% reduction in falls following the introduction of fall risk evaluation forms and educational programs for both staff and residents.

Numerous methods are used for developing a fall risk assessment tool. The development of some tools was based only on a literature review or on expert opinion. The majority of tools were developed on the basis of incident reviews. This is of

concern, as incident reviews of patients who fall do not allow a comparison of risk factors with a non-faller population. This may lead to biased estimates of the importance or lack of importance of risk factors. In addition, once most tools were developed, they were not tested and had no reported sensitivity or specificity, making it difficult to evaluate the accuracy of the tools (Myers & Nikoletti, 2003).

Falls in Institutionalized Elderly

Numerous epidemiologic studies have reported the incidence of falls and fall-related injuries among institutionalized populations; these data are presented in Table 1. The mean fall incidence calculated from these studies is about three times the rate for community-living elderly persons (mean = 1.5 falls per bed per year) due both to the frailer nature of institutionalized populations and to more accurate reporting of falls in institutions.

As shown in Table 1, only 4% of falls in nursing homes (range = 1% - 10%) result in fractures while other severe injuries such as head trauma, soft-tissue injuries, and severe lacerations, occur in about 12% (range = 1% - 36%) of falls; however, once injured, an elderly faller has a much higher chance of a fatal outcome than a younger faller. Each year, about 1800 fatal falls occur in U.S. nursing homes. Among persons 85 years and older, 1 out of 5 fatal falls occur in a nursing home. Nursing home residents also have an excessively high incidence of hip fracture, and have been shown to have higher mortality rates following hip fracture than community-living elderly persons. Furthermore, due to high frequency of recurrent falls in nursing homes, the likelihood of sustaining an injurious fall is substantial (Rubenstein, Josephson, & Osterweil, 1996).

Descriptions of the available studies providing data on the epidemiology of falls in a range of settings (community-based, hospital-based, and long-term care institution surveys) are presented in Table 2. The highest incidence of falls (.65 to 3.6 per bed annually with 1.65 mean) is evident with individuals residing in long-term care institutions. Hospitals are next with rates of .62 to 2.9 per bed annually with 1.5 mean. The generally healthy elderly people residing in the community represent the lowest rate of falls (.22 to .625 per bed annually).

Injuries are the sixth leading cause of death in the population of adults 75 and older (NSC, 1983), with falls the leading source of injury-related deaths (Figure 3) (Baker & Harvey, 1985). Falls are the largest single cause of accidental death of older adults. Rubenstein et al (1988) stated that about half of the estimated 1.5 million nursing home residents in the United States fall at least once annually, and 10 to 20% of nursing home falls result in severe injuries. Falls are even more common in nursing homes, where the average annual incidence of falls is 1600 per 1000 patients (Tinetti & Speechley, 1989). The likely increase in the number of fall related injuries occurring in nursing home could be attributed to the longer life expectancy and the percentage of the elderly (e.g. those 85 years and older) in the total U.S. population (U.S. Bureau of the Census, 1989).

Table 1 Incidence of falls and fall-related injuries in long-term care facilities (Adapted from Rubenstein et al, 1996)

Reference	Site	Mean Age and Population	Annual Incidence Per 1000 Beds	Percent of Falls with Serious Injury (%)	Percent of Falls with Fracture (%)
Gryfe et al, 1977	BC-Canada	81%≥75	650	17	6
Pablo, 1977	CC-Canada	72	730	17	0
Feist, 1978	NH-USA	83	3300	4	3
Cacha, 1979	NH-USA	82	2400	1	NA
Miller and Elliot, 1979	NH-USA	82	1400	NA	1
Louis, 1983	NH-USA	83	760	12	NA
Louis, 1983	NH-USA	79	1100	14	NA
Colling and Park, 1983	NH-USA	NA	2600	5	2
Blake and Morfitt, 1986	BC-UK	≥60	3600	3	NA
Berry et al, 1981	CC-USA	68%≥70	1500	5	3
Berryman et al, 1989	NH-USA	≥65	2000	NA	NA
Gross et al, 1990	NH/BC-USA	82	220	15	10
Rubenstein et al, 1990	NH/BC-USA	≥65	1200	NA	2
Gostynski, 1991	NH/BC-Switzerland	86	1300	6	2
Neufeld et al, 1991	NH/BC-USA	84	630	NA	5
Svensson et al, 1991	NH-Sweden	95%≥65	350	35*	NA
Tinetti et al, 1992	NH-USA	84	1530	3	3
Ejaz et al, 1994	NH-USA	NA	1480	17	NA
Luukinen et al, 1995	NH-Finland	≥70	1540	8	4
Thapa et al, 1995	NH-USA	≥65	2040	26	8
Simple means of all surveys			1490	11.8	3.8

*Percent of injurious falls in this study considered to be serious. BC = board and care facility; CC = chronic care facility; NH = nursing home; NA = data not available.

Table 2 Incidence of fall in different settings: Review of population-based studies.

(Adapted from Rubenstein et al., 1988).

Reference	Population/ Site (N)	Age	Annual Incidence per 1,000	% of fall w/ fracture
A. Community-based surveys				
Exton-Smith, 1977	Community survey (N=963)	65-69	400	NA
		70-74	510	
		75-79	610	
		80-84	730	
		85-90	750	
Perry, 1982	Apartment complex (N=64)	89% > 70	625	5.0%
Gabell, 1985	2 general practices	>65	224	NA
Simple mean of all surveys			325	
B. Hospital-based surveys				
Scott, 1976	Acute	>60	620	3.5%
Sehested, 1977	Geriatric	91% >60	2,900	4.2%
Morris, 1980	Geriatric	99% >65	1,500	1.7%
Berry, 1981	Chronic	68% >70	1,500	3.2%
Catchen, 1983	Acute	>65	1,900	5.0%
Morgan, 1985	Acute	>65	1,400	NA
Morse, 1985	Acute	NA	840	1.3%
Simple mean of all surveys			1,500	
C. Long-term care institution surveys				
Gryfe, 1977	Residential home	81% >75	650	6.1%
Miller, 1979	Skilled	82.3 (mean)	1,400	NA
Louis, 1983	Skilled	83.3 (mean)	760	NA
Colling, 1983	Skilled	NA	2,600	2.3%
Blake, 1986	Residential home	>60	3,600	NA
Simple mean of all surveys			1,650	

NA = not available

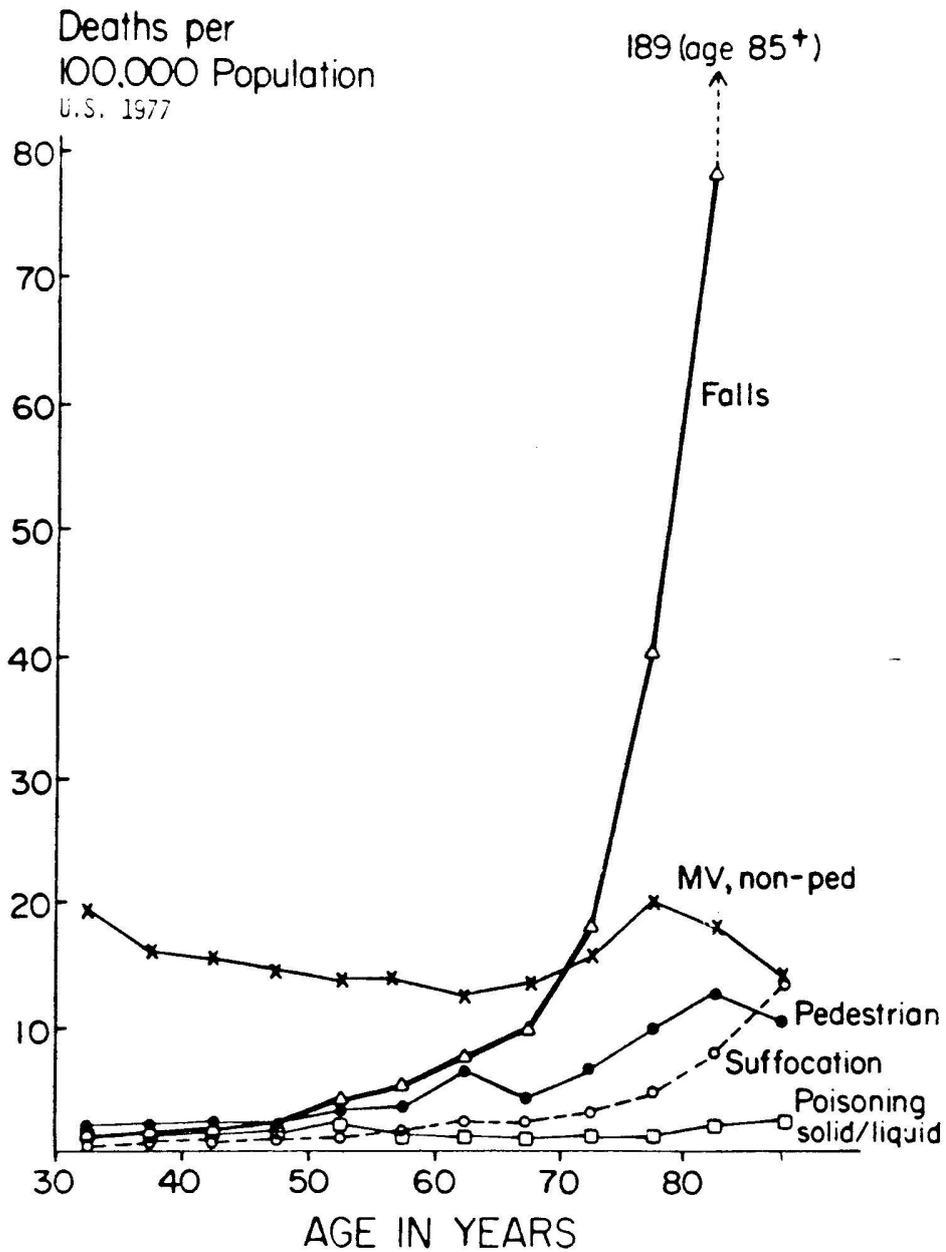


Figure 3 Deaths per 100,000 population by age in 1977 (Baker and Harvey, 1985)

Epidemiology of Slip and Fall Accidents of Older Individuals

Upon review of the literature on the epidemiology of falls with elders, it is evident there is no single type of fall, and little agreement on the cause of the higher occurrence of falls. Both in the community and institutional settings, falls are generally categorized by the associated medical, social, and environmental factors involved. Several factors related to falls among older institutional adults (e.g., nursing homes) have been reported in the literature: age, gender, family status, mental status, the number of chronic conditions, alcohol consumption, the onset of acute disease, impaired functional capacity, micturition syncope, cardiac arrhythmias, and acute cardiac changes. Deficiencies involving these factors make the aged person particularly prone to accidental slips and falls (Rodstein, 1972). The epidemiology of fall injuries states that the elderly population has an especially high mortality from a particular injury. The reasons for this mortality include: (1) greater exposure to the etiologic agent; (2) greater susceptibility to the injury or disease; or (3) greater likelihood of a fatal outcome, once the injury or disease occurs (Baker & Harvey, 1985). Fifty percent of elderly persons who fall do so repeatedly (Tinetti & Speechley, 1989). Campbell, Reinken, Allan, and Martinez (1981) stated that the annual incidence of falls among elderly persons living in the community increases from 25% at 70 years of age to 35% after 75 years of age. There is a higher occurrence of falls in the institutional (e.g., hospital and nursing home) environment (Rubenstein et al., 1988) which is evident by the fact that over 50 percent of those living in nursing homes fall each year versus 30 percent that live in the community (Tinetti & Speechley, 1989). Women fall more frequently than men until the age of 75 years, after which the frequency is similar in both genders (Campbell et al., 1981).

Risk Factors for Falls Among the Geriatric Population

One of the most important parts of a fall prevention program is determining a person's risk for falls. Falls are usually due to a combination of both intrinsic and extrinsic factors, making the nature of falls a complex, multi-factorial issue. The causes of nursing home falls and their relative frequencies as described in four detailed studies are shown in Table 3. The table also provides a comparison of fall causes among non-institutionalized elderly persons summarized from seven detailed studies. As can be seen, the distribution of causes clearly differs between populations studied. Institutionalized populations tend to have a higher proportion of falls caused by gait disorders, weakness, dizziness and confusion whereas community-living populations tend to have a higher proportion of environment-related falls. These differences represent many contrasts between community-living and institutionalized populations, including differences in underlying frailty and fall risk, environmental hazards, overall fall rates, and reporting differences (Rubenstein et al, 1996).

Studies among institutionalized populations, in addition to identifying immediate causes for falls, have shown the incidence of specific risk factors that significantly increase the possibility of falling. Some of these risk factors may only be there for a short time whereas others may be related to a chronic condition. Risk factors that have been identified in case-control studies are presented in Table 4; along with an approximate mean relative-risk of each factor. Of the 10 studies reviewed, 6 performed physical examinations on fallers and non-fallers, whereas the remaining studies relied on information obtained from medical chart reviews. It is possible to identify people at an increased risk of sustaining a fall or fall-related injury by identifying the presence of

certain risk factors (Rubenstein et al, 1996). Although investigators have not used a consistent taxonomy, a recent review of fall risk factor studies ranked the risk factors and summarized the relative risk of falls for persons with each risk factor (Table 5) (Rubenstein & Josephson, 2002).

Table 3 Causes of falls in nursing homes compared with community-living populations* (Adapted from Rubenstein et al, 1996)

Cause of Falls	Nursing Home (N = 4 studies 1076 falls)	Community-Living (N = 7 studies 2312 falls)
Gait/balance disorder, Weakness	26% (20%-39%) [†]	13% (2%-29%)
Dizziness/vertigo	25% (0%-30%)	8% (0%-19%)
Environment-related	16% (6%-27%)	41% (23%-53%)
Confusion	10% (0%-14%)	2% (0%-7%)
Visual disorder	4% (0%-5%)	0.8% (0%-4%)
Postural hypotension	2% (0%-16%)	1% (0%-6%)
Drop attack	0.3% (0%-3%)	13% (0%-25%)
Syncope	0.2% (0%-3%)	0.4% (0%-3%)
Other specified causes [‡]	12% (10%-34%)	17% (2%-39%)
Unknown	4% (0%-34%)	6% (0%-16%)

*Summary of studies that carefully evaluated elderly persons after a fall and specified a "most likely cause".

[†]Mean percent calculated from the total number of falls in the studies reviewed. Ranges (in parenthesis) indicate the percentage reported in each of the studies. Percentages do not total 100% because some studies reported more than one cause per fall.

[‡]This category includes arthritis, acute illness, drugs, alcohol, pain, epilepsy, and falling from bed.

Table 4 Important individual risk factors for falls: summary of twelve controlled studies performed in long-term care institutions (Adapted from Rubenstein et al, 1996)

Risk Factor	Significant/Total†	Mean RR-OR‡	Range
Physical Examination			
Weakness	6/6	5.2 (5)?.	(1.6-8.4)
Balance deficit	4/5	3.2 (4)	(1.0-5.4)
Gait deficit	4/4	3.6 (2)	(2.4-4.8)
Impaired mobility/walking aid	3/3	3.0 (2)	(1.7-4.6)
Functional impairment	3/3	3.0 (2)	(3.0-3.1)
Visual deficit	4/5	2.4 (4)	(1.1-4.5)
Postural hypotension	3/4	2.0 (4)	(1.0-3.4)
Cognitive impairment	3/5	1.5 (4)	(1.0-2.0)
Drugs			
Number of drugs	5/6	NA	NA
Antidepressants	5/8	2.2 (8)	(1.0-5.7)
Sedative/hypnotic	5/9	1.8 (9)	(1.0-3.2)
NSAIDs	2/6	1.6 (6)	(1.0-2.4)
Vasodilators	2/7	1.4 (7)	(1.0-2.2)
Diagnoses			
Arthritis	2/4	1.6 (4)	(0.9-2.4)
Depression	2/5	1.6 (5)	(1.0-2.5)

†Number of studies with significant association/total number of studies looking at each factor.

‡Relative risks (prospective studies) and odds ratios (retrospective studies).

?Number in parenthesis indicates the number of studies that reported relative risks or odds ratios.

Table 5 Results of univariate analysis of most common risk factors for falls identified in 16 studies that examined multiple risk factors (Adapted from Lundebjerg, 2001)

Risk Factor	Significant/Total†	Mean RR-OR‡	Range
Muscle weakness	10/11	4.4	1.5-10.3
History of falls	12/13	3.0	1.7-7.0
Gait deficit	10/12	2.9	1.3-5.6
Balance deficit	8/11	2.9	1.6-5.4
Use assistive device	8/8	2.6	1.2-4.6
Visual deficit	6/12	2.5	1.6-3.5
Arthritis	3/7	2.4	1.9-2.9
Impaired ADL	8/9	2.3	1.5-3.1
Depression	3/6	2.2	1.7-2.5
Cognitive impairment	4/11	1.8	1.0-2.3
Age > 80 years	5/8	1.7	1.1-2.5

†Number of studies with significant odds ratio or relative risk ratio in univariate analysis/total number of studies that included each factor

‡Relative risk ratios (RR) calculated for prospective studies. Odds ratios (OR) calculated for retrospective studies.

Factors intrinsic to the elderly person, the type of activity in which he or she is engaged, and the hazards and demands of the environment contribute to most falls in varying degrees (Tinetti & Speechley, 1989). Causes of falls can be grouped in numerous ways; by presenting symptom complex (e.g., dizziness, drop attack, slips), by a precipitating mechanism (e.g., postural hypotension, environmental hazards), and by underlying risk factors (e.g., antihypertensive medications, decreased vision). Because the causes of falls cannot be placed into various classifications, a potential for ambiguity exists. This may clarify the lack of consistency in the literature on slips and falls that attempts to classify causes of falls.

The data in Table 6 presents information on fall etiologies from a variety of published studies. In general, the most frequent cause of falls is represented in the “accidents and environment-related” category. The next most common cause fluctuates from study to study: “miscellaneous” causes in three studies, postural hypotension (Scott, 1976), weakness, drop attack (Sheldon, 1960), and dizziness/vertigo (Lucht, 1971). The last column in Table 6 presents the average of all the studies combined. In general, 55% of falls were associated with medically diagnosed conditions, and 37% were related to environmental hazards.

Numerous studies state that intact visual, vestibular, proprioceptive, and muscular systems are needed to ambulate safely and minimize the occurrence of falls (Lacour, Vidal, & Xerri, 1983; Nashner, 1982; and Tideiksaar, 1990). With the effects of aging acting on these systems comes an increased possibility for slip and fall-related injuries.

A change in an individual’s motor program is needed when walking from one type of floor surface to another. As these changes are done effortlessly and automatically

with an unimpaired gait, they require considerable effort with a gait impaired by the effects of aging. When walking, elders must pay close attention to surface and environmental changes due to reductions in their automatic movements. A review of the literature on accidents related to the occurrence of slips and falls states that numerous factors are involved in these accidents (i.e., neurological and musculoskeletal disabilities, problems with gait and balance, use of psychoactive medications, visual impairment, dementia, combination of medication, stroke, Parkinson disease or neuromuscular disease).

Table 6 Causes or types of falls: review of literature. (Adapted from Rubenstein et al., 1988).

Reference	Sheldon	Clark	Lucht	Scott	Exton-Smith	Brodcklehurst	Morfitt	Total
Year	1960	1968	1971	1976	1977	1978	1983	
Population	H	H	H/NH	Hosp	H	H	H	
Number of falls	500	450	472	259	190	376	339	2,661
Primary cause of fall								
Accident/envirn. related	44.8%	44.0%	38.9%	11.6%	27.9%	23.1%	52.9%	36.9%
Drop attack	25.0%	15.6%	-----	1.5%	13.1%	21.3%	-----	11.4%
Postural change/hypotension	3.6%	2.7%	-----	23.5%	-----	-----	13.0%	5.1%
Syncope	-----	.4%	1.5%	-----	-----	-----	2.0%	1.0%
Dizziness/vertigo	7.4%	4.0%	19.1%	2.7%	12.1%	-----	6.8%	7.7%
Weakness,balance/gait	3.2%	-----	12.1%	22.8%	9.5%	29.5%	11.6%	12.3%
Other*	6.0%	25.8%	17.2%	16.6%	37.4%	18.6%	19.4%	18.1%
Unknown	4.6%	6.6%	16.1%	21.2%	-----	7.4%	-----	7.9%

Intrinsic Risk Factors

Risk factors for falls are divided into two categories. The first category is intrinsic or internal factors, including sensory loss or changes, syncope, hemiplegia, hypotension, cardiac problems, balance impairment, gait impairment, progressive neurological disorders, decreased range of motion and muscle strength, side effects of medications, cognitive or perceptual impairment, vertigo, or any disease state that may influence mobility. These factors usually cannot usually be changed, but they can be managed controlled. Table 7 presents various intrinsic risk factors for falling and possible interventions.

Table 7 Intrinsic risk factors for falling and possible interventions. (Adapted from Tinetti and Speechley, 1989)

RISK FACTOR	INTERVENTIONS	
	MEDICAL	REHABILITATIVE OR ENVIRONMENTAL
Reduced visual acuity, dark adaptation, and perception	Refraction; cataract extraction	Home safety assessment
Reduced hearing	Removal of cerumen; audiologic evaluation	Hearing aid if appropriate (with training); reduction in background noise
Vestibular dysfunction	Avoidance of drugs affecting the vestibular system; neurologic or ear, nose, and throat evaluation, if indicated	Habituation exercises
Proprioceptive dysfunction, cervical degenerative disorders, and peripheral neuropathy	Screening for vitamin B ₁₂ deficiency and cervical spondylosis	Balance exercises; appropriate walking aid; correctly sized footwear with firm soles; home safety assessment
Dementia	Detection of reversible causes; avoidance of sedative or centrally acting drugs	Supervised exercise and ambulation; home safety assessment
Musculoskeletal disorders	Appropriate diagnostic evaluation	Balance-and-gait training; muscle-strengthening exercises; walking aid; home safety assessment
Foot disorders (calluses, bunions, deformities)	Shaving of calluses; bunionectomy	Trimming of nails; appropriate footwear
Postural hypotension	Assessment of medications; rehydration; possible alteration in situational factors (e.g., meals, change of position)	Dorsiflexion exercises; pressure-graded stockings; elevation of head of bed; use of tilt table if condition is severe
Use of medications (sedatives: benzodiazepines, phenothiazines, antidepressants; antihypertensives; others: antoarrhythmics, anticonvulsants, diuretics, alcohol)	Steps to be taken: 1. Attempted reduction in the total number of medications taken 2. Assessment of risks and benefits of each medication 3. Selection of medication, if needed, that is least centrally acting, least associated with postural hypotension, and the shortest action 4. Prescription of lowest effective dose 5. Frequent reassessment of risks and benefits	_____

History of Falls

Once an elderly person falls, he or she is two to three more likely to fall again within a year. Thus, a history of falls is often a predictor of future falls. The influence on the history of an individual's falls on subsequent falls has been given minimal emphasis although it is consistently one of the strongest risk factors reported, particularly in studies conducted in long-term settings. Numerous studies have shown that persons who have already fallen are likely to fall again (Ruckstuhl et al, 1991; Kinn & Hood, 2001; Janken et al, 1986). Knowing if the resident had a fall history (whether or not the resident fell in the past 180 days) was the single most predictive factor for a future fall. Sehested and Severin-Nielsen (1977) found that a high percentage of their falls was due to a tendency of individuals to fall repeatedly.

Experiencing a fall can have far more repercussions than just a physical injury. The fear of future falls and a reduced level of personal confidence may cause a reduced level of independence, isolation, lower levels of social contact, and depression. Hendrich, Nyhuis, Kippenbrock, and Soja (1995) stated that a fall event may initiate the cascade of decreased mobility, decreased activities of daily living, decreased body system functioning, and increased susceptibility to disease in the elderly (Figure 5). The causes and results of falls are cyclical in nature, whereby the fall leads to restriction of activity, loss of autonomy and self confidence, depression and anxiety, deconditioning, possible prescription of psychoactive drugs, subsequently placing the individual at increased risk of falling. This may explain the increased risk of a fall of individuals who have had a past history of falls.

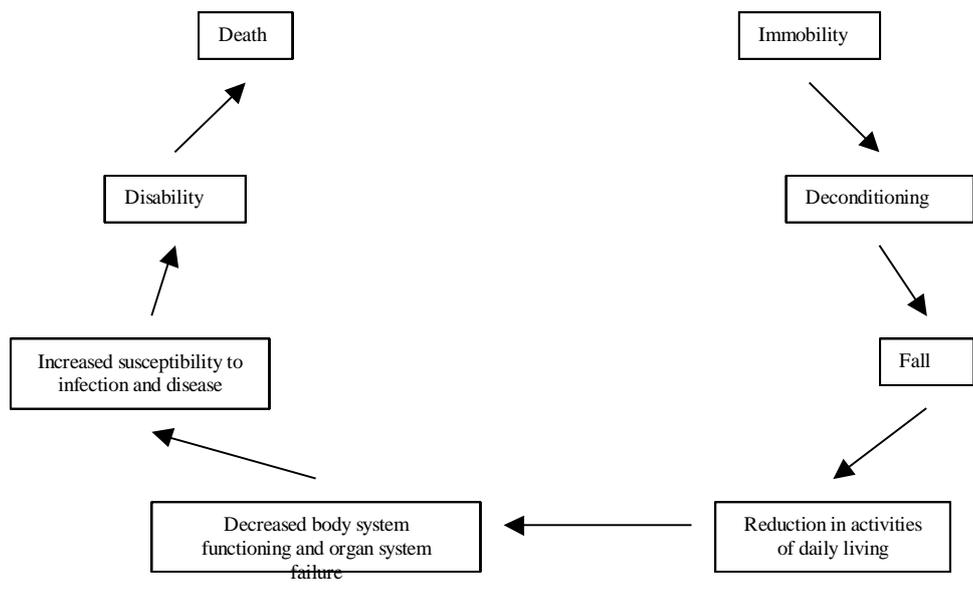


Figure 4 The fall event cascade. (Adapted from Hendrich et al, 1995)

Age

Age as a risk factor for predicting fall risk has received conflicting results in the literature. Where some researchers have found that older, frailer individuals are more susceptible to an increased frequency of falls, others have found that younger more active individuals have a greater frequency of falls. Researchers indicate that younger age groups (70-79 years old) are less likely to request nursing assistance before arising; therefore, they are at greater risk of falling. Also, younger age groups (70-79 years old) tend to be more active than elders in their 80's. The majority of falls by elderly persons occur during their usual activities, such as walking or changing position (Tinetti & Speechley, 1989). A study found that ambulating activities provide residents an opportunity to fall. Also, researchers found that women aged 40-55 had the highest incidence but the least number of major falls, and men aged 56-69 were at the highest risk of minor falls. They found that younger, more alert elderly persons are more mobile and this increased activity exposes them to greater risk. Also, alert older persons take more chances and they showed significant defects in judgment. Campbell et al. (1981) state that there is a definite progression with age; the younger are more active and exposed to occasional, accidental falls; those somewhat older are a less active group, less prone to occasional falls; and the oldest form a quite frail group, exposed to the risk of repeated falls because of impaired function.

The ability to ambulate, transfer, and remain upright depends on many systems of the body. Many of these systems decrease in function as we age. There will now be a discussion of these systems individually.

Medications

One of the most important factors causing falls in the elderly is the use of medications. As the body ages, it becomes less efficient at handling many drugs (Macdonald & Macdonald, 1982). This inefficiency causes an adverse drug reaction, which is any unwanted and potentially harmful effect caused by a drug when the drug is given at the recommended dosage (Guccione, 1993). These side effects result in impaired mentation, stability, and gait.

For all settings (i.e., community, long-term care, hospital, and rehabilitation) there is a consistent association between psychotropic medication use (i.e., Neuroleptics, benzodiazepines, and antidepressants) and falls. These medications can cause a patient to get dizzy or light-headed and are among the medications that cause the greatest risk for falls. Especially important are agents with sedative, antidepressant, psychotropic, and antihypertensive effects, particularly diuretics, vasodilators, and beta-blockers (Rubenstein et al, 1996). Diuretics may cause fatigue, volume depletion, or electrolyte disturbance. Antihypertensive agents may impair alertness or cause postural hypertension or fatigue (Tinetti & Speechly, 1989). Sedatives such as benzodiazepines, phenothiazines, and antidepressants appear to predispose the elderly to falling independently of the effects of dementia or depression, the diseases for which these drugs are most commonly used in the elderly (Ray, Griffin, Schaffner, Baugh, & Melton, 1987). Specific classes of medications found to increase the risk of falling in nursing home residents include psychotropic drugs, sedatives, cardiac drugs, and nonsteroidal anti-inflammatory drugs (Rubenstein et al, 1996). The fall risk is increased the more

medications a person takes. Fall risk increases greatly when a person is taking five or more medications.

Several case-control studies in nursing homes have shown an association between falls and medication use, although this association has varied widely. Reported odds ratios range from 1.0 to 5.7 (Rubenstein et al, 1996). Table 8 displays some of the more general studies. Virtually all studies show that the general effect of taking drugs is to increase fall frequency in the elderly. In one study, residents taking four or more prescription medications had a significantly greater risk of falling (Macdonald, 1985). Ladimer (1975) has stated; “the number of accidents, however defined, is evidently related to drugs not alone because of quantity, but because of the number of simultaneous medications, irrational mixtures, poor administration, and adverse reactions left equally unmonitored.” Studies have shown a direct relation between the total number of medications used and the risk of falling (Tinetti et al, 1986). A study showed a persistent association between psychotropic drugs and falls when controlling for other risk factors (Rubenstein et al, 1996). Although there are no randomized, controlled studies of manipulation of medication as a sole intervention, reduction of medications was a prominent component of effective fall-reducing interventions in community-based and long-term care multifactorial studies. Multifactorial studies suggest that a reduction in the number of medications in patients taking more than four preparations is beneficial (Lundebjerg, 2001).

Table 8 Studies relating drugs to falls in the elderly. (Adapted from Macdonald, 1985)

Study	No. of Patients	Sample	Conclusions
Prudham and Evans (1981)	2497	Stratified population sample (weighted =80)	Any drug: 48% fallen in past year; No drug: 42 % fallen in past year; Tranquilizers: 11 % versus 7.2%; Diuretics: 22.6% versus 17.6%
Davie and colleagues (1981)	100	Psychogeriatric outpatients	Any drug increases falling rate or dizziness; Phenothiazine or tricyclics: approximately two-thirds have falls or dizziness; On both, average patient is symptomatic; On any 3 to 4 drugs, nearly all symptomatic
Campbell and colleagues (1981)	553	Stratified population sample (weighted =80)	More psychotropics in men fallers; More hypotensives in women fallers
Tinker (1979)	116 beds	Acute illness, geriatric inpatients	25% fallers on daytime sedation versus 6% of total patients; 7% of fallers on hypotensive versus 3% of total patients
Macdonald (1977)	390	Geriatric femoral fracture patients	Strong association between barbiturates and frequent falls (45% of barbiturate users had frequent falls versus 22% of non-users)
Macdonald (1977)	1622	Geriatric outpatients	Strong association between barbiturates and falls as reason for outpatient referral (85% of barbiturate takers versus 24% in non-users)
Wild and colleagues (1981)	125	Geriatric fallers in community plus matched controls	Fallers more likely to have taken hypnotics or sedatives

Cardiac System

Several physiological changes take place in the cardiovascular system that predispose elders to low blood pressure (hypotension) and irregular heart beats (dysrhythmia). The systems that are sensitive to changes in blood pressure do not function as well as we get older. This may result in increased episodes of dizziness and vertigo. This dizziness and vertigo can cause a person to fall.

Frail and institutionalized elders are most likely to have serious consequences from orthostatic hypotension, such as falls and fractures. Orthostatic (postural) hypotension is described as a 20 mm Hg or greater decline in diastolic blood pressure that occurs when an individual assumes a more upright posture (e.g., moving from lying to sitting or sitting to standing) (Guccione, 1993). This drop in blood pressure results in instability by compromising the cerebral blood flow (Tinetti & Speechley, 1989). Orthostatic hypotension has been found to be common among elderly persons. It has 5% to 25% prevalence among “normal” elderly people living at home. It is even more common among persons with predisposing risk factors common in nursing homes, including autonomic dysfunction, hypovolemia, low cardiac output, parkinsonism, metabolic and endocrine disorders fluid-volume depletion, decreased venous return, deconditioning, and medications (particularly sedatives, antihypertensives, vasodilators, and antidepressants) (Rubenstein et al, 1996; Lipsitz, 1983). The orthostatic drop may be accentuated on arising in the morning because the baroreflex response is diminished after prolonged recumbency, as it is after meals and after ingestion of nitroglycerin (Rubenstein et al, 1996).

Numerous studies have found that orthostatic hypotension is a factor related to an increased risk of falls. Campbell et al. (1981) found that men experiencing pattern falls had lower systolic blood pressure. They found that numerous falls were related to persons demonstrating a drop of 20mmHg or more of systolic pressure on rising. Researchers found that among subjects with a history of previous falls in the past six months, those with orthostatic hypotension had an increased risk of recurrent falls. They concluded that orthostatic hypotension is an independent risk factor for recurrent falls among elderly nursing home residents. Although orthostatic hypotension alone may not be sufficient to produce falls in most elderly patients, its occurrence in combination with other disabilities may impair postural control and cause a fall.

Despite the high occurrence of orthostatic hypotension, it is a fairly infrequent cause of falls. This is possibly because of its temporary nature, making it often difficult to document after the fall or because most people with orthostatic hypotension feel light headed and intentionally find a seat rather than fall (Rubenstein et al, 1996).

Musculoskeletal System

As a person ages the musculoskeletal system, responsible for balance, declines. Muscle atrophy, calcification of tendons and ligaments, and increased curvature of the spine affect balance. Once an elderly person starts to fall it is very difficult, if not impossible, for them to stop or recover from a fall.

Profound changes in muscle properties take place as individuals' age. As individuals reach their mid-twenties, physiological changes occur that affect the potential for slip and fall incidents. This is evident by the fact that isometric and isokinetic muscle strengths peak in the mid twenties and then gradually decline. This decline accelerates

after the age of 50 (Larsson, 1982; Astrand & Rodahl, 1986). The changes in muscle force production and muscle strength based on effects of ageing have the most influence on the initiation of slip-induced fall accidents (Larsson, Grimby, & Karlsson, 1979; Bonder & Wagner, 1994). These same changes also play a significant role with the inability to recover from slips and falls (Larsson 1982; Bonder & Wagner 1994).

Do, Breniere, and Brenguier (1982) stated that a person's determination to react appropriately to regaining a loss of balance is based on his/her ability to generate explosive strength and control rapid, large-scale lower extremity motions. The inability of older adults to utilize their joints and extremities to counterbalance the body's horizontal momentum during the recovery from a slip or fall, represents one hypothesis for the increased frequency of slip and falls among the elderly. Numerous studies supporting this hypothesis indicate declines in both voluntary muscle strength and rates of muscle force production, as well as, increased probability of slips and falls.

Additionally, older adults' capacity to generate explosive strength may be affected more by aging than their ability to generate maximum strength (Hakkinen, Kraemer, Kallinen, Linnamo, Pastinen, & Newton, 1996; Thelen, Wojcik, Schultz, Ashton-Miller, & Alexander, 1997). Therefore, the ability of elder individuals to regain a loss of balance may be impeded by a decrease in their lower extremity muscle strength and muscle activation rate. This, in turn, increases the potential for a slip-induced fall. This increased likelihood of slipping is evident in a study by Larsson et al. (1979) who stated that the decline of strength in the quadriceps muscle of older individuals could alter the vertical displacement of the center of gravity of the body abruptly, resulting in a jarring effect. Also, Wolfson, Whipple, Amerman, Kaplan, and Kleinberg (1985)

indicated the strength of the ankle muscle was considerably lower for those who fall than non-fallers. Additionally, it suggested that adjusting the center of gravity of the entire body to avert the potential for falls was difficult due to the reduced strength of the ankle muscles.

The proportions of slow twitch versus fast twitch muscle fibers change as people get older (Lexell, 1995). Slow twitch fibers, which are recruited at low muscle force level, increase with the aging process. On the other hand, fast twitch fibers, which are recruited as forces increase, diminish with advancing age (Binder & Mendell, 1990).

Gait Adaptation

Elderly persons experience changes in gait. They do not lift up their feet as high as younger persons and therefore may not be able to swing their feet over a loose tile or a curled edge on a rug. Many orthopedic conditions can cause a person to be at a higher risk for injury from falls. Joint pain, arthritis, and osteoporosis can cause an unsteady gait that may result in falls. Amputation of a limb also results in instability in posture increasing a person's risk.

In the nursing home, the category of weakness and gait problems was the most common cause for falls. Researchers report the occurrence of lower extremity weakness to range from 48% among community-living older persons to 57% among residents of an intermediate-care facility to over 80% among residents of a skilled nursing facility. The findings of one study that compared fallers with non-fallers discovered that lower extremity weakness was a significant risk factor, increasing the odds of falling about five fold (Rubenstein et al, 1996).

The cause of muscle weakness and gait problems is multi-factorial. Aging introduces physical changes that affect strength and gait. On average, healthy older people score 20% to 40% lower on strength tests than young adults, and among chronically ill nursing home residents, strength is considerably less than that. Much of the weakness seen in the nursing home stems from deconditioning due to prolonged bed-rest or limited physical activity, together with chronic debilitating medical conditions, such as heart failure, stroke, or pulmonary disease. Other common age-related deteriorations that impair gait include increased postural sway, decreased gait velocity, stride length and step height, prolonged reaction time, and decreased visual acuity and depth perception. Gait problems can also stem from dysfunction of the nervous, musculoskeletal, circulatory or respiratory systems as well as from simple deconditioning following a period of inactivity (Rubenstein et al, 1996).

Gait disorders affect 20%-50% of the elderly population. Almost three-quarters of nursing home residents need assistance with ambulation or are unable to ambulate. Case-control studies in nursing homes reported that over two thirds of fallers have significant gait disorders, a occurrence 2.4 to 4.8 times higher than among non-fallers. Gait and balance impairments as a group were found to be a significant risk factor for falls, related to about a three to four fold increased risk of falling. Thus, gait and balance impairments are the most important immediate causes, as well as the most serious risk factors for falls in the nursing home (Rubenstein et al, 1996).

Age-related changes in posture and balance can have an effect on an individual's gait. Numerous differences in the gait characteristics of older and younger people have been demonstrated in the literature of biomechanics (Murray, Kory, Clarkson, & Sepic,

1966; Gillis, Gilroy, Lawley, Mott, & Wall, 1986; Imms & Edholm, 1979; and Winter, Patla, Frank, & Walt, 1990). For example, the decline of walking speed observed in older adults (Murray et al., 1966; Finley & Karpovich, 1969; Imms & Edholm, 1981; Meserlain, 1995). Normal pace for elder individuals is about 100 steps/min (Meserlain, 1995). Imms and Edholm (1981) found that despite the medical history of elderly persons, their walking velocity decreased with advancing age. Another aspect of elders' gait characteristics is their tendency to walk slower resulting in a shorter step length and broader walking based. This slower walking pace also allows older adults to walk with an increase in stance time and double support time (Murray et al, 1966; Gillis et al, 1986; Imms & Edholm, 1979; and Winter et al, 1990). Researchers have noticed that individuals tended to shorten their stride length in order to decrease foot velocities and foot shear forces and reduce the possibility of slipping while ambulating on slippery floor surfaces (Cooper & Glassow, 1963; Ekkubus & Killey, 1973). In general, the shorter stride length, broader walking base, and the slower walking velocity are believed to result in a more stable, safer gait pattern. However, these gait changes may have some significant implications on the initiation of slip induced falls. Regardless of this stability, the main source of fatalities in individuals over the age of 75 was slips and falls (National Safety Council, 1998).

Perkins and Wilson (1983) stated that the majority of slips that lead to falls occur when the frictional force (F_{μ}) opposing the movement of the foot is less than the shear force (F_h) of the foot directly after the heel makes contact with the floor. By calculating the ground reaction forces exerted between the shoe and ground on a non-slippery floor surface, Perkins (1978) identified six peak forces in a normal gait cycle. The ratio of

horizontal to vertical foot forces (F_h/F_v) was also determined. The Required Coefficient of Friction (RCOF) is the measured ratio of the horizontal foot force to vertical foot force. This ratio is important because it signifies the minimum coefficient of friction (COF) that must be available at the shoe-floor interface to prevent slipping (Lockhart, 1997; Lockhart, Smith, Wolstad, & Lee, 2000a), as well as, where in the walking stride a slip is most likely to occur. An increased difference between the RCOF and available dynamic COF of the floor surface causes a greater occurrence of slips and falls (Hanson, Redfern, & Mazumdar, 1999). Also, slips and falls are more prevalent when increases in stride length and horizontal heel contact velocity result in higher horizontal force, as well as, higher RCOF (Perkins, 1978).

Lockhart (1997; 2000a) reported that the RCOF in older adults was slightly higher than that in younger adults resulting in an increased potential for slips and falls. However, many studies state that the stride length of older adults was shorter and walking velocity in older adults was slower indicating that there might be other factors contributing to older individuals slightly higher RCOF (Winter, 1990; Lockhart, 1997; Lockhart, Wolstad, Smith, & Hsiang, 2000b). Besides the shorter stride length and slower walking velocity, older adults have a significantly higher horizontal heel contact velocity than younger adults, which increases their potential for slips and falls (Winter, 1990; Lockhart et al, 2000a).

Step length and horizontal heel contact velocity can have an effect on horizontal foot force. Changing properties of the hamstring muscle are evident with advancing age. Normally, the hamstring muscle decelerates the forward momentum of the leg prior to the contact of the heel to the floor after mid-swing. The higher horizontal heel contact

velocity in older adults is caused by this decrease in hamstring muscle activation (Winter, 1990). The instantaneous velocity as the heel makes contact with the floor surface is known as heel contact velocity. As a result, an increase in friction demand between the heel of the shoe and ground at the heel contact may be due to an increase in horizontal heel contact velocity. This leads to a greater occurrence of slips and falls since more friction between the shoe and floor surfaces is needed to avoid slipping. Due to the consistency of vertical foot force across individuals, the horizontal foot force at the heel contact mainly determines RCOF in the individual. The mass of the foot multiplied by the foot horizontal acceleration is equal to the horizontal foot force at the heel contact. Even though the ambulation speed of older adults is slower, the horizontal heel velocity during the heel contact phase of the gait cycle is considerably higher for elderly individuals than younger ones (Winter et al, 1990). This increase in horizontal heel velocity may increase the possibility for slip-induced falls. Therefore, general gait instability with elder adults might increase the RCOF, thus increasing the likelihood of accidents induced by slips and falls.

In conclusion, the occurrence of slips and falls could be influenced by a combination of gait instability and sensory conflicts to the postural control system. The sensitivity of the elderly to visual and proprioceptive inputs, as well as, their difficulty in managing sensory conflicts during dynamic visual environments may further increase their likelihood of slip and fall accidents.

Nervous System

Many nuerologic conditions, such as Parkinson's Disease, Seizure Disorder, paralysis and Diabetic Neuropathy affect the balance and mobility of the elderly. The

stiffness and poor mobility that is characteristic of Parkinson's Disease often results in a halting gait that can lead to falls. Seizure Disorder is uncontrolled seizures that are often the cause of serious falls as a person loses consciousness. Paralysis on one side of the body, due to hemiplegia/hemiparesis can cause functional instability. Falls can occur as the person overcompensates for this loss of function. Diabetic Neuropathy is very common in the elderly and causes a loss of feeling in the extremities. This loss of feeling can result in a loss of balance, coordination, and sensitivity in the lower extremities. All this adds up to an increased fall risk.

Genitourinary System

Incontinent episodes are one of the leading causes of falls. Often a person slips on the floor after having an incontinent episode or falls trying to get to the bathroom in an attempt to avoid an incontinent episode. Sehested and Severin-Nielsen (1977) found that falls were positively related to the need to defecate.

Perception

Redfern and Schuman (1994) define postural control as the regulation of the body's center-of-mass over its base of support. The decline of postural control because of sensory degradations among older adults has been documented in numerous studies (Sheldon, 1963; Woolacott, Sumway-Cook, & Nashner, 1982). An increased risk of falling may also be associated with this decline in postural control (Pyykko, Jantti, & Aalto, 1990; Alexander, Shephard, Mian, & Schultz, 1992; Isaacs, 1985; Brocklehurst, Robertson, & James-Groom, 1982; Overstall, Exton-Smith, Imms, & Johnson, 1977). It is a generally accepted concept that sensory integrity declines with aging. Sensory inputs

crucial to detecting perturbation and maintaining balance are: vision, proprioception, and vestibular sensations (Lacour et al, 1983; Nashner, 1982).

Changes in vision occur with age. To see clearly, an older person needs three times the light and color contrast. This deficit in vision increases a person's risk for falling. Objects that are not seen in poor light or are not noticed become fall hazards. There is a gradual decline in visual acuity prior to the sixth decade, followed by a rapid decline in many patients from 60 to 80 years of age. Visual acuity may decline as much as 80% by the ninth decade. Impairment in visual accommodation has been noted. By age 40 to 55, visual correction is necessary in most people for accurate near vision (Guccione, 1993).

Tinetti and Speechley (1989) state that vision is important in maintaining stability, both during standing still and while ambulating. Factors associated with stability that may be affected by age-related changes include visual acuity, adaptation to the dark, peripheral vision, contrast sensitivity, and accommodation (Goldman, 1986; Cohn & Lasley, 1985). As a result, impairment of an elder's use of visual reference information to detect loss of balance and recover from falls will be evident. For example, Stelmach and Worringham (1985) states that older adults are deprived of the part of the visual field most sensitive to movement due to the narrowing of the overall visual field. Also, elder individuals rely typically on slower (latency 120-200 ms) visual control of balance than on vestibular and proprioceptive control (Pykko et al, 1990). On the contrary, Strandberg and Lanshammar (1981) state that there is minimal time (0.1 to 0.2 seconds) available to attain ample frictional forces to avoid slips and falls at the heel contact phase of the gait cycle. Thus, the likelihood for slip and fall related accidents could be created

due to visual deficits that may result in the increased time taken for the visual system to alert the central nervous system to initiate changes in posture to accommodate for a hazardous condition.

There are no randomized, controlled studies of interventions for individual visual problems despite a significant relationship between falls, fractures, and visual acuity. Fall-related hip fractures were higher in patients with visual impairment. Visual factors associated with two or more falls included poor visual acuity, reduced contrast sensitivity, decreased visual field, posterior subcapsular cataract, and non-mitotic glaucoma medication (Lundebjerg, 2001)

Several studies state that older adults also have significantly higher deficits in the reception of stimuli produced within the body (Rabbitt & Rogers, 1965; Woolacott et al, 1982; Skinner, Barrack, & Cook, 1984). When an individual changes position the proprioceptive system contributes to his/her stability. The significance of ankle proprioception with the elder populations ability to detect losses of balance and recovery from falls was demonstrated by Woolacott et al. (1982). With the elimination of ankle proprioception, they concluded that elderly persons had great increases in postural sway. Isaacs (1985) states that this increase in postural sway is related to a greater risk of falling.

The vestibular systems effect on posture is in its maintenance of balance of the entire body by perceiving the changes in direction as well as in movement. Even though changes due to aging that have an affect on vestibular functions have not been widely studied, the vestibular systems ability to elicit fall responses (Melvill & Watt, 1971(a),

1971(b)), and to resolve conflicting visual and proprioceptive information (Nashner, 1982) is in agreement.

Also impaired hearing results in the inability to heed warning signs. A wet floor or an approaching staff member becomes a hazard for those who no longer hear the warnings of others.

Cognition

Persons with poor cognition may make poor decisions, misperceive danger or place themselves in dangerous situations that can result in falls and injury. If mobility problems are also present, the risk for falls greatly increases.

Confusion and cognitive impairment are frequently cited causes of falls and may reflect an underlying systemic or metabolic process (e.g., electrolyte imbalance, fever) (Rubenstein et al, 1996). Decline in cognitive ability from a higher previous level of function brings multiple problems that influence the potential for falls of the elderly. The terms confusion and dementia are commonly used to describe mental function of the elder persons. Dementia is a term used to describe a fairly global decline intellectual function. The key term of dementia is acquired and persistent. Acquired implies that abilities an elderly person once obtained are now dysfunctional. Persistence implies that the course of the disease proceeds in a steady state. The prevalence of dementing illnesses in nursing home residents over age 65 has been estimated as high as 50% (Guccione, 1993). The prevalence of dementia increases rapidly with age, from 2.8% at ages 65 to 74 years to 9% at ages 75 to 84 years and 28% at age 85 years and above (Schneider & Guralnik, 1990). Dementia can increase falls by impairing judgment, visuospatial perception, and ability to orient oneself geographically. Falls also occur

when residents with dementia wander, attempt to get out of wheelchairs, or climb over bed siderails (Rubenstein et al, 1996).

The hypothesized relationships between dementia, depression, and falls are presented in Figure 4. This model represents hypotheses of a speculative and simplified nature. Depression is shown to be affected by physical illness, functional impairment, and dementia. The effects of depression and dementia on the risk of falling are hypothesized to be indirect and the pathways are almost identical.

Numerous studies have found that the incidence of dementing illness is an important factor in predicting fall risk. Hendrich et al. (1995) found that depression was a significant risk factor with falls. Depression results in decreased attention span and diminished concentration in the elderly population. These cognitive changes may explain the higher risk for depressed patients. Janken et al. (1986) found in their study of clinical depression strong correlations between drug therapy, hypotension, and increased fall rates. The prevalence of dementia in nursing homes is much higher than among community-dwelling older individuals ranging from 47% to 56% (Rovner, Kafonek, Filipp, Lucas, & Folstein, 1986). Campbell et al. (1981) found that individuals having pattern falls tended to be more depressed and had lower mental test scores. Rodstein (1964) reported a relation of mental confusion among residents involved in fall related accidents.

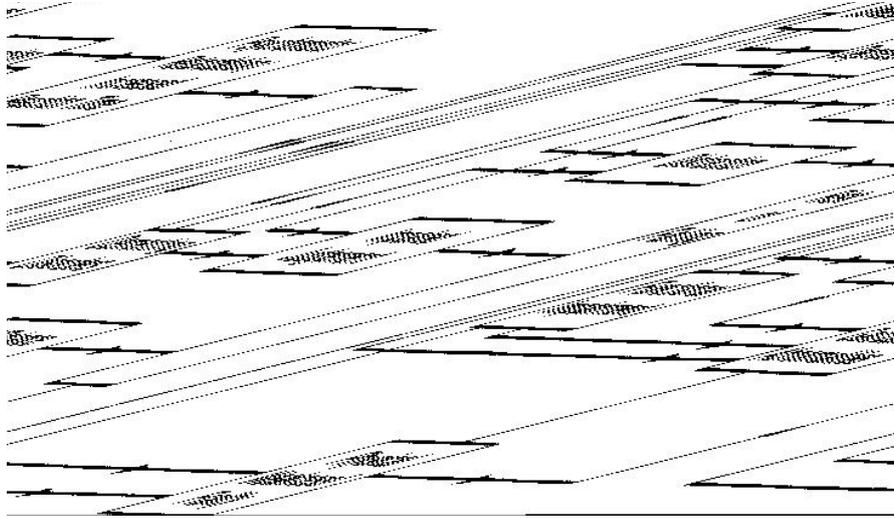


Figure 5 Model showing hypothesized relationships between selected host characteristics and risk of falling. (Adapted from Mosey, 1985)

Other Intrinsic Factors

Acute conditions such as influenza, urinary infections, and pneumonia can cause hypotension, syncope, and electrolyte imbalance resulting in weakness. Any condition that causes an elevated temperature may also cause weakness and falls.

Extrinsic or External Risk Factors

The second category of fall risk is extrinsic or external risk factors. Extrinsic factors involve the environment surrounding the person, such as placement of furniture, existence of obstacles, use of assisting walking devices, lighting, stairs, or any other object in the person's environment that may put one at risk for falls (Larson, Stevens-Ratchford, Pedritti, & Crabtree, 1996). These factors can be adjusted, thereby, decreasing fall risk.

Appliances/Devices

Various appliance and devices utilized by elderly nursing home residents can increase their risk for falling. The use of canes, walkers, and crutches increase the risk for falls if used improperly. These appliances can get caught on loose rugs or small elevations on the floor surface and cause a person to fall. Periods of lightheadedness or dizziness can occur due to irregular heartbeats caused by a malfunctioning pacemaker. Also, restraints and devices improperly used can be the cause of serious falls. Whenever possible, alternative interventions should be used. A mat on the floor with a lower bed is much safer for residents than side rails, which may cause injury if residents crawl over or fall through them attempting to get up. Bed and chair alarms are a safe and excellent way to monitor residents who are at risk for falls.

Studies of multi-factorial interventions that have included assistive devices have demonstrated benefit. However, there is no direct evidence that the use of assistive devices alone will prevent falls. Therefore, while assistive devices may be an effective element of a multi-factorial intervention program, their isolated use without attention to other risk factors cannot be recommended (Lundebjerg, 2001).

Environmental

Forty percent of the falls in the elderly population involve environmental hazards (Acello, 2001). Many factors in the environment can increase a person's risk for falls. Glare on the floor, loose rugs, patterned carpets, and slippery floors are problems for the older adults who have poor eyesight and unable to recognize these hazards quickly. Also, improper footwear can cause falls. If the sole of the shoe is too thick it will not allow the person to "feel" the surface beneath their foot. Shoes should have non-slip soles but still allow a good base of support.

Significant Environmental Change

Recent transfers to hospitals or nursing homes can be very confusing to patients. Disorientation in unfamiliar surroundings is normal for all people, but increases, as persons get older. Getting up in the middle of the night to go to the bathroom and turning in the wrong direction may result in a fall.

People tend to be admitted to institutions, particularly nursing homes, in a state of crisis or often in a seriously debilitated or incapacitated state, which may, in itself, explain the possibility of high occurrences of slips and falls during the transition. New environments can adversely affect frail older individuals, who may be poorly tolerant to

change. Relocation from home to a nursing home results in many significant changes for residents. These include unfamiliar surroundings and, possibly, new roommates, social situations, nursing staff, and physicians. It would be reasonable to hypothesize that the stress of relocation might increase the incidence of falls with older individuals.

The impact of environmental change on the psychological well-being and physical survival of the elderly have been documented in many studies. These studies propose that the conditions related to moving into an institution generate many of the effects attributed to residing in an institutional environment. Researchers found that the incidence of falling doubled after relocation of nursing home residents to a new facility. They found that older individuals who change their living environments are at increased risk of fall and fall-related injuries. The first 3 to 4 months after relocation are the most stressful for residents. In addition, it has been theorized that individuals with less cognitive control would be subject to more stress following relocation. Other studies (Blenker, 1967; Goldfarb, Shahinian, & Turner, 1966; and Lieberman, Prock, & Tobin, 1968) demonstrated that by shifting the environment (i.e., the orientation to time, place, and person) of elderly persons sharply increased the mortality rate. Leitch, Knowelden, and Seddon (1964) stated that numerous fractures are sustained by residents who have resided in an institution for only a relatively short period of time. Also, Sehested and Severin-Nielsen (1977) found the highest occurrence of falls during the first week of hospitalization. This high initial value was assumed to be a result of feelings of insecurity and tendencies toward periodic confusion due to living in a new environment. Furthermore, Bunternghit, Lockhart, Wolstad, and Smith (1999) stated that the sensitivity of older people to visual and proprioceptive inputs and their difficulty in

handling sensory conflicts during dynamic visual environments may further increase the likelihood of slip and fall accidents. Even though evidence suggests that destructive physical processes and harmful psychological effects result from environmental changes, several investigators propose that a greater understanding of what particular circumstances and which kinds of elder individuals will experience such environmental change as severe crises.

Levey and Loomba (1977) considered the characteristics of environmental change in terms of “overload”. The relationship between the characteristics of the old and new environments play a significant role on how disruptive and/or destructive the change in environment will cause. Thus, the greater the environmental change experienced in the transitional period, the greater the probability that the elder individual will need to develop adaptive responses that may or may not be beyond his/her capacity. Therefore, institutionalization can be viewed as the extent to which it forces an individual to utilize past personal adaptive responses from his/her previous environment or create new adaptive responses. This review of the effects of selection and the degree of environmental change presents an explanation of how these two factors may have a harmful effect on the population residing in long-term institutional care.

Situation Awareness and Aging

As elders transition from home to a nursing home, they can be subjected to increased demands while performing their normal activities of daily living. While the transition can be manageable in their familiar homes, older individuals may experience difficulty as the new environment and life style may tax the limits of their cognitive and physiological systems resulting in the inability to make good decisions to avoid falls.

To manage the risk of falling and the potential for injury with fall related accidents, the body incorporates voluntary movements with “associated postural adjustments” (Gronqvist & Lockhart et al., Accepted 2001). To ensure precise and harmonious movement, these automatic and smooth adjustments are organized into the movement repertoire. These adjustments can be classified based on the timing relative to the occurrence of slips and falls. The two postural control system classifications are adaptation and anticipation. These adjustments may be significantly associated with people’s situation awareness (SA), which is their perception and understanding of their surroundings and their capacity to plan future states. Adaptation, which is reactive in nature and involves the coordination of the neuromusculoskeletal system, is concerned with the physical capability to accommodate challenges in the environment. Anticipation, which is proactive and involves navigating through the control and adaptation of gait, is concerned with the ability to distinguish environmental challenges. The level of SA people can reach in an environment may dictate whether they can anticipate environmental changes possibly leading to a loss of balance. A poor SA may be indicative to adaptive postural adjustments due to perturbations.

Situation Awareness (Stage 1 – Perception)

The initial stage of SA acquisition (perception) may be disrupted by the aging process. This is evident in the reduced ability for elders to take information from their environment and accurately store it in memory (Bostad & Hess, 1996). This is evident in the fact that aging affects the speed to process resources (Craik & Byrd, 1982; and Salthouse, 1991). Also, growing older is associated with an increased inability to inhibit non-selected information (Hasher & Zacks, 1988). These aging effects may result in the

elderly perceiving less complete environments than younger adults. This is especially true when elders are presented with considerable amounts of information, when information is presented in multiple modalities, and when numerous tasks are performed simultaneously. More importantly, specific conditions may moderate the negative impacts of aging on basic cognitive functions. Hess and Saughter (1990) found that older adults have trouble with schema activation when cues in the surroundings stray from schema-based expectations. Therefore, the effects of aging will be less evident in undemanding settings that have environmental support, unpaced situations, and activities that utilize a persons past experiences.

The ability of the senses to efficiently register information is an important part of perception. Cognitive and sensory functions are needed to register information. Changes specific to various sensory functions, such as visual, vestibular, and kinesthetic systems, are related to growing old. For example, numerous studies have documented the effects of aging on the visual system. Schieber and Baldwin (1996) state that aging effects in the lens and retina result in a decline of near visual acuity, blue-green color discrimination, dark adaptation, contrast sensitivity, and (Weale, 1963) declines in transmission of light to the retina. Not only would these changes affect the quality, quantity, and type of information reaching the sensory memory, but also would significantly impact the structure of SA. Short-term memory-also called immediate memory, working memory, primary memory, and buffer memory- is adversely affected by chronic emotional stress, psychological exhaustion, or too much input (Kaplan & Saddock, 1998).

The single sensory mode that permits people to recognize an unsafe environmental condition is through the use of their vision. In order to acquire the

feedback from other postural control systems to properly adapt to their gait, individuals may need to recall the slippery surface they had previously walked on. Patla (1991) stated that the classifications of visual control of locomotion are broken down into both avoidance and accommodation strategies. Altering the placement of the foot, increasing ground clearance, changing the direction of gait, and controlling the speed of the swing foot, are all examples of avoidance strategies. During the placement of the foot, Redfern and Schuman (1994) stressed that temporal control is as important as spatial control in maintaining balance while walking. Long-term changes, such as reducing step length on a slippery surface, are considered accommodation strategies. Andres & O'Connor, (1992) display in walking trials that subjects can become accustomed to walking over slippery surfaces. The ability for subjects to adapt to a slippery surface takes place in a single step cycle when they are aware of the slipperiness of the surface being approached. Given that growing old is a significant factor in the defective co-activation of functional stretch reflex, the very old individuals depend on slower (latency 120-200 ms) visual control of balance, which add to an increased threat of slipping, tripping and falling (Pyykko et al., 1990).

Situation Awareness (Stage 2 – Comprehension)

Problems during the comprehension stage of SA may be related to the effects of aging. Inhibition problems and declines in processing resources affect the ability to make an accurate mental model of the situation in working memory. This is evident in a study by Hasher and Zacks (1988) that claimed that reductions in inhibitory processes limit information considered by limiting the capacity of working memory due to the introduction of new environmental conditions. Problems with aging effects of

comprehension include the capacity to employ processing operations to deal with varying quantities and complexity of information plus experiencing hardships with using information registered during Stage 1.

Situation Awareness (Stage 3 – Projection)

The inability to get a clear picture of the environment and the decreased capacity to formulate inferences essential for future projections are evident due to the aging effects in working-memory processes. Some parts of these functions need conscious processing (Bolstad & Hess, 1996). Generating inferences must take a bottom-up approach when such information is not obtainable because of changing environmental surroundings. This may result in age differences becoming more common due to the increased demand on working memory processes.

Confinement

Numerous studies have found that being confined to a bed or chair does not decrease but increases the individual's risk of fall potential. About one-half of nursing home residents are either chair- or bed-bound. One study found that 53% of all "accidents" (most of which were falls) occurred in non-ambulatory residents. Another study found that the annual rates of falls and related injuries were 269 and 71 per 100 beds, respectively, for residents fully dependent on staff for all their activities for daily living compared with 155 and 66 per 100 beds for independent residents (Thapa et al., 1995).

The purpose of the study was to assist health care professionals in their assessment of fall risk and in their management of elderly patients both at risk of falling and those who have fallen.

METHOD

Subjects

Particular characteristics of the resident population (65 years old over) were collected from The Cove, a long-term care unit, located in the Wybe and Marietje Kroontje Health Care Center. The Center is part of a retirement community located in Blacksburg, Virginia. Approximately 400 Fall Assessment Tools were collected for a two-year period (Jan 01, 2000 through December 31, 2001) consisting of the entire resident population residing at the long-term care facility during that time period. Using the Fall Assessment Tools, residents were divided into a fall status and a non-fall status. This status was determined by identifying, which Fall Assessment Tools are related to subsequent falls as reported by the incident/accident reports that exist. Fall Assessment Tools with no subsequent falls (i.e., no incident/accident reports exist after the Fall Assessment Sheet was conducted) were considered in the non-fall status. Fall Assessment Sheets are conducted quarterly (approximately every 90 days). The unit of data consists of the Fall Assessment Sheet (either fall or non-fall status) as determined by the evidence of one or more reported fall within the three month time period until the next Fall Assessment was conducted. All names of individuals and phone numbers were stricken from the records to maintain confidentiality. The procedures of the study were

reviewed and approved by the Virginia Tech Internal Review Board and presented to officials at the Warm Hearth Village.

Demographics

During the study period, 109 residents, 30 male residents and 79 female residents resided at the 60-bed facility. A comparison between male and female fallers and male and female non-fallers yielded no significant differences. There was no significant difference ($F_{1,29} = 1.0792, p = 0.3075$) between the average age of males who fall and males who do not fall. No significant difference ($F_{1,77} = 0.3426, p = 0.5601$) was found between the average age of females who fall and females who do not fall. Also, there was no significant difference found ($F_{1,66} = 0.8992, p = 0.3465$) between the average age of males who fall and females who fall. Last, there was no significant difference found ($F_{1,55} = 0.2112, p = 0.6477$) between the average age of males with no reported falls and females with no reported falls. See Table 9 below.

Table 9 Resident Information

	Non-Fallers		Fallers	
	Male Mean (SD)	Female Mean (SD)	Male Mean (SD)	Female Mean (SD)
Age (yrs)	83.00 (11.24)	85.65 (6.08)	86.43 (6.73)	84.78 (6.86)

There was no significant difference between groups.

A total of 222 falls occurred in the first 90-day stay of the 109 residents. Figure 6 depicts the percentage of falls that occurred based on the location that the fall occurred in the nursing home. The location the fall occurred was found on the incident/accident reports. It was found that the highest percentage of falls occurred in the resident’s bedroom (approximately 65%). Figure 7 displays the percentage of falls that occurred based on how the falls occurred as depicted by the incident/accident reports. It was found

that the incident/incidents leading up to the actual fall were not known due to the description of how the fall occurred as annotated on the incident/ accident reports on approximately 65% of falls was that the staff member found the resident on the floor.

Figure 8 depicts the percentage of falls that occurred on an eight-hour shift. It was found that the highest percentage of falls (approximately 49%) occurred during the 3pm to 11pm shift. The time that the fall occurred was found on the incident accident reports.

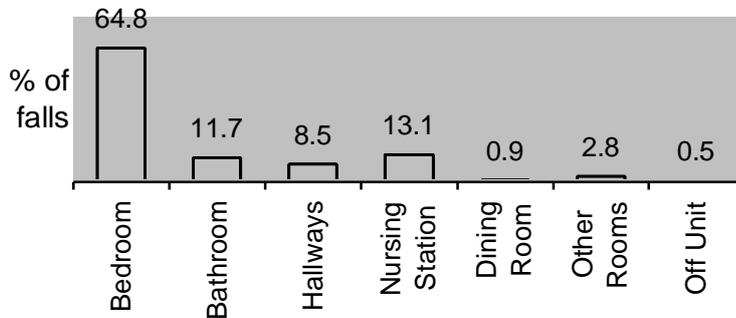


Figure 6 Percentage of where falls occurred

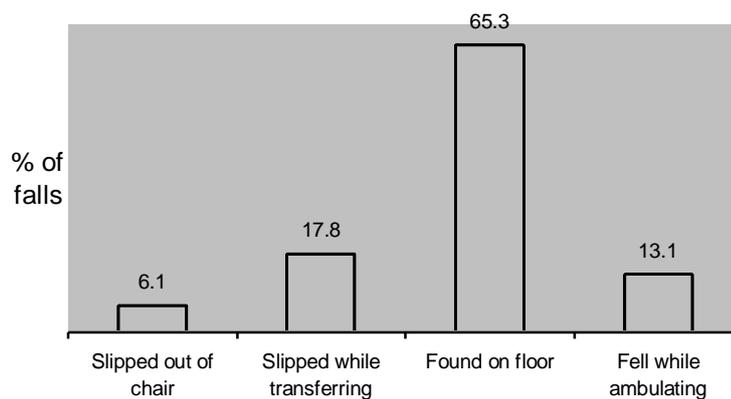


Figure 7 Percentage of how falls occurred

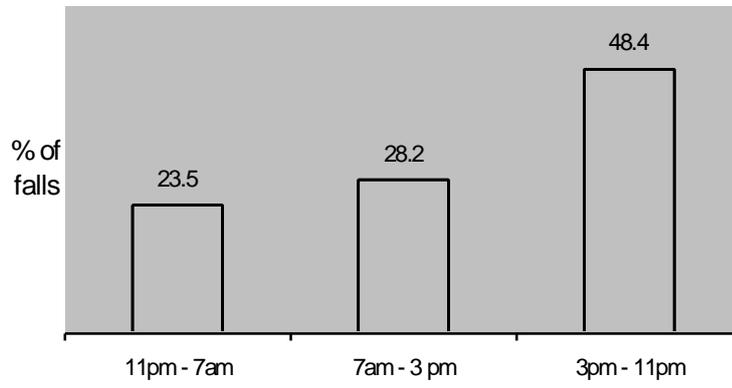


Figure 8 Percentage of falls occurred by shift

Long-Term Care Facility Description

The long-term care facility is licensed by the state Department of Health and is Medicaid certified. The residents of this 60-bed facility are age 65 years and older. The residents are referred to the facility in numerous ways. Their doctor who will write an order to discharge individuals from short-term care usually refers the residents to this facility for long-term care needs. Also, family members will make the decision. There are various reasons for the admission of an elder to a long-term care facility including, loss of functional ability and declining cognitive abilities. The population is predominantly women (75%). Approximately 75% of the population are private pay residents, meaning that the individual themselves or their family members pay the full cost of care. Medicaid covers the cost of the other 25% of the population. This particular nursing home has an average prevalence of falls of 30% compared to 14.9%, which is the average prevalence of falls of other long-term care facilities of the state. This gives the facility a 100 percentile state rank of prevalence of falls. It must be noted that the facility practices a restraint free policy, but does utilize alarm systems for fall-prone residents.

Data Collection Tools/Instruments

For this study, Incident/Accident Reports, Fall Assessment Tools, and demographic information from individual medical records was utilized.

Incident/Accident Report

The staff member who witnessed the event of a fall or who finds a resident sitting/laying on the floor completes the I/A report. The incident/accident report documents the event of any incident/accident involving a resident, employee, visitor or other person to provide information and statistics for the Quality Assurance Committee/Safety Committee and, if necessary, for litigation investigations. The report includes the following type of information: person involved; employee involved in incident/accident; visitor/other involved in incident/accident; exact location of incident/accident; date and time of incident; the resident's condition, both before and after the incident; type of injury inflicted due to accident; resident's vital signs immediately after the incident; description of what happened, why it happened, and what the causes were; individuals notified of the accident and when they were notified; and, if the resident was taken to the hospital or administered first aid.

Fall Assessment Tool

The assessment tool utilized at the long-term care facility to determine an individual's risk of falling is the Fall Assessment Tool. This tool was reprinted and distributed by medical supply company with permission of the Veterans Administration Medical Center in Gainesville, Florida. The Fall Assessment Tool was created by; Evelyn Berryman, RNC, MED; Dorothy Caskin, RN, MSN; Alan K. Jones, RN, MBA; Fay Tolley, RN, BSN; and, Jean MacMullen, RN, MSN. The medical supply company that distributes this assessment estimates that 700 nursing homes, sub-acute centers, and

hospitals in the mid-atlantic region currently utilize this Fall Assessment Tool. After a thorough literature review no validity/reliability estimates for this tool were found.

This screening tool is accomplished when the resident enters the facility and then is done on a quarterly basis. This screening tool consists of ten items. Each item is rated on a point system. The first item is the individuals' age (1). One point is given if the individual is 80 or more years old. Two points are given if he or she is 70-79 years of age. Three points is given if the individual is 69 years old or younger. This suggests that falls are associated with younger age groups of elder persons. The second item consists of mental status (2). No points are given if the individual is oriented at all times or comatose. Two points are given if he or she is confused at all times and four points are given if there is intermittent confusion. The third item is the day number of stay (3). No points are given if the individual has been at the facility over three days and two points are given for a stay up to three days. The fourth item deals with elimination (4). No points are given if the individual is independent and continent. One point is given if the person uses a catheter and/or colostomy. Three points are given if he or she eliminates with assistance and five points for an individual who is independent and incontinent. The fifth item is the history of falling within the past six months (5). If there is no history, no points are given. Two points are given if the individual has fallen 1 or 2 times before and five points is given if there is a more than two falls in the past six months. The sixth item deals with visual impairment (6). If the individual has visual impairments of any kind one point is given. The seventh item is concerned with confinement to a chair of bed (7). If the individual is not confined no points are given. Three points are given if he or she is confined. The eighth item deals with a drop in systolic blood pressure (8). Two points

are given if there is a 20mm Hg or more drop in systolic blood pressure between lying and standing. The ninth item is concerned with gait and balance (9). The individuals' gait is assessed while standing on one spot with both feet on the ground for 30 seconds without holding on to something, while walking straight forward, while walking through a doorway, and walking while making a turn. One point is given for each of the following: wide base of support; loss of balance while standing; balance problems when walking; decrease in muscular coordination; lurching, swaying or slapping gait; gait pattern changed when walking through a doorway; jerking or instability when making turns; and, use of assistive devices (cane, walker, furniture, etc...). The tenth and last item consists of medications (10). A list of medications is printed on the reverse side of the form. Staff is to identify how many medications the resident are taking at the date the assessment was conducted. No points are given if the person is taking no medication. If he or she is taking one medication one point is given. Two points are given if the individual is taking two or more medications. If a change of medication and/or dosage occurs within the past five days from the date of the assessment, an additional one point is given to the medication score. The last item on the Fall Assessment Tool is the total score. This is accomplished by adding up all ten scores. This will identify the fall risk score of that individual at the time the assessment was conducted. A score of ten or above indicates a risk of falling.

The Fall Assessment Tools are completed utilizing various sources of information. The assessment must be completed within 24 hours of the resident's admission to the facility. Upon admission, a meeting is held with the new resident, members of the resident's family, and administrative and clinical staff of the facility.

This meeting is conducted in partial to retrieve a detailed history of any and all safety concerns that the staff needs to process and prepare for as the resident transitions into the long-term care facility. This meeting also gives the admission registered nurse (RN), who completes the initial Fall Assessment Tool, accurate information to assess the resident's fall risk score. The age risk indicator was received from the resident's medical chart. The mental status risk indicator was determined by the family, the history of physical located in the medical chart, or by a visual inspection of the resident. The day number of stay indicator is only checked initially to determine if the resident has been residing in the facility less than 3 days. The elimination risk indicator is determined by the family or by conferring with the staff. The history of falls risk indicator is evident by the comments of the family, history of physical, or by past injuries. The visual impairment risk indicator was determined by the history of physical. Examples of visual impairments are glaucoma, cataracts that have not been removed, and macular degeneration. The confinement to a chair or bed risk indicator was evident by a visual inspection of the resident, report from the family, or confirmation from the staff. The drop in systolic blood pressure risk indicator was determined by a report of low blood pressure in the medical chart. The gait and balance risk indicator was conducted by a visual inspection of the resident while he or she ambulates. The medication section of the resident's medical chart determines the medicine risk indicator. After the initial fall assessment was conducted the responsibility of completing subsequent quarterly fall assessments was transferred to the RN who is Medical Data Sheet Coordinator.

Medical Records

Various demographic data, such as the residents' age as well as their admission date and death/release date from the facility was collected from the individual medical records.

Experimental Variables

Independent Variables

Fall Status. Fall status was determined based upon if a report of a fall exists between the quarterly dates individual fall assessment tools were conducted. If the evidence of an incident/accident report related to a fall exists within the quarterly dates the fall assessment sheet conducted prior to the reported fall has a fall status. A fall assessment with no reported falls within the quarterly dates is considered the non-fall status. A total of up to eight separate quarters was collected for the two-year period.

Fall Frequency. Fall frequency was determined by assessing the number of falls that exist between the quarterly dates individual fall assessment tools were conducted. The number of falls that occurred in each quarter was determined by a count of incident/accident reports related to falls of that particular quarter.

Dependent Variables

1. **Age.** The age of each individual was determined from the Age Item of the Fall Status Tool. The age status consists of one of the following: 80 or more years, 70-79 years old, or 69 years old or younger.

2. Mental Status. The mental status of each individual was determined by reviewing the Mental Status Item of the Fall Assessment Tool. The mental status consists of one of the following three categories: Oriented at all times, Confusion at all times, or Intermittent confusion.

3. Length of Stay. The length of stay variable was determined by reviewing the Day Number of Stay Item of the Fall Assessment Tool. The day number of stay status consists of one of the following two categories: Over 3 days or Up to 3 days.

4. Elimination Status - The elimination status of each individual was determined by reviewing the Elimination Item of the Fall Assessment Tool. The elimination status consists of one of the following four categories: Independent and continent, Catheter and/or Ostomy, Elimination with assistance, and Independent and incontinent.

5. Past History of Falls – This variable was determined by obtaining the History of Fall Score from the Fall Assessment Tool. The Past History of Falls consists of one of the following three categories: No history of falls, One or two falls, and Multiple falls.

6. Visual Impairment – The visual impairment status of each individual was determined by reviewing the Visual Impairment Item of the Fall Assessment Tool. The tool displays whether the resident had a visual impairment or not at the time the fall assessment was conducted.

7. Confined to Chair or Bed Status – The confinement status of each individual was determined by reviewing the Confinement to Bed or Chair Item of the Fall Assessment Tool. The tool displays whether the resident was confined to a bed or chair at the time the fall assessment was conducted.

8. Drop in Systolic Blood Pressure – The blood pressure drop status of each individual was determined by reviewing the Drop in Systolic Blood Pressure Item of the Fall Assessment Tool. The tool displays whether the resident had a condition of a 20mm hg drop of blood pressure when standing up from the sitting or supine position at the time the fall assessment was conducted.

9. Gait and Balance Status – The gait and balance variable was determined by identifying the subject's score for the Gait and Balance Item of the Fall Assessment Tool. The score was the sum of whether the individual has the following: Wide base of support; Loss of balance while standing; Balance problems when walking; Decrease in muscular coordination; Lurching, swaying, or slapping gait; Gait pattern change when walking through a doorway; Jerking or instability when making turns; or use of assistive devices (cane, walker, etc).

10. Number of Medications – The number of medications variable was determined by identifying the number of medications the individual was taking at the date the fall assessment tool was conducted. The medication must fall in the following groups: Alcohol Anesthetic; Antihistamine; Antihypertensives; Antiseizure/Antiepileptic; Benzodiazepines; Cathartics; Diuretics; Hypoglycemic agents; Narcotics; Psychotropics; Sedatives/Hypnotics; or other medicines that could cause falls.

Table 10 Fall predictor variables

Fall Predictor Variables	
Age (1)	1 Point = 80 or more years 2 Points = 70-79 years old 3 Points = 69 years old or younger
Mental Status (2)	0 Points = Oriented at all times or comtose 2 Points = Confusion at all times 4 Points = Intermittent confusion
Day Number of Stay (3)	0 Points = Over 3 days 2 Points = Up to 3 days
Elimination (4)	0 Points = Independent and continent 1 Point = Catheter and/or Ostomy 3 Points = Elimination with assistance 5 Points = Independent and incontinent
History of falls over past 6 months (5)	0 Points = No history of falls 2 Points = 1 or 2 falls 5 Points = Multiple falls
Visual Impairment (6)	0 Points = No visual impairment 1 Point = Visual impairment
Confined to Chair or Bed (7)	0 Points = Not confined 3 Points = Confined
Drop in Systolic Blood Pressure (8)	0 Points = No drop in blood pressure 2 Points = Drop of 20mm Hg or more between lying or standing
Gait and Balance (9)	1 Point given for each of the following: Wide base of support; Loss of balance while standing; Decrease in muscular coordination; Lurching, swaying, or slapping gait; Gait pattern change when walking thru doorway; Jerking or instability when making turns; or use of assistive devices
Medicines (10)	0 Points = No medicines on the list 1 Points = 1 medication on the list 2 Points = 2 or more medications on the list Add 1 point if change in medication or dosage in past 5 days
Total Score	A score of ten or above indicates a risk of falling

Analysis Plan

Multiple Regression Correlation

Multiple Regression Correlation (MRC) analysis was used to create models that allow us to model, one by one, each of the fall risk factors as a linear function of fall frequency (FF). Regression analysis was performed to describe and predict the relationship between the independent (predictor [X]) and dependent (response variable [Y]) variables. The response variables [Y] were fall frequency. The predictor variables [X] were (1) age, (2) mental status, (3) day number of stay, (4) elimination status, (5) past history of falls, (6) visual impairment status, (7) confined to chair or bed, (8) drop in systolic blood pressure, (9) gait and balance status, and (10) medication status.

For the description purpose, this analysis was used to explain which variables (predictor) and how they are related to fall frequency. For the prediction purpose, a statistical model developed by analyzing the relationship between response variables was utilized to predict fall frequency given the predictor variables.

The data was analyzed by utilizing techniques (scatter plot, residual vs. predicted, normal probability plot, hat matrix, Cook's D, and Variance Inflation Factor (VIF) – for the multicollinearity) available for evaluating assumptions (the assumption of a probabilistic process, functional specification of mean response, constant variance, normality assumptions). The predictor variables were selected by utilizing cp, step-wise selection, and backward elimination procedures for the dependent variable – fall

frequency (FF). Risk of falls was measured to build multiple regression models using predictor variables based on the literature review and the institutional data.

$$\text{FF} = (-)\text{Age} + (+)\text{Mental Status} + (-)\text{Day Number of Stay} + (+)\text{Elimination} + (+)\text{History of Falls} + (+)\text{Visual Impairment} + (+)\text{Confinement} + (+)\text{Drop in Systolic BP} + (+)\text{Gait} + (+)\text{Medications} + \text{Error}$$

After the equation is determined from the multiple regression, a model validation was conducted by computing an adjusted R^2 . This computation was completed with an independent sample data of 20 residents.

Logistic Regression

Logistic Regression utilizing the total score of the fall assessment tool was used to determine the probability that a fall will occur in the proceeding three-month time period. The dependent variable was either 1 for fall and 0 for non-fall. The independent variable is the total score of the fall assessment tool.

Logistic regression is used when the dependent variable we wish to predict is dichotomous: that is, it has only two values. These could be, and often are, coded as 0 and 1. As Neter, Wasserman, and Kutner (1989) pointed out, special problems arise when the dependent variable is dichotomous (binary):

1. There are non-normal error terms.
2. There are non-constant error variance.
3. There are constraints on the response function.

In logistic regression we directly estimate the probability of an event occurring (because there are only two possible outcomes for the dependent variable). For one predictor (X), the probability of an event can be written as

$$Pr ob(event) = \frac{1}{1 + e^{-(B_0 + B_1 X)}}$$

where B_0 and B_1 are the estimated regression coefficients and e is the base of the natural logarithms.

Statistical Analysis

A general test of the predictive validity of the Fall Assessment Tool was conducted. Simple linear regression analysis was performed to describe and predict the relationship between the independent (predictor (X)) and dependent (response variable (Y)) variables. The response variable (Y) was fall frequency. The predictor variable (X) was the total score of the Fall Assessment Tool.

In addition, ANOVA was performed to determine significant differences between predictor variables fallers and non-fallers.

Procedure

Data Collection

A method for measuring and evaluating Human Factors and Ergonomics (HFE) outcomes consists in the analysis of records, documents, and archives. Records of interest of HFE professionals may include medical records and records of accidents and injuries. The main strengths of this set of methods are that it allows a historical evaluation of the phenomenon under study. This historical analysis can link certain

events to outcome measures to examine the effectiveness of these events over time. The main weaknesses of these methods are limited information and lack of reactivity.

Using available historical institutional data, I collected fall-related incident data for an historical period of two years ranging from January 2000 when the long-term care facility opened until December 2001. This historical data consists of medical records related to the occurrence of falls during the two-year period. A unit of data consists of a fall assessment sheet and approximately 90 days that follow until the next fall assessment sheet is conducted. Particularly, the medical data of approximately 300 completed fall assessment tools conducted during the two-year period. Approximately 200 fall assessment tools were related to one or more falls. This was determined by identifying if any falls occurred within the date the fall assessment was conducted until the end of the quarter when a new fall assessment was conducted. Fall assessment sheets related to a subsequent fall were categorized in the fall status. Assessments with no reported falls were categorized in the non-fall status. The medical data consists of the fall assessment tools and incident/accident reports related to recorded falls. Also, demographic information including the residents' age, date of admission, and date of release, if applicable, was recorded.

RESULTS

Treatment of Data

The individual dependent variables and fall status were analyzed using a one-way analysis of variance (ANOVA). Bivariate regression was performed to describe the relationships between the dependent variables. Multiple regression analyses were performed utilizing step-wise selection to determine which dependent variables were statistically significant to the independent variable of fall frequency. Model validation was then conducted on an independent sample of residents by computing an adjusted R^2 . Logistic regression analyses were performed to determine the probability of a fall occurring based on the total score of a fall assessment. The statistical packages of JMP and SAS were utilized for all data analyses. Results were considered significant at $\alpha = 0.05$.

ANOVA Results

All dependent variable in this study were analyzed with a one-way repeated measures (score x fall status) analysis of variance. Summary of the ANOVA results are listed in Table 11.

Table 11 Summary of ANOVA Means and Standard Deviations.

Variables (unit)	Fall Assessments Mean (SD)	Non-Fall Assessments Mean (SD)
Age (score)	1.1791 (0.4581)	1.2143 (0.565)
Mental Status (score)	2.0000 (1.3817)	1.8095 (1.6415)
Day Number of Stay (score)	0.2687 (0.6872)	0.0952 (0.4311)
Elimination (score)	2.9254 (0.9335)	2.5714 (1.6696)
*History of Falling (score)	1.6716 (1.8618)	0.9524 (1.1677)
Visual Impairment (score)	0.6418 (0.4831)	0.7143 (0.4572)
Confined to Chair or Bed (score)	1.4478 (0.1834)	1.7143 (0.2316)
Drop in Blood Pressure (score)	0.0896 (0.4167)	0.0000 (0.0000)
Gait and Balance (score)	1.7612 (1.4574)	1.4048 (1.1699)
Medications (score)	1.6119 (0.7168)	1.3571 (0.8211)
*Total (score)	13.7015 (3.9003)	11.8095 (0.5938)

*Denotes significant difference between groups.

Age (score) Comparison

The results indicated no statistically significant difference ($F_{1,107} = 0.127, p = 0.735$) between fall related assessments and non-fall related assessments. Fall related residents had a slightly lower age score than non-fall related residents (Table 12 and Figure 9).

Table 12 Descriptive summary of age score on main effect fall status.

Fall Status	Count	Mean (score)	Std. Dev.
Fallers	67	1.1791	0.4581
Non-Fallers	42	1.2143	0.565

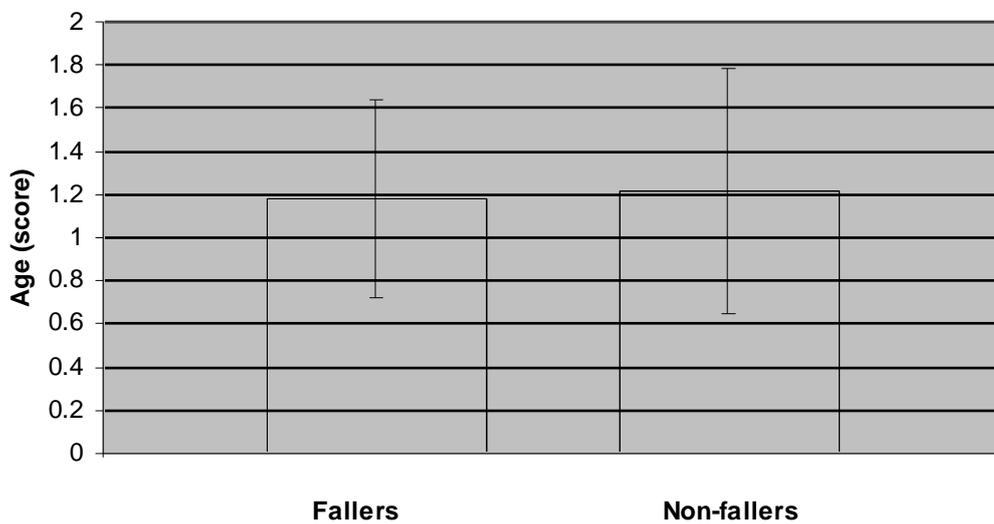


Figure 9 Fall status effect on age score.

Mental Status (score) Comparison

The results indicated no statistically significant difference ($F_{1,107} = 0.4238$, $p = 0.5333$) between fall related assessments and non-fall related assessments. Although not significant, fall related residents had a slightly higher mental status score than non-fall related residents (Table 13 and Figure 10).

Table 13 Descriptive summary of mental status score on main effect fall status.

Fall Status	Count	Mean (score)	Std. Dev.
Fallers	67	2.0	1.3817
Non-Fallers	42	1.8095	1.6415

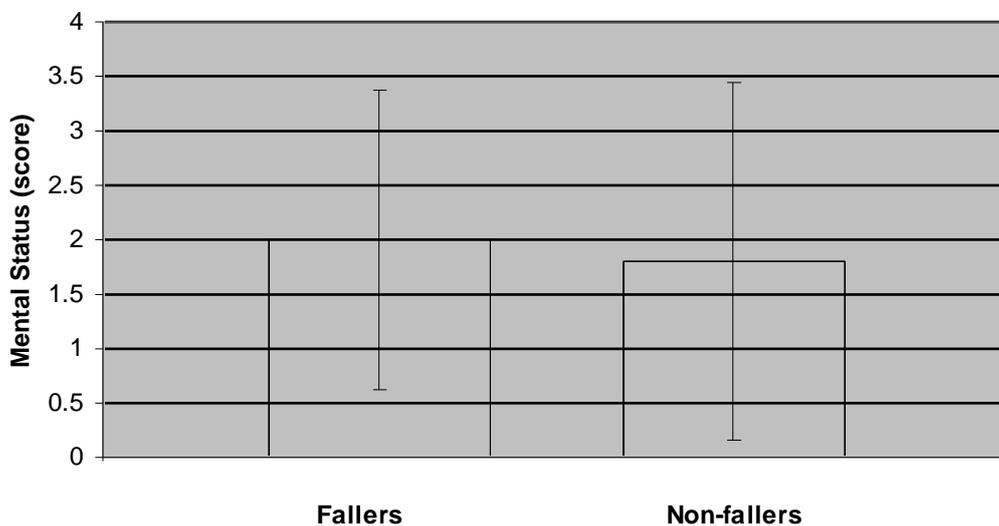


Figure 10 Fall status effect on mental status score.

Day Number of Stay (score) Comparison

The results indicated no statistically significant difference ($F_{1,107} = 12.142, p = 0.1084$) between fall related assessments and non-fall related assessments. Although not significant, fall related residents had a slightly higher day number of stay score than non-fall related residents (Table 14 and Figure 11).

Table 14 Descriptive summary of day number of stay score on main effect fall status.

Fall Status	Count	Mean (score)	Std. Dev.
Fallers	67	0.2687	0.6872
Non-Fallers	42	0.0952	0.4311

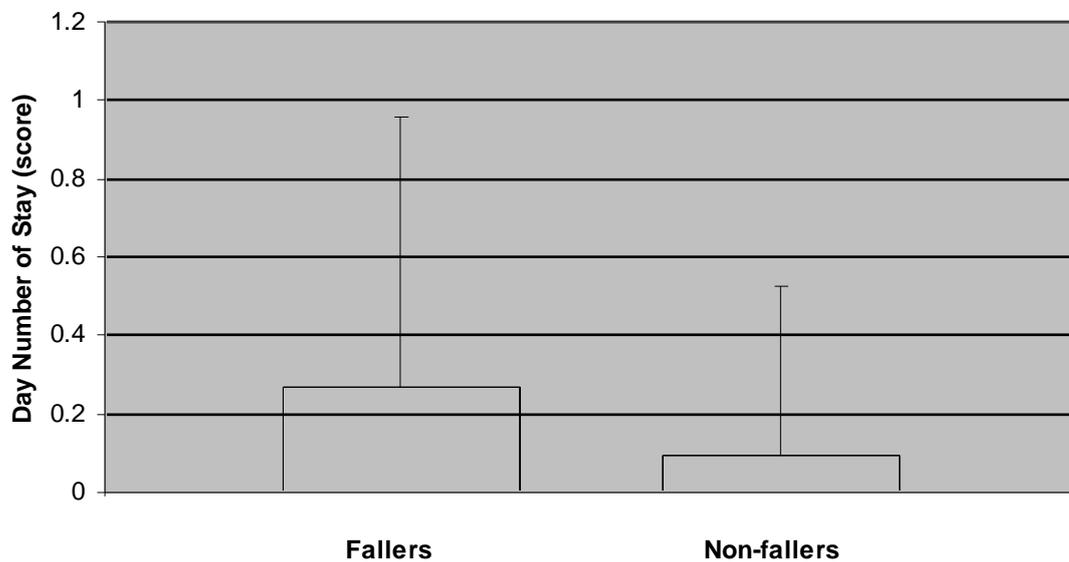


Figure 11 Fall status effect on day number of stay score.

Elimination (score) Comparison

The results indicated no statistically significant difference ($F_{1,107} = 1.1734$, $p = 0.2827$) between fall related assessments and non-fall related assessments. Although not significant, fall related residents had a slightly higher elimination score than non-fall related residents (Table 15 and Figure 12).

Table 15 Descriptive summary of elimination score on main effect fall status.

Fall Status	Count	Mean (score)	Std. Dev.
Fallers	67	2.9254	0.0952
Non-Fallers	42	2.5714	1.6696

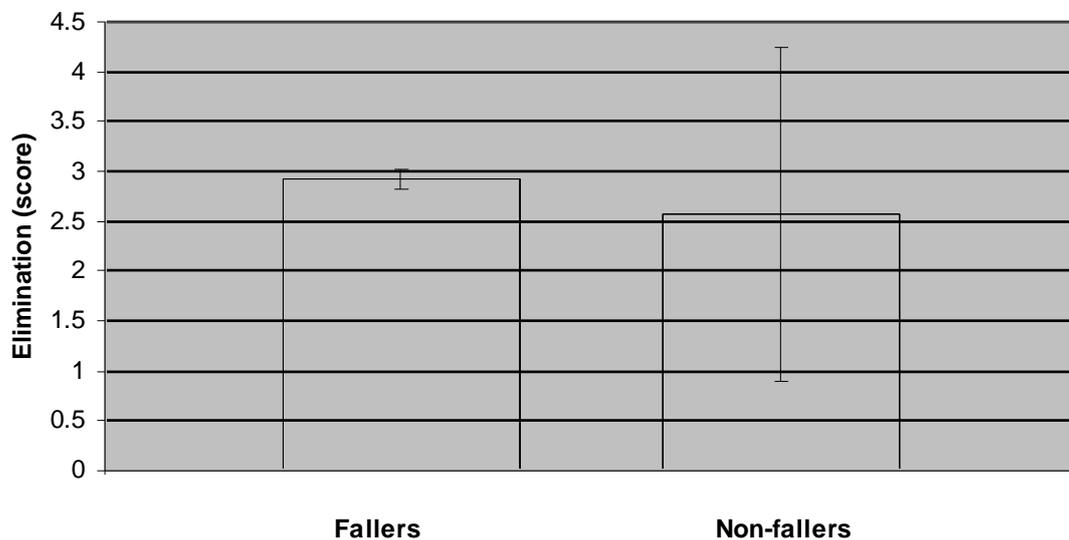


Figure 12 Fall status effect on elimination score.

History of falls over the past 6 months (score) Comparison

The results indicated a statistically significant difference ($F_{1,107} = 5.0199$, $p = 0.0147$) between fall related assessments and non-fall related assessments. Residents with a fall status had a higher history of falls over the past 6 months score than residents with non-fall related assessments (Table 16 and Figure 13).

Table 16 Descriptive summary of history of falls over the past 6 months score on main effect fall status.

Fall Status	Count	Mean (score)	Std. Dev.
Fallers	67	1.6716	1.8618
Non-Fallers	42	0.9524	1.1677

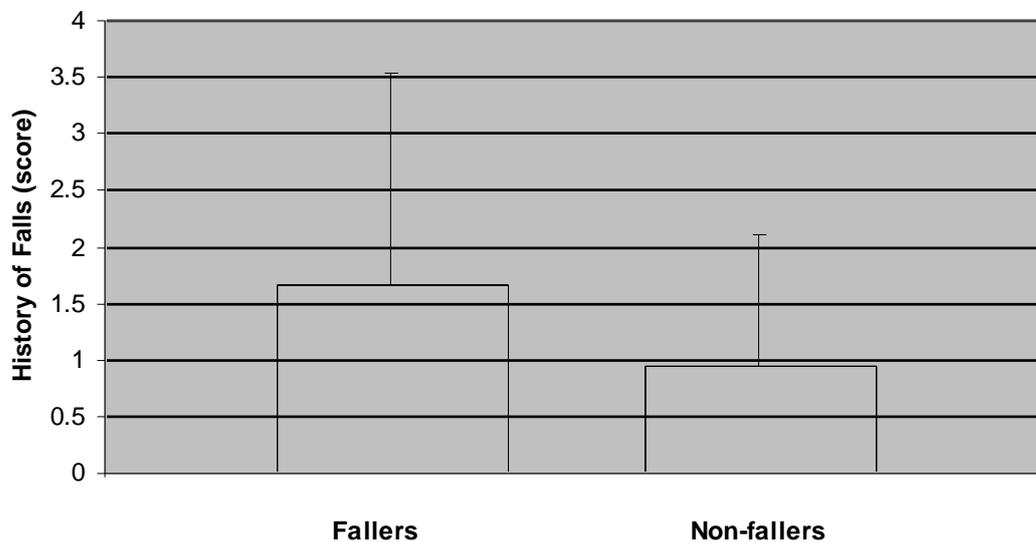


Figure 13 Fall status effect on history of falls over the past 6 months score.

Visual impairment (score) Comparison

The results indicated no statistically significant difference ($F_{1,107} = 0.6055$, $p = 0.4327$) between fall related assessments and non-fall related assessments. Fall related residents had a slightly lower visual impairment score than non-fall related residents (Table 17 and Figure 14).

Table 17 Descriptive summary of visual impairment score on main effect fall status.

Fall Status	Count	Mean (score)	Std. Dev.
Fallers	67	0.6418	0.4831
Non-Fallers	42	0.7143	0.4572

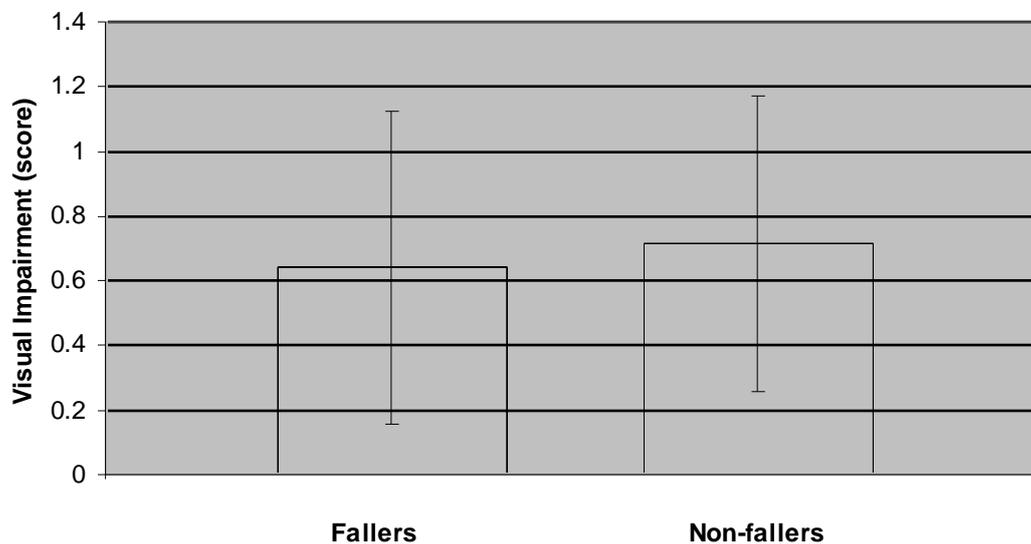


Figure 14 Fall status effect on visual impairment score.

Confined to Chair or Bed (score) Comparison

The results indicated no statistically significant difference ($F_{1,107} = 0.8137$, $p = 0.3697$) between fall related assessments and non-fall related assessments. Residents with fall related assessments had a slightly lower confinement score than residents with non-fall related assessments (Table 18 and Figure 15).

Table 18 Descriptive summary of confined to chair or bed score on main effect fall status.

Fall Status	Count	Mean (score)	Std. Dev.
Fallers	67	1.4478	0.1834
Non-Fallers	42	1.7143	0.2316

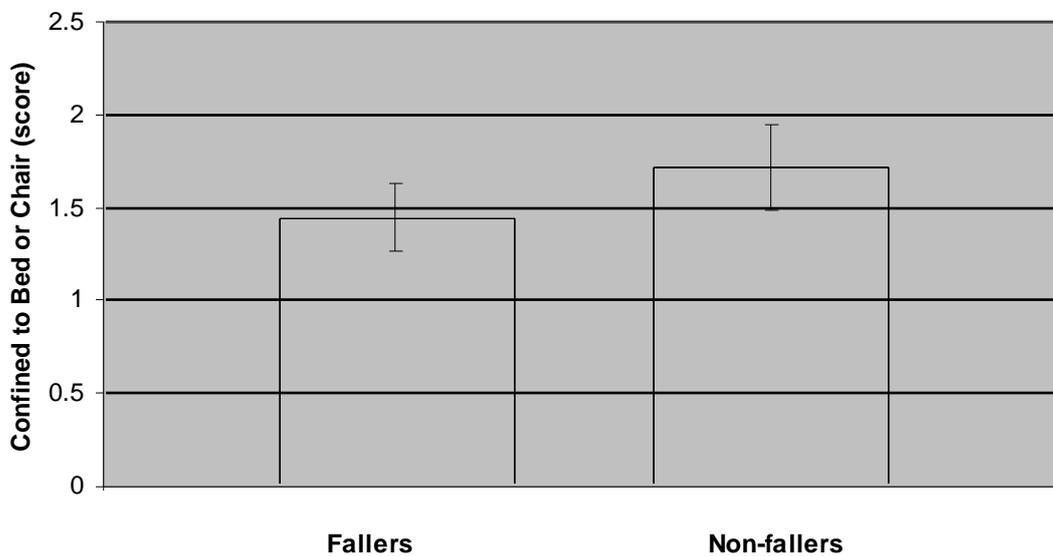


Figure 15 Fall status effect on confined to chair or bed score.

Drop in Systolic Blood Pressure (score) Comparison

The results indicated no statistically significant difference ($F_{1,107} = 1.9326$, $p = 0.0832$) between fall related assessments and non-fall related assessments. Although not significant, residents with fall related assessments had a slightly higher drop in systolic blood pressure score than residents with non-fall related assessments (Table 19 and Figure 16).

Table 19 Descriptive summary of drop in systolic blood pressure score on main effect fall status.

Fall Status	Count	Mean (score)	Std. Dev.
Fallers	67	0.0896	0.4167
Non-Fallers	42	0.0	0.0

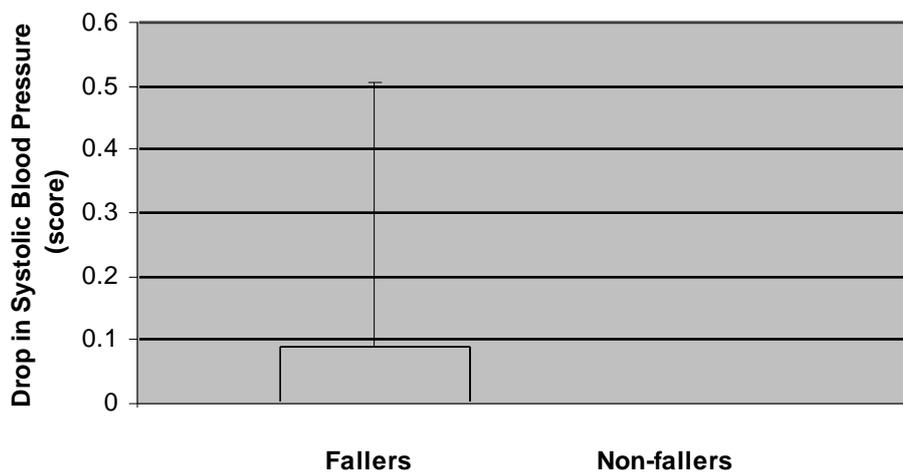


Figure 16 Fall status effect on drop in systolic blood pressure score.

Gait and Balance (score) Comparison

The results indicated no statistical significant difference ($F_{1, 107} = 1.7878$, $p = 0.1629$) between fall related assessments and non-fall related assessments. Although not significant, residents with fall related assessments had a slightly higher gait and balance score than residents with non-fall related assessments (Table 20 and Figure 17).

Table 20 Descriptive summary of gait and balance score on main effect fall status.

Fall Status	Count	Mean (score)	Std. Dev.
Fallers	67	1.7612	1.4574
Non-Fallers	42	1.4048	1.1699

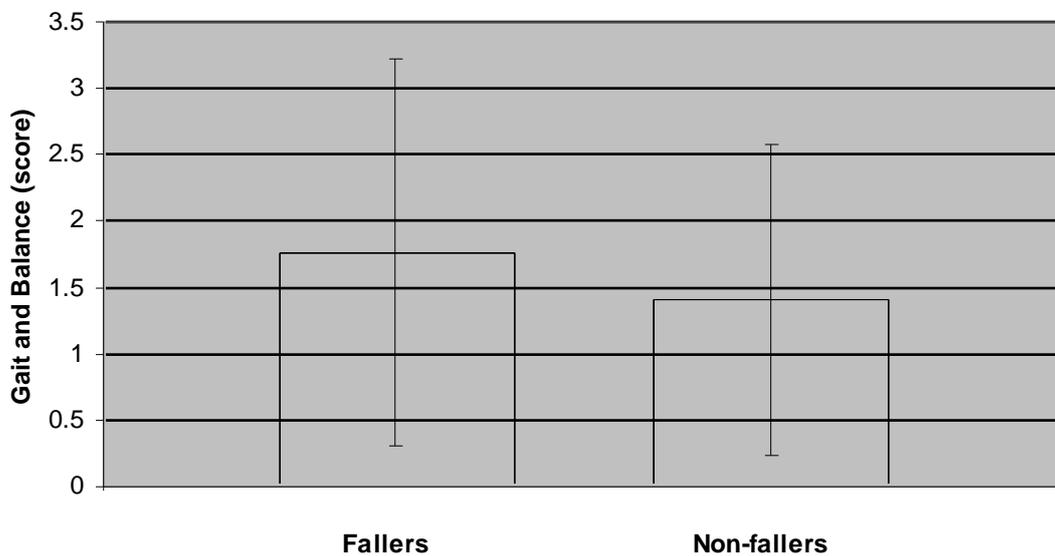


Figure 17 Fall status effect on gait and balance score.

Medicines (score) Comparison

The results indicated no statistical significant difference ($F_{1, 107} = 2.9135$, $p = 0.1021$) between fall related assessments and non-fall related assessments. Although not significant, residents with fall related assessments had a slightly higher medicines score than residents with non-fall related assessments (Table 21 and Figure 18).

Table 21 Descriptive summary of medicines score on main effect fall status.

Fall Status	Count	Mean (score)	Std. Dev.
Fallers	67	1.6119	0.7168
Non-Fallers	42	1.3571	0.8211

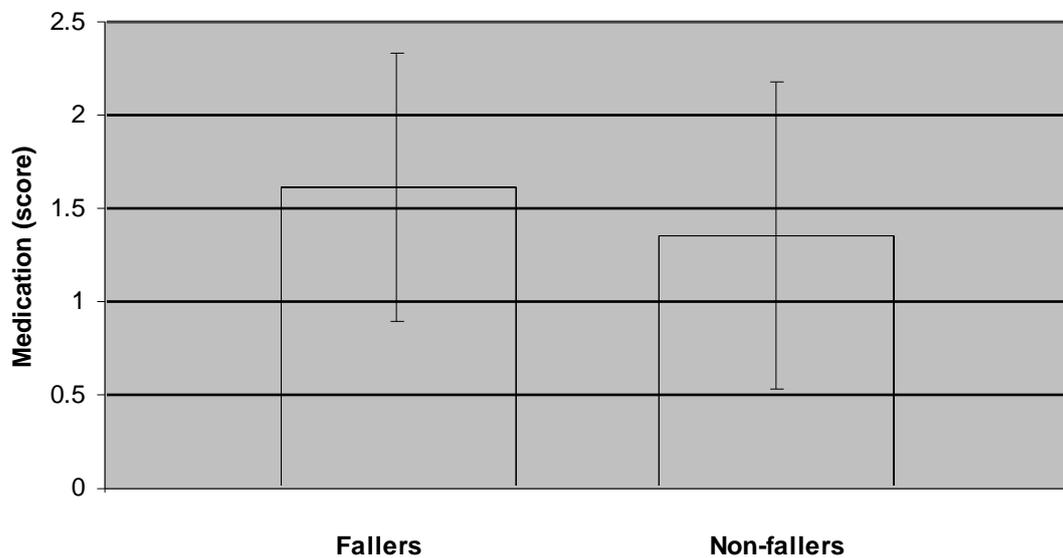


Figure 18 Fall status effect on medicines score.

Total (score) Comparison

The results indicated a statistically significant difference ($F_{1, 107} = 6.2404$, $p = 0.0135$) between fall related assessments and non-fall related assessments. Residents with a fall status had a higher total score than non-fall related residents (Table 22 and Figure 19).

Table 22 Descriptive summary of total score on main effect fall status.

Fall Status	Count	Mean (score)	Std. Dev.
Fallers	67	13.7015	3.9003
Non-Fallers	42	11.8095	0.5938

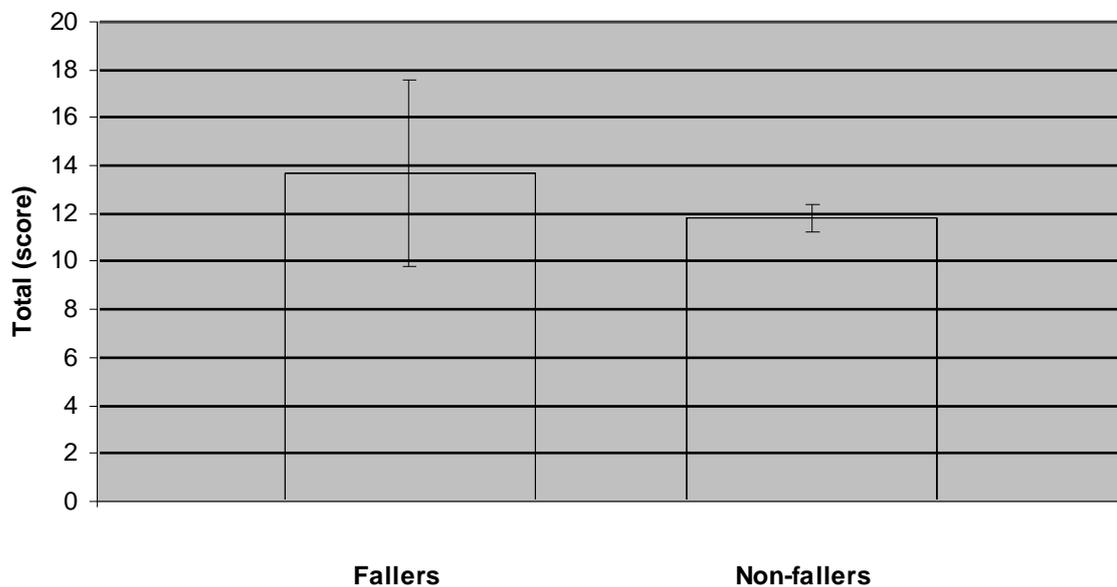


Figure 19 Fall status effect on total score.

Bivariate Regression

Bivariate regression was used to determine the relationships among all independent variables (fall frequency, and fall status) and dependent variables (age, mental status, day number of stay, elimination, history of falling, visual impairment, confined to chair or bed, drop in blood pressure, gait and balance, medications, and total scores). Summary of bivariate regression results are listed in Table 23.

Table 23 Summary of Bivariate Regression

Relationships	R ²
Fall Frequency and Age (score)	R ² = -0.05
Fall Frequency and Mental Status (score)	R ² = -0.01
Fall Frequency and Day Number of Stay (score)	R ² = 0.06
Fall Frequency and Elimination (score)	R ² = 0.06
Fall Frequency and History of Falling (score)	R ² = 0.24*
Fall Frequency and Visual Impairment (score)	R ² = -0.12
Fall Frequency and Confinement (score)	R ² = -0.05
Fall Frequency and Drop in Blood Pressure (score)	R ² = 0.13
Fall Frequency and Gait and Balance (score)	R ² = 0.12
Fall Frequency and Medications (score)	R ² = -0.1
Fall Frequency and Total (score)	R ² = 0.13
Fall Status and Age (score)	R ² = -0.03
Fall Status and Mental Status (score)	R ² = 0.06
Fall Status and Day Number of Stay (score)	R ² = 0.14
Fall Status and Elimination (score)	R ² = 0.1
Fall Status and History of Falling (score)	R ² = 0.21*
Fall Status and Visual Impairment (score)	R ² = -0.08
Fall Status and Confinement (score)	R ² = -0.09
Fall Status and Drop in Blood Pressure (score)	R ² = 0.13
Fall Status and Gait and Balance (score)	R ² = 0.13
Fall Status and Medications (score)	R ² = 0.16
Fall Status and Total (score)	R ² = 0.23*

* Denotes significant relationship between variables

Discussion of significant correlations

Fall Frequency and History of Falling (score)

The results indicated a statistically significant relationship ($F_{1, 108} = 6.6358$, $p = 0.0114$) between fall frequency and history of falling (score) with $R^2 = 0.24$. This significant positive relationship indicates that when the fall frequency for a three-month period increased the history of fall score increased.

Fall Status and History of Falling (score)

The results indicated a statistically significant relationship ($F_{1, 108} = 5.0199$, $p = 0.0271$) between fall status and history of falling (score) with $R^2 = 0.21$. This significant positive relationship indicated that when the fall assessment sheet had a fall status the history of fall score was high.

Fall Status and Total (score)

The results indicated a statistically significant relationship ($F_{1, 108} = 6.2404$, $p = 0.014$) between fall status and total (score) with $R^2 = 0.23$. This significant positive relationship indicated that fall assessments in the fall status tended to have a high total score.

Multiple Regression Correlation (MRC) analysis

The results were analyzed using multiple regressions based on the model present in the Method section (see page 70). An alpha level of .05 was used for all statistical tests.

The fall frequency (FF) was regressed on the linear combination of the ten predictor variables: X_1 (Age Score), X_2 (Mental Status Score), X_3 (Day Number of Stay Score), X_4 (Elimination Score), X_5 (History of Falling Score), X_6 (Visual Impairment Score), X_7 (Confined to a Chair or Bed Score), X_8 (Drop in Systolic Blood Pressure Score), X_9 (Gait and Balance Score), X_{10} (Medications Score). The MRC analysis utilizing the C(p) selection method identified a model containing four predictor variables: Day Number of Stay Score, History of Falls Score, Visual Impairment Score, and Gait and Balance Score. A significant regression equation utilizing/including these four variables account for 17% ($R^2 = 0.174$) of the variance in fall frequency (FF), $F(4, 429) = 22.65$, $p = <.0001$, adjusted $R^2 = 0.1667$.

Model Validation

It is crucial to obtain some measure of how well the regression equation will predict on an independent sample of data. In other words, to determine whether the equation has generalizability. To accomplish the models predictive power, 20 residents data not utilized in the original study was used to compute an adjusted R^2 . The model resulted in the following equation shown below:

$$FF = 1.02853 + (0.62970)(\text{Day Number of Stay}) + (0.49348)(\text{History of Falls}) - (0.80311)(\text{Visual Impairment}) + (0.16115)(\text{Gait and Balance})$$

Bivariate regression of the data set below resulted an adjusted R^2 of 0.265. The results are shown in Table 24 and Figure 20 below:

Table 24 Actual fall frequency versus predicted fall frequency.

Fall Frequency – Actual	Fall Frequency – Predicted
4	2.9
2	2.7
4	3.2
3	5.6
2	3.2
1	0.2
2	1.2
3	2.7
4	3.0
1	2.0
3	3.0
3	1.5
5	1.9
3	0.2
4	3.0
3	3.0
2	3.2
5	2.7
3	1.2
2	2.0

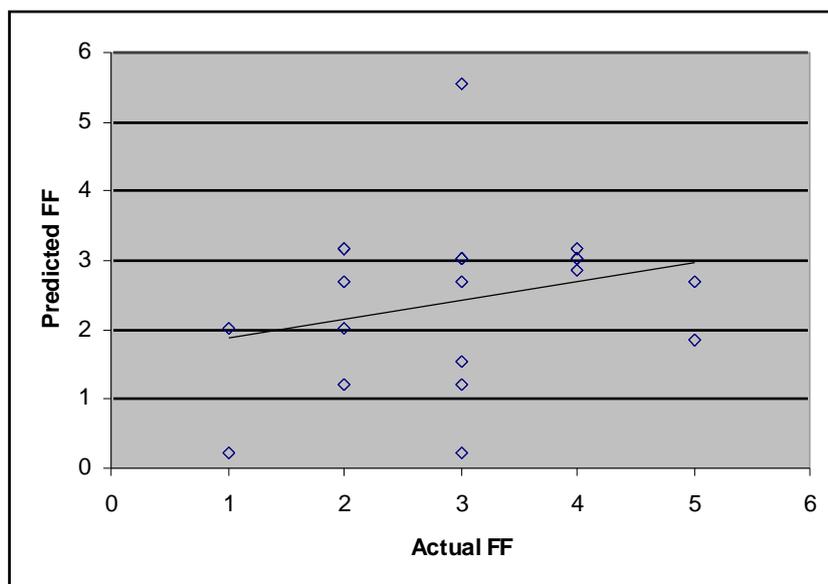


Figure 20 Scatter plot – actual versus predicted fall frequency

Logistic Regression analysis

The next analysis is utilizing the total score of the fall assessment tool to determine the probability that a fall will occur in the proceeding three-month time period. Logistic regression is used to determine the probability that a fall will occur. The dependent variable is either 1 for fall and 0 for non-fall. The independent variable is the total score of the fall assessment tool.

Logistic regression was used instead of the linear multiple regression, because the dependent variable (whether the fall assessment sheet is associated with subsequent reported falls) was binary with an outcome of 1 (yes) and 0 (no).

The logistic regression equation is as follows:

$$Pr ob(Fall) = \frac{Exp(-1.2364 + (0.1337)(TotalScore))}{1 + Exp(-1.2364 + (0.1337)(TotalScore))}$$

Table 25 and Figure 21 display the probability of a fall within the 90-day period following the date the fall assessment was conducted based on the total score of the assessment. Example – If a resident receives a total score of 10 on the fall assessment, there is a 53% chance that the resident will sustain a fall in the next quarter.

Table 25 Logistic Prediction by Total Score

Total Score	Logistic Prediction	Frequency of Total Scores
0	23%	0
1	25%	0
2	28%	0
3	30%	1
4	33%	2
5	36%	1
6	39%	2
7	43%	1
8	46%	4
9	49%	6
10	53%	10
11	56%	9
12	59%	15
13	62%	12
14	65%	8
15	68%	15
16	71%	10
17	74%	2
18	76%	3
19	79%	1
20	81%	1
21	83%	2
22	85%	1
23	86%	2
24	88%	1
25	89%	0
26	90%	0
27	91%	0
28	92%	0
29	93%	0
30	94%	0
31	95%	0
32	95%	0
33	96%	0
34	96%	0
35	97%	0

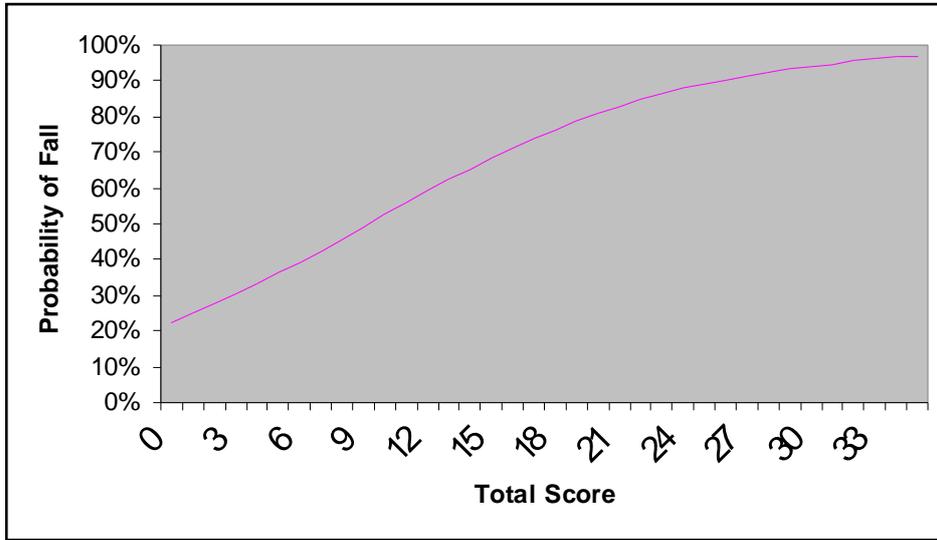


Figure 21 Logistic prediction of fall by total score

Discussion

Hypotheses and Historical Findings:

The first objective of the study was to investigate if predetermined fall risk variables were significantly higher with residents with a reported fall/falls than residents with no reported occurrence of falls. The first part of the discussion will explore predictor variables that were found to be statistically significant.

The results indicated that residents with a fall status had a significantly higher history of falls indicator score than the residents with a non-fall status. There was a statistically significant difference between fall related residents and non-fall related residents. The results of the current findings support the literature where previous studies have found a relationship between a history of falling and the subsequent occurrence of falls of elders residing in a long-term care facility (Prudham and Evans, 1981; Ruckstuhl et al, 1991; Keily et al, 1998; Kinn and Hood, 2001; Janken et al, 1986). Also, the results of the bivariate regression between a high history of falls indicator score and increased fall frequency indicated a significant relationship, which supports the literature.

Although the findings support the literature, a study found that the practice of assessing fall risk utilizing only one risk factor is inadequate as an intervention to reduce falls. This is due to the numerous clinical characteristics that contribute to the risk of falls in elderly persons. Therefore, fall risk assessment must take on a multifactorial approach (Effective Health Care, 1996). It is evident that the current design of the history of falls indicator score on the assessment tool being employed by the institution is effectively identifying who is at risk of falling based on the history of subsequent falls.

In summary, the history of falls predictor scores of fall assessments related to a subsequent fall/falls was significantly higher than the history of falls predictor scores of assessments with no occurrence of a fall. Therefore the current design of the history of falls risk variable on the assessment tool may accurately represent this particular risk factor of subsequent falls. It is not adequate to only consider this factor when determining an elderly individuals propensity to fall.

The next part of the discussion will address those fall predictor variables that were not statistically significant between a group of residents who had sustained a fall/falls and a group of residents with no reported fall. Nine of the ten fall risk variables utilized on the tool were found to have no statistical significance between the groups. These variables include age, mental status, day number of stay, elimination, visual impairment, confined to chair or bed, drop in systolic blood pressure, gait and balance, and medicines. The findings of each variable will follow.

The results indicated that the group of residents who had sustained a fall/falls had a slightly lower age indicator score than the group of residents with no reported fall. There was no statistically significant difference between the two groups of residents. Demographics proved that the average age for males who had sustained a fall/falls were older than the males who did not sustain a fall. In contrast, females who had a sustained a fall/falls were slightly younger than the females who did not sustain a fall. There was no statistical significant difference found between the chronological age of male and female non-fallers and fallers, male fallers and male non-fallers, and female fallers and female non-fallers.

The findings of this study support the literature that states that age as a risk factor for predicting fall risk has received conflicting results. One study found that older, frail individuals are more susceptible to an increased frequency of falls. Campbell et al. (1981) state the oldest elders form a quite frail group exposed to the risk of repeated falls because of impaired function. In contrast, Kalchthaler et al. (1978) found that younger, more alert elderly persons are more mobile and this increased activity, as well as, significant defects in judgment exposes them to greater risk.

The next fall risk variable was mental status. The results indicated that the group of residents with a reported fall/falls had a slightly higher mental status age indicator score than the group of residents with no reported fall. There was no statistically significant difference between the two groups of residents. Previous studies have found a relationship between an elder individuals mental status and the occurrence of falls (Rubenstein et al, 1996; Mosey, 1985; Hendrich et al, 1995; Janken et al, 1986; Campbell et al, 1981; Rodstein, 1964). However, bivariate regression indicated no significant relationship between the mental status score and increased fall frequency.

The third fall risk variable of the assessment tool was the day number of stay. The results indicated that residents with a reported fall/falls had a slightly higher day number of stay indicator score than residents with no reported fall. There was no statistical significant difference between the day number of stay indicator scores of the group of resident that had sustained a fall and the group of residents with no reported fall. This finding supports previous studies that found a relationship between a significant environmental change and the occurrence of falls with elders (Friedman et al, 1995; Leitch, Knowelden, and Seddon, 1964; Bunternghit, Lockhart, Wolstad, Smith, 1999;

Sehested and Severin-Nielsen, 1997). The results of the bivariate regression between the day number of stay indicator score and increased fall frequency indicated no significant relationship.

The next indicator on the tool was identifying an individual's elimination status. The results indicated that the group of residents with a reported fall/falls had a higher eliminations status indicator score than the group of residents with no reported fall. There was no statistically significant difference found between the two groups of residents. The literature review found a relationship associated with incontinence and with an increased fall risk. Upon review of the elimination fall risk predictor variable, it appears that fall risk is applied to elders who are both incontinent and independent, which combines incontinence with mobility. This may be due to the increased risk of an elder slipping on a slick, wet surface. Often a person slips on the floor after having an incontinent episode or falls trying to get to the bathroom in an attempt to avoid an incontinent episode. In this study however, the bivariate regression indicated no significant relationship between the elimination score and increased fall frequency.

Visual impairment was next on the fall assessment tool. The results of this study indicated that the group of residents with a reported fall/falls had a higher visual impairment indicator score than the group of residents with no report of fall. The difference of the visual impairment score between the two groups was not statistically different. This finding does support the literature review where numerous studies found a relationship between an elder's visual impairment and the occurrence of falls (Guccione, 1993; Tinetti and Speechley, 1989; Goldman, 1986, Cohn and Lasley, 1985; Lundebjerg,

2001). Bivariate regression indicated no significant relationship between the visual impairment score and increased fall frequency.

The next variable was whether the resident was confined to a bed or chair. The results indicated that the group of residents who sustained a fall/falls had a lower confined to chair or bed indicator score than the group of residents with no reported fall. A statistically significant difference was not found between the two groups of residents. This finding does not support the literature review where a study found a relationship between an elder individual's non-ambulatory status and the occurrence of falls (Thapa et al, 1996). Bivariate regression indicated no significant relationship between the confined to a chair or bed score and increased fall frequency.

Drop in systolic blood pressure was the next item of the fall assessment tool. The group of residents who had sustained a fall/falls had a higher drop in blood pressure indicator score than the group of residents with no reported fall. There was no statistically significant difference between the two groups of residents. This finding supported the literature review where previous studies found a relationship between a drop in systolic blood pressure and the occurrence of falls with elders (Guccione, 1993; Tinetti and Speechley, 1989; Rubenstein et al, 1996; Campbell et al, 1981; Ooi et al, 2000). The results of the bivariate regression between the drop of blood pressure indicator score and increased fall frequency indicated no significant relationship.

The next fall risk factor was the assessment of a resident's gait and balance status. The group of residents who had sustained a fall/falls had a higher gait and balance indicator score than the group of residents with no reported fall. The difference in score between the two groups was not found to be statistically significant. This finding support

the numerous studies that found a relationship associated with gait and balance problems and an increased fall risk (Rubenstein et al, 1996; Winter et al, 1990; Imms and Edholm, 1981; Meserlian, 1995). Bivariate regression indicated no significant relationship between the gait and balance score and increased fall frequency.

The last item scored on the fall assessment is each resident's medication status. The results indicated that the group of residents who had sustained a fall/falls had a higher medications indicator score than the group of residents with no reported fall. No statistically significant difference was found between the two groups of residents. This finding supports the literature review where numerous studies found a relationship between particular medications and the occurrence of falls (Macdonald and Macdonald, 1982; Guccione, 1993; Rubenstein et al, 1996, Tinetti and Speechley, 1989; Lundebjerg, 2001). However, bivariate regression indicated no significant relationship between the medication use score and increased fall frequency.

One explanation for the lack of discrimination between the groups of residents may be due to the simplicity of the tool. For example, the scoring scheme for assessing drop in blood pressure as it relates to fall risk may not contain the sensitivity to identify specific blood pressure factors, such as autonomic dysfunction, hypovolemia, low cardiac output, parkinsonism, metabolic and endocrine disorders, fluid-volume depletion, decreased venous return, and deconditioning. It is difficult to overcome this, due to the complexity of elderly individuals and the limited time the long-term care staff have to complete fall assessments. It would be unethical to discourage fall assessment tools to be utilized by the current setting, but it is evident for the need of further research. Another explanation for the study findings is that the domains of the current fall risk assessment

tool may not accurately capture the factors that place a resident at increased risk for falls, resulting in inaccurate risk assessments, and in particular, low specificity.

In summary, the current method of assessing fall risk proved to be inaccurate. The group of residents who had sustained a reported fall/falls had a significantly higher history of falls score. The other nine fall risk predictors were not significantly different between the group of residents who had sustained a reported fall/falls and the group who had not sustained a reported fall. There may be various factors that affect the prediction of fall risk in this setting. These factors include the training/education of the staff tasked to perform the fall assessment. Another factor may be the psychometrics of the fall assessment design. The psychometrics include the scoring design of each factor, the weight of each factor in relation to the total fall risk, and level of the total score that currently defines a resident as a fall risk. The current method also overestimated the resident population at risk for falling.

The second objective of the study was to investigate if a combination of predictor variables could be utilized to predict fall frequency (number of times an individual will fall during the three-month period after a fall assessment is conducted). Identifying which predictor variables are highly correlated with increased fall frequency allows the long-term care staff a more specific area to focus their resources and attention to address the residents who fall numerous times each quarter.

Multiple regression was used to create a model that allowed us to model, one by one, each of the fall risk variables as a linear function of increased fall frequency. The backward elimination procedure was used to eliminate all risk factors except for four, including history of falls, visual impairment, day number of stay, and gait and balance,

which were statistically significant with increased fall frequency. The other six risk factors were dropped from the model either because they were not statistically significant with increased fall frequency or because the variable contributed nothing over and above what is being contributed by other variables that remain in the model.

It was determined that the model was not able to accurately predict fall frequency. The model depicted that as a resident's visual impairment score went down the fall frequency increased. This result contradicted the earlier findings that the group of residents who had sustained a reported fall/falls had a slightly higher visual impairment score than the group who had not sustained a reported fall. Therefore, the model as indicated by the multiple regression analysis may not accurately represent the predicted number of falls sustained by a resident in a 90-day period.

The last objective of the study was to investigate the probability of falling during a 90-day period by the total score a resident received on the fall assessment tool. Logistic regression was conducted to determine this probability. It was evident that most residents had received a total score of ten or more. This translated to assigning fall risk to all residents and overestimating the risk of falling. The regression displayed that by receiving a score of 10 gave a resident a 53% probability of falling. This appeared to state that there was a fifty-fifty chance that a resident would fall. This did not appear to give the staff member's definitive information to assigning fall risk. The total score of 10 may be set too low to provide a distinction between fallers and non-fallers.

Summary and Recommendations

In summary, this study focused on the fall predictor variables utilized to identify fall risk of residents at a local long-term care facility. The findings from this study

indicate that only one fall risk predictor variable (history of falling) was significantly different between residents with a reported subsequent fall/falls and individuals with no reported falls. The other nine fall predictor variables of the fall assessment displayed no statistical significant difference between groups of fallers and non-fallers residing in a long term care facility. The results indicated that the current method of assessing fall risk was not accurate and was unable to discriminate between resident populations who had sustained a fall and those that did not sustain a fall.

Various factors may affect the current method of assessing fall risk. The first factor includes the education/training provided to individuals tasked to complete the fall assessment sheet. There was no record of any formal training guide that accompanied the fall assessment tool. Inadequacies in education/training may affect the validity of the fall assessment tool and subsequently diminish the accuracy of the assessment.

The next factor may be various areas of design of the fall assessment tool. The literature has documented that the fall risk variables on the current fall assessment tool are factors related to increased fall risk. The first area of design of the tool is the psychometrics. This may include the psychometrics of the individual fall risk variables. The psychometrics of each variable may include the weight given to each fall risk variable in relation to the total score of the fall assessment tool and the scoring scheme of each fall risk variable. The other aspect of psychometrics of the tool is the total score. The current total score may not contain the sensitivity to accurately and consistently predict an individuals' fall risk.

In conclusion, the results of this study suggest that various factors of the current fall assessment practices, including the design of the current fall assessment tool and the

training/education of individuals performing the assessment, may have an affect on the fall assessment tools ability to distinguish between individuals who have sustained falls and individuals who have not had an occurrence of a fall. Further investigation of various aspects of the fall prediction assessment need to be explored with individuals who are representative of the current long-term care residents and those professionals that care for them. Also, engineering, management, and environmental controls must be addressed and instituted in long-term care facilities. These include floor surfaces, footwear, adaptive equipment, use of restraints, range of motion and strengthening programs, staff training, and institutional procedures.

Recommendations for future research

1. Methods of education/training personnel tasked to complete the fall assessment tool should be investigated to identify its importance in fall risk prediction.
2. Further research should be conducted to test fall risk assessment tools in long-term care settings.
3. Further investigation into the design and psychometrics of fall assessment tools with careful attention to the characteristics distinguishing fallers from non-fallers in long-term care settings.
4. The effects of significant environmental change, as it relates to increased fall risk, should be studied further to develop a better predictive environmental change indicator and management/environmental controls.
5. Further investigation into the effect of various disease processes on increased fall risk in long-term care settings.

6. Further investigation of other areas of fall risk, including gender differences and fear of falling to identify their importance in fall risk prediction.
7. Further investigation into the characteristics of non-fallers before they sustain a fall is needed to identify which personal characteristics had declined prior to the fall.

Limitations and Assumptions of the Study

A principal limitation in the study was the lack of control over the environment. Due to the fact that the data was historical in nature, there was a limitation in what type of data could be collected based on the procedures of the long-term care facility. It was found that due to various data missing or out of place, many residents were unable to be included in the historical research. Also, much of the detail needed to get a precise picture of how a fall occurred was left unaware either because the staff was not present at the time of the fall or that the resident was unable to give a precise reoccurrence of the fall secondary to his/her decreased cognitive status. Additionally, various RN's were the recorders of the data utilized in the study. This left the researcher no control on the method the data was collected. Each RN's capability of adequately assessing a resident was based on their position on the staff, past experience with the population, and training they received on the fall assessment tool.

Another limitation stemmed from the inability to locate any reliability/validity reports for the fall assessment tool after an extensive literature review. This left numerous unknowns about the design of the tool and its psychometrics.

The last limitation of this study was that it was conducted at only one long-term care facility. Each individual facility and clinical setting has its own dynamics. It would

be difficult to assume that the findings of this specific study could be representative of other long-term care facilities, clinical settings, or various fall assessment tools.

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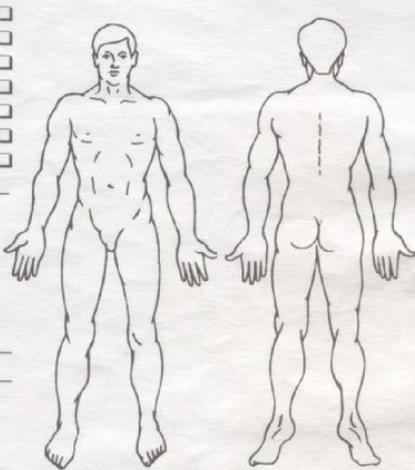
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APPENDIX A

Incident/Accident Report

INCIDENT/ACCIDENT REPORT

PERSON INVOLVED		(Last name)	(First name)	(Middle initial)	Adult <input type="checkbox"/>	Child <input type="checkbox"/>	Male <input type="checkbox"/>	Female <input type="checkbox"/>	Age _____	
Date of incident/accident	Time of incident/accident	A.M. <input type="checkbox"/>	Exact location of incident/accident							
		P.M. <input type="checkbox"/>	Resident's room <input type="checkbox"/> (No. _____)	Hallway <input type="checkbox"/>	Bathroom <input type="checkbox"/>	Other <input type="checkbox"/>	Specify _____			
RESIDENT <input type="checkbox"/>	Resident's condition before incident/accident									
List diagnosis if contributed to incident/accident:	Normal <input type="checkbox"/>		Confused <input type="checkbox"/>	Disoriented <input type="checkbox"/>	Sedated <input type="checkbox"/> (Drug _____ Dose _____ Time _____)	Other <input type="checkbox"/> Specify _____				
	Were bed rails ordered? Yes <input type="checkbox"/> No <input type="checkbox"/>		Were bed rails present? Yes <input type="checkbox"/> No <input type="checkbox"/>		If Yes, Up <input type="checkbox"/> Down <input type="checkbox"/>		Was height of bed adjustable? Yes <input type="checkbox"/> No <input type="checkbox"/>		If Yes, Up <input type="checkbox"/> Down <input type="checkbox"/>	
	Was a restraint in use? Yes <input type="checkbox"/> No <input type="checkbox"/>									
Physical restraint <input type="checkbox"/> Type _____			Chemical restraint <input type="checkbox"/> Specify _____							
EMPLOYEE <input type="checkbox"/>	Department				Job title			Length of time in this position		
VISITOR <input type="checkbox"/>	Home address						Home phone			
OTHER <input type="checkbox"/>	Occupation				Reason for presence at this facility					
Equipment involved <input type="checkbox"/>	Property involved <input type="checkbox"/> Describe						Was person authorized to be at location of incident/accident? Yes <input type="checkbox"/> No <input type="checkbox"/>			
Describe exactly what happened; why it happened; what the causes were. If an injury, state part of body injured. If property or equipment damaged, describe damage.				TYPE OF INJURY		Indicate on diagram location of injury:				
				1. Laceration <input type="checkbox"/>	2. Hematoma <input type="checkbox"/>	3. Abrasion <input type="checkbox"/>	4. Burn <input type="checkbox"/>	5. Swelling <input type="checkbox"/>	6. None apparent <input type="checkbox"/>	7. Other (specify below) <input type="checkbox"/>
										
Vital signs (if applicable) when the resident is supine and at one and three minutes after standing (If unable to stand, use supine to sitting position).				LEVEL OF CONSCIOUSNESS						
Vital Signs	Initial Incident Supine	One Minute After Standing	Three Minutes After Standing	_____						
Temperature				_____						
Pulse				_____						
Respirations				_____						
Blood Pressure				_____						
Name of physician notified				Time of notification _____ A.M./P.M.		Time responded _____ A.M./P.M.				
Name and relationship of family member/resident representative notified				Time of notification _____ A.M./P.M.		Time responded _____ A.M./P.M.				
Was person involved seen by a physician? Yes <input type="checkbox"/> No <input type="checkbox"/> If Yes, physician's name				Where		Date	Time	A.M. <input type="checkbox"/>	P.M. <input type="checkbox"/>	
Was first aid administered? Yes <input type="checkbox"/> No <input type="checkbox"/> If Yes, type of care provided and by whom				Where		Date	Time	A.M. <input type="checkbox"/>	P.M. <input type="checkbox"/>	
Was person involved taken to a hospital? Yes <input type="checkbox"/> No <input type="checkbox"/> If Yes, hospital name				By whom		Date	Time	A.M. <input type="checkbox"/>	P.M. <input type="checkbox"/>	
Name, title (if applicable), address & phone no. of witness(es)				Additional comments and/or steps taken to prevent recurrence:						
SIGNATURE/TITLE/DATE				SIGNATURE/TITLE/DATE						
Person preparing report				Medical Director						
Director of Nursing				Administrator						

APPENDIX B

Fall Assessment Tool

Fall Assessment Tool

Date: _____

I. Age: 1 point = 80 or more years 2 points = 70 -79 years old 3 points = 69 years old or younger Score: _____				
II. Mental Status 0 points = Oriented at all times or comtose 2 points = Confusion at all times 4 points = Intermittent confusion Score: _____				
III. Day Number of Stay 0 points = Over 3 days 2 points = Up to 3 days Score: _____				
IV. Elimination 0 points = Independent and continent 1 point = Catheter and/or Ostomy 3 points = Elimination with assistance 5 points = Independent and incontinent Score: _____				
V. History of falls over the past 6 months 0 points = No history of falls 5 points = Multiple falls 2 point =1 or 2 falls Score: _____				
VI. Visual Impairment = 1 point Score: _____				
VII. Confined To Chair or Bed = 3 points Score: _____				
VIII. Drop in Systolic Blood Pressure of 20mm Hg or more between lying or standing = 2 points Score: _____				
IX. Gait and Balance Assess resident's gait while: 1) Standing in one spot with both feet on the ground for 30 seconds without holding on to something; 2) Walking forward; 3) Walking thru a doorway; 4) Walking while making a turn. 1 point for each of the following: Wide base of support; Loss of balance while standing; Balance problems when walking; Decrease in muscular coordination; Lurching, swaying, or slapping gait; Gait pattern change when walking thru doorway; Jerking or instability when making turns; or use of assistives devices (cane, walker, etc) Score: _____				
X. Medicines From the medicines listed below, indicate how many the patient is currently Alcohol Anesthetic, Antihistamine, Antihypertensives, Antiseizure/Antiepileptic, Benzodiazepines, Cathartics, Diuretics, Hypoglycemic agents, Narcotics, Psychotropics, Sedatives/Hypnotics, or Other medicines that could casue falls 0 points = No medicines on the list 1 point = 1 medication on list 2 points = 2 or more medications on the list With a change of mediation and/or dosage in the past 5 days, add 1 point to the medication score Score: _____				
XI. Score A score of ten (10) or above indicates a risk of falling: Total Score: _____				
Signatures & Date: _____ _____				

Resident Name: _____	Physician: _____	Room #: _____
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APPENDIX C

Current Medical Chart Order

**Cove Current (Active) Chart Order
Kroontje Health Care Center
Blacksburg, Virginia**

FRONT OF CHART

I.D. Sheet with picture
Admission Face Sheet

RETENTION

Permanent
Permanent

ADVANCE DIRECTIVE

Advance Directive Acknowledgement
Living Will
P.O.A.

Permanent for
*Latest Revision**

CARE PLANS

Care Plans
Interdisciplinary Sign Off Sheet
Acute Care Plan – Pressure Ulcer
Acute Care Plan – Skin Tear
Acute Care Plan – URI
Social Services Care Plan
Family/Resident Care Plan Meeting Letter
MDS
New Admission Potential Problem List
w/Preliminary Care Plan

1 month w/Current in
Care Planning Book
(Same as above)
Initial + 15 months
Permanent

ASSESSMENTS

Braden Scale
Bowel and Bladder Assessment
Bowel and Bladder Training Schedule
AIMS Form
Fall Assessment Tool Guidelines
Neurological Assessment Flow Sheet
Restraint Acknowledgement Form
Restraint Information
Elopement Risk Assessment Sheet
Pain Management Log
Daily Transmitter Testing Log
Resident Lift Evaluation

Current For All

ADMISSION

*Permanent for all Unless
Otherwise Specified*

Admission Check List *(Leave on until complete. Not part of Permanent Chart)*
New Resident Orientation
Attending Physician Agreement (Nursing Facility)
Resident Authorization Acknowledgement
Insurance Card Forms
Clothing Inventory
Virginia Uniform Assessment Instrument
Resident Status Change Report
Bed Hold Admit Information
Bed Hold Agreement
Virginia Department of Medical Assistance Services MI/MR Supplemental Level I

HISTORY AND PHYSICAL

Most Recent

History and Physical
Discharge Summary

PHYSICIANS ORDERS

Physicians Orders *3 months by date*
Medical Standing Order Sheet *Permanent*
Standing Order for Admission of Influenza Vaccine *Original and Most Current*
Standing Order for Admission of Pneumococcal Vaccine *Original and Most Current*
Admission Orders and Plan of Care *Initial Permanent, Most Current for Others*
Consultant Pharmacist Drug Regimen Review *1 year*
Progress Notes
The Cove Individual Reviews *1 year*

PROGRESS NOTES

Progress Notes *1 year*
Consults (forms from other facilities) *1 year*

NURSING NOTES

Nursing Notes (Interdisciplinary Progress Note) *3 months*
Admission Nursing Assessment *Permanent*
Monthly Summary *3 months*

FLOW SHEET

Vital Signs and Weight Log	<i>1 Month on Chart. Current in Weekly Vital Notebook</i>
I&O Record	<i>Most Current</i>
Tube Feeding Record	<i>Most Current</i>
Diabetic Monitoring Flowsheet	<i>Most Current</i>

MEDICATION AND TREATMENT

	<i>2 Months Current Month in MARS Book</i>
MARS (after pulled from MARS notebook)	
Treatment Sheets (after pulled from MARS notebook)	
Behavior Monitoring Intervention Flow Sheet	
Weekly Pressure Ulcer Progress Report	
Weekly Skin Condition Report Form	<i>(Keep on chart until healed, and then thin)</i>
Monthly Care Record (same as ADL)	<i>2 Months on chart. Most current in ADL book</i>
Influenza Immunization Assessment Sheet	<i>Most Current</i>

LAB

Lab Reports (obtained after admission to the facility)	<i>6 Months</i>
Radiology Reports	<i>6 Months</i>
Resident Immunization Record	<i>Permanent</i>
TB Screening Evaluation	<i>Permanent</i>

REHAB AND THERAPY

*Initial Screening for Therapy Reports are
permanent. Thin others once discharged from treatment.*

Rehab Orders and Records
Genesis Eldercare Rehab Services
Occupational Therapy
Physical Therapy
Speech Therapy

SOCIAL SERVICES

Social Services Assessment	<i>Permanent</i>
Room Change Form	<i>Last 2</i>
Annual Resident's Rights/Grievance Procedure Review	<i>Most Recent</i>
Initial Social Services History	<i>Permanent</i>
Admission/Social Record	<i>Permanent</i>

DIETARY

Nutrition Assessment Form	<i>Permanent</i>
Long Term Care Quarterly Nutritional Assessment	<i>Permanent</i>
Hydration Check	<i>1 year</i>
Resident Diet Order Communication Form	<i>1 year</i>

ACTIVITIES

Initial Activities Assessment	<i>Permanent</i>
Beauty/Barber Shop	<i>Permanent</i>
Release for out of Facility Activities	<i>Permanent</i>

DENTAL

Oral Dental Assessment	<i>Permanent</i>
Dental Progress Notes	<i>Initial and Most Current</i>
Oral Health Exam and Recommendations	<i>Permanent</i>
Daily Oral Health Care Plan	<i>Initial and Most Current</i>

MISCELLANEOUS RECORDS

Release of Responsibility for Leave of Absence	<i>Last 2</i>
Transfer Forms	<i>Last 2</i>
Blood Test Consent Forms	<i>Permanent</i>
Influenza Vaccine Consent/Pneumonia Vaccine Consent	<i>Most Recent</i>
All other consents	<i>Permanent</i>
Copy of Discharge Instructions/Follow up Care	<i>Last 2</i>

HOSPICE RECORDS

All Hospice Records	<i>Permanent</i>
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*(Residents may revise their wishes regarding Advance Directives; the latest revision of instructions should be maintained on the record at all times).

Adopt date: 10/11/00
Revised: 10/26/00
Revised: 12/12/00
Revised: 01/16/02

VITA

Keith Allan Bishop

Upon graduation from High School in 1991, Mr. Bishop entered the United States Air Force as an Information Management Specialist. After completing three years of active duty military service, Mr. Bishop enrolled at Worcester State College. He earned a Bachelor of Science degree in May 2000 from the department of Occupational Therapy. From May 2000 to August 2001, Mr. Bishop was employed as a licensed Occupational Therapist in an array of clinical settings including sub-acute rehabilitation, adult psychosocial dysfunctions, and long-term nursing care.

Mr. Bishop has worked as a home health-care licensed Occupational Therapist, graduate teaching assistant, as well as, a graduate research assistant on several projects since 2001. Sponsors of these research projects have included the Locomotion Research Laboratory and the Toyota Motor Corporation. Mr. Bishop is a member of the American Occupational Therapy Association and the Human Factors and Ergonomics Society.