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MULTIFACTORIAL SCREENING FOR FALL RISK IN COMMUNITY-DWELLING OLDER ADULTS IN THE PRIMARY CARE OFFICE: DEVELOPMENT AND VALIDATION OF THE FALL RISK ASSESSMENT & SCREENING TOOL (FRAST)

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By

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ABSTRACT PAGE

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Abstract Title: Multifactorial Screening for Fall Risk in Community-Dwelling Older Adults in the Primary Care Office: Development & Validation of the Fall Risk Assessment & Screening Tool (FRAST)
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ABSTRACT

Background: Unintentional falls are an increasing public health problem as incidence of falls rises and the population ages. The Centers for Disease Control and Prevention reports that 1 in 3 adults aged 65 years and older will experience a fall this year; 20% to 30% of those who fall will sustain a moderate to severe injury. Physical therapists (PTs) and other primary care practitioners (PCPs) caring for older adults are usually engaged with these patients after the first injury fall and may have little opportunity to abate fall risk before the injuries occur.
Purpose: This manuscript describes the content selection, development and validation of a simple-to-administer, multifactorial Fall Risk Assessment & Screening Tool (FRAST). The FRAST is designed specifically for use in primary care settings by minimally-trained staff to identify those older adults with heightened fall risk requiring PCP intervention. The FRAST incorporates previously validated measures within a new multifactorial tool and includes targeted recommendations for intervention.
Methods: Development of the multifactorial FRAST used a 5-part process: identification of significant fall risk factors, review of best evidence, selection of items, creation of the scoring grid, and development of a recommended action plan. The FRAST was then validated via data collection across Montana in 2010 and included 99 subjects fitting specified inclusion/exclusion criteria: aged 65+, community-dwelling, independent ambulators (with or without assistive devices).
Results: FRAST has been developed and validated to assess fall risk in the target population. Many fall risk factors have been considered and 15 items selected for inclusion. FRAST includes four previously validated measures to assess balance, depression, falls efficacy, and home safety.
Conclusion: Fall risk for community-dwelling older adults is an urgent, multifactorial, public health problem. Providing PCPs with a very simple screening tool is imperative. FRAST was created and validated to allow for safe, quick, and low-cost fall risk screening by minimally-trained office staff with interpretation and follow-up provided by the PCP.

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REVIEW OF LITERATURE

Purpose: This manuscript describes the content selection, development and validation of a simple-to-administer, multifactorial Fall Risk Assessment & Screening Tool (FRAST). The FRAST (Figure 1) is designed specifically for use in primary care settings by minimally-trained staff to identify those older adults with heightened fall risk requiring PCP intervention. The FRAST incorporates previously validated measures within a new multifactorial tool and includes targeted recommendations for intervention. The FRAST is not intended to diagnose specific fall risk factors.

Background*:* One in three adults over the age of 65 will fall this year.[1;2] Of those that fall, 20%-30% will sustain significant injury.[3] The direct medical cost to our health care system for falls in older adults is staggering,[4] but the personal losses are far more significant. For many older adults, falls are the primary cause for loss of independent living, development of fear[5] and/or anxiety which oftentimes results in limitation of physical activity and/or loss of social contact. For many, falls bring life-changing injuries that eventually lead to death.[6]

Historically, many concerned professional healthcare provider groups have studied falls and identified single-dimension factors that are important in predicting fall risk. Physicians and physical therapists have created many tests that consider balance and physical mobility such as the Timed-Up-And-Go Test (TUG) [7], the Tinetti Test of Balance (Tinetti)[8], the Berg Balance Scale (BBS)[9] and others.[10] Pharmacists have recognized that polypharmacy significantly increases fall risk.[11] Occupational therapists have learned that hazards in the home are associated with higher fall risk and created various home assessment forms.[12] Social workers and psychologists have studied the negative effects of fear of falling[13], depression[14-16] and anxiety[17] on fall incidence and created a variety of questionnaire-based measures;[18] optometrists and audiologists are now recognizing the risks of poor vision, dizziness and hearing loss in older adults.[19] Recently, health care providers have begun to recognize the value and increased need for multifactorial fall risk assessments,[20] and primary care providers are realizing that fall prevention strategies can be incorporated into clinical practice.[21] However, each one-dimensional tool when used alone may miss a significant number of potential fallers.[22]

The sad truth is that older people most commonly do not receive fall prevention interventions until *after* they have fallen and – in most cases – until *after* they have also sustained an injury. In the United States, we usually only access health care when we have an illness or injury – which gives us a reimbursable diagnosis. This is especially true for those over the age of 65 with Medicare as their primary health insurer. According to the Center for Medicare Services (CMS) press release of June 25, 2010, prevention dollars are just now becoming available but are still few and far between.[23] Regardless, health care providers must begin to screen for fall risk as part of normal preventive health

care for older adults in the primary care office. Proactive steps to alleviate the identified risk factors must be instituted immediately in order to prevent falls. Physical therapists must play a key role in facilitating this change.

The primary care office needs a simple, multifactorial, but reliable fall risk assessment tool that can be administered by minimally-trained office staff and includes an action plan to effectively guide the primary care practitioner (PCP). The primary purpose of this literature review is to explore the current evidence in regards to each of the identified fall risk factors.

Approach to literature review: Statistical data from the Center for Disease Control (CDC) was first considered to target the research on identified fall risk factors. Searches were conducted in Hooked on Evidence, PubMed and Cochrane reviews between December of 2009 and July of 2010 for studies written in English and published in peer-reviewed journals. Search criteria included combinations of the following key words: falls, fall risk, fall prevention, older adults, community-dwelling, age, balance, physical activity, depression, fear of falling, medications, polypharmacy, vision, multifocal glasses, epidemiology, home modification, vestibular, dizziness, interventions, statistics, physical therapy, primary care, physician and rural. Due to the broad range of topics to be investigated and the multidisciplinary nature of the content, a meta-analysis was not performed. Abstracts and articles from peer-reviewed journals were read and then categorized by the fall risk(s) that they studied. Each article was reviewed for quality, size of study sample and relevance to the project. Whenever possible, only recent manuscripts studying community-dwelling adults over the age of 65 were included.

Overall, more than 425 manuscript abstracts were read; of those, over 300 were reviewed and catalogued and 170 were considered as significant sources for this manuscript.

***Results of Literature Review*:** Multiple factors have been shown to increase fall risk in community-dwelling adults over the age of 65; [20;22;24;25] these factors can be broken into 3 categories including:

- **Demographic** factors include age, gender, race, etc.
- **Internal factors** include considerations such as health, medications, physical activity, balance, psychosocial and cognitive issues and vision care.
- **External factors** include such things as environment, hazards in the home and yard, neighborhood accessibility (sidewalks, transportation, shopping), and access to medical care.

Fall risk factors found to be less significant, difficult to assess objectively by minimally-trained staff and/or not supported by more than two published studies were not included. When possible, factors were combined to limit the length of the FRAST. For instance, polypharmacy is utilized as an indirect measure of medical history.

Demographic Factors: Age (Figure 1, item 1): According to the CDC in 2005, considering all races and both sexes of Americans aged 65-85+, there were 3,284,671 unintentional injuries.[26] Of those unintentional injuries in older adults, there were 2,114,113 (64.4%) falls.[26] We know that 1 out of 3 adults aged 65 and over will fall each year in the United States.[27] Certainly then, one must consider an adult's age when assessing their risk for falls. However, beyond being over age 65, can we further delineate the risk? Yes. Stevens et al described in 2005 that the risk of being seriously

injured in a fall increases with age.[4] In 2001, the rates of fall injuries for adults 85 and older were four to five times that of adults aged 65 to 74.[28] Furthermore, nearly 85% of deaths from falls in 2004 were among people aged 75 and older[28] and people 75 and older who fall are 4-5 times more likely to be admitted to a long term care facility for a year or longer.[3] Therefore, based upon these findings in the literature, it was very important to assign an elevated risk (medium) for those aged 65-74 and assign a greater or heightened risk (high) level for those aged 75 and older.

Directions: For each question, please check the box with the response that best represents you today. Whenever your responses are in the high or medium risk column, we strongly encour age you to discuss the recommended actions in the last column with your health care provider. Please fill in your initials, year of birth and age on each page. Thank you.

RISK FACTOR	LOW RISK = 0	MEDIUM RISK = 1	HIGH RISK = 2	ACTION RECOMMENDED
1. As of today, my age is _____.	Below 65 years old.	Between 65 and 75 years old.	Over 75 years old.	Attending a fall prevention program may be recommended to lower your fall risk.
2. My gender is _____ .		Male	Female	
3. A fall is any event that led to an unplanned, unexpected contact with a supporting surface such as the floor. Have you fallen?	No, I have not fallen.	In the past six months, I have fallen only once and was NOT injured.	In the past 6 months I have fallen 2 or more times, OR In the past 2 years, I have fallen and been injured requiring medical attention.	People who have had falls or have balance issues are at greater risk for more falls. Your doctor may recommend a: 1. Full annual physical exam 2. Fall prevention program 3. PT[1] evaluation for balance 4. PT or OT[2] evaluation of home 5. PT or podiatrist evaluation of footwear 6. Home fall alarm system
4. How would you describe your daily physical activity level? This might be walking, an exercise class, working out at the gym, swimming or dancing. When you are active, your heart works harder and your breathing gets deeper.	I am engaged in exercise or moderate physical activity 30 min/day, 5-7 days/week.	I am engaged in exercise or moderate physical activity at least 15 min/day, 2-4 times/week.	I am generally not active and do not do exercise that makes my heart rate or breathing increase.	Your doctor may feel that you should begin to exercise, but before you do, s/he might suggest a physical therapy referral to design a safe, individualized program that meets your needs safely.
5. How many prescription medicines do you take?	I have not been prescribed any medications.	I currently take at least one but not more than 4 prescription medications.	I currently take 5 or more prescription medications.	It is recommend that 1. Your doctor and/or pharmacist review your medications carefully 2. You use a weekly pill dispenser to avoid mistakes 3. You keep a list of your medicines
6. In regard to your eye care, please choose the best answer:	I see my eye doctor at least once/year.	I have seen an eye doctor once in the past 2 years.	I have not seen an eye doctor in the past 3 years.	Your doctor may refer you to an eye doctor for an annual exam and to discuss vision care options.
7. In regard to your glasses or contacts, please choose the best answer	I do not wear glasses or contacts.	I wear single-vision glasses or contact lenses (not bifocals or progressive lenses).	I wear multifocal lenses or contacts.	Your doctor may refer you to an eye doctor for an annual exam and to discuss vision care options. Please Note: Multifocal lenses (bifocals, progressive lenses, etc.) may increase fall risk.
8. Do you ever get dizzy?	No, I do not have any problem with dizziness.	I occasionally feel dizzy if I get up out of bed fast or when I am ill.	Dizziness is a problem for me.	Your doctor can check to see if your blood pressure drops when you stand up or if there are other medical problems. He/she may also recommend PT, audiologist or ENT[3] referral.

RISK FACTOR	LOW RISK = 0	MEDIUM RISK = 1	HIGH RISK = 2	ACTION RECOMMENDED
9. In the past week, have you used any assistive devices (AD) to walk? Assistive devices include canes, quad canes, and/or walkers.	No I don't have an assistive device or need one to walk safely. My doctor has not recommended that I use an assistive device.	I have and correctly use an assistive device that was prescribed for and fit to me. A therapist taught me how to use it correctly.	I use an assistive device but no one has taught me how to use it. OR I lean on furniture and walls as I walk by.	If you use an assistive device (AD) or need one, your doctor might want you to see a PT if: 1. You need to begin to use an AD. 2. Yours was not fit for you by a PT. 3. You have not been taught how to use it properly. 4. It has been a long time since a PT fit it and it may now need updating.
10. Choose the group of statements that best describes your overall risk-taking behaviors:	I am careful and seldom take risks. I am not easily distracted. I do not hurry to answer the phone.	Sometimes I do things that later I (or others) think may have been risky.	I refuse to limit myself as I age. I might climb up a ladder or learn a new risky sport.	Remaining active is critical, but sometimes taking risks has greater implications as we age. Discuss your answers with your health provider and seek their advice.
11. In the past week, how socially active have you been?	I come and go often and see others 5-7 days/week and/or I am married.	I see other people 2-4 days/week.	I see other people less than 2 times/week.	Your doctor might advise you to visit with the service coordinator at your Area Agency on Aging and/or Senior Center to learn about programs to assist you.
12. Please carefully complete the Home Safety Checklist on pages 4 and 5. When you finish, count the total check marks that you made.	I have fewer than 6 check marks.	I have 6-11 checks.	I have more than 11 checks.	It appears that your home is not as safe as it might be. It is important that either an OT or PT make a home visit and help you consider modifications that would make your home safer for you.
13. Please complete the Modified Falls Efficacy Scale on page 6. What is your average score? (Add up the score on each of the ten items and then divide the sum by 10)	My average score is 8, 9 or 10.	My average score is between 3 and 7.	My average score is 0, 1 or 2.	This score might indicate that your concern about falling is causing you to limit your activities. Your doctor may recommend any or all of the following: 1. Group fall prevention program. 2. Physical therapy referral. 3. Referral to a counselor/social worker.
14. Please complete the Mood Scale on page 7 and then score it following the directions on the bottom	I scored between 0 and 5 on the mood scale.	I scored 6,7 or 8.	I scored 9 or above.	Your doctor may want to discuss a number of options with you to help improve your mood.
15. Please let the receptionist know that you are ready to take your timed-up-and-go test (TUG).©	My TUG score was 7 seconds or less.	I scored between 8-13 sec. on my TUG test.	My TUG test score was greater than 13 sec.	The TUG test is a test for balance and mobility. If your time is longer, your doctor may want to have you see a physical therapist.
TOTAL SCORE			___ out of 30	

Scoring: 0-4 = low fall risk; 5 and above: recommend review with your PCP.

Test reviewed and discussed with client. The following actions have been suggested: _____

Total Score/ Fall Risk Rating: ___ out of 30 Fall Risk: Low Risk or High Fall Risk

Printed Name/Signature/credentials/Date: _____

Your Initials: _____Year of Birth: _____ Age Today: _____

[1]Physical Therapist, [2]Occupational Therapist, [3]Ear, Nose & Throat doctor

Figure 1: FRAST

Demographic Factors: Gender (Figure 1, item 2): Although men are more likely to die from a fall, women are 67% more likely to have a nonfatal fall injury.[29] In 2003, about 72% of older adults admitted to the hospital for hip fractures were women.[30] In studying unintentional, nonfatal, injury falls, it was found that about 70% of fallers were women.[21] Although, men are more likely to die from a fall, women are more likely to sustain a hip fracture. On the basis of these findings, being a woman will impart a high fall risk on FRAST and being a man will impart a medium fall risk.

Internal Factors: History of Falls (Figure 1, item 3): Literature on falls quickly reveals the high risk of falls in people with a history of falls.[31-37] Articles discussing other risk factors include statements such as "*previous falls*, strength, gait and balance impairments and medications are the strongest risk factors for falling."[26] Among the general population of seniors, the factors strongly associated with risk of falling *include a history of prior falls*.[38] Many patients do not report falls to their doctor for a number of reasons spanning from not having time to discuss the issue, memory loss,[39;40] embarrassment, not feeling it was important or being fearful of being asked to give up independent living. Likewise, busy practitioners fail to inquire about previous falls.[41] Discerning a complete fall history is of paramount importance in assessing fall risk and necessary fall prevention strategies. In a literature review and meta-analysis on fall risk factors performed in 2010, Deandrea et al found that the strongest associations were found for history of falls for all fallers.[38] Sai et al studied fall predictors in the community-dwelling elderly in 2010; their findings also concluded that significant predictors of being a faller were a history of falls at baseline.[42] Of note, in Shumway-

Cook's studies, a faller is defined as a person who self-reports two or more falls within the past 6 months and a fall was defined as any event that led to an unplanned, unexpected contact with a supporting surface.[7;33] In order to provide consistency with the evidence, we will use these criteria in the FRAST as well.

Based upon the evidence of increased fall risk associated with a history of previous falls, fall history will be included in the FRAST. A single fall within the past year without injury will impart a medium level of risk and two or more falls within the previous 6 months (i.e. recurrent falls) or a single fall with injury will impart a high fall risk.

Internal Factors: Physical Activity (Figure 1, item 4): Medicine has been well aware for many years of the protective influence that daily physical activity exerts upon our overall health and mental well-being. Increased physical activity is known to lead to greater muscular strength, improved mood, greater social interaction, improved cardiovascular health, greater cognitive power and longevity; [43-47] but what about having a direct positive impact on the fall risk of older adults? Kruger et al conducted a detailed analysis of the Behavioral Risk Factor Surveillance system data from 2005. They concluded that regular physical activity is an important means to maintaining independence because it substantially reduces the risk for developing many diseases, contributes to healthy bones, muscles and joints and can reduce the risk for falling.[48] In Skelton and Beyer's review published in 2003, the authors found that in younger, community-dwelling fallers, multifactorial group interventions including targeting of balance, strength, power, gait , endurance, flexibility, co-ordination and reaction may be more effective than home based exercise.[49] A Cochrane review published by Howe et al

in 2007, stated that for the 34 included studies (2883 participants), statistically significant improvements in balance ability were observed for exercise interventions compared to usual activity.[50] Gill et al stated in their 2009 article that male veterans who reported being less active than their peers were 1.42 to 2.46 times more likely to fall than those who reported being about as or more active than their peers.[51] Deshpande et al found that in an elderly population, activity restriction associated with fear of falling is an independent predictor of decline in physical function.[13;15;52] In considering clinical trials of Tai chi and Qigong (TC & QG) in older adults, Rogers et al found significant improvements in clusters of similar outcomes indicating interventions utilizing TC & QG may help older adults improve physical function and reduce blood pressure, fall risk and depression and anxiety.[53] The American College of Sports Medicine[54] and the American Heart Association[55;56] both recommend that adults over the age of 65 exercise moderately 30 minutes/day, 5-7 days/week.

Many studies have documented the interrelated findings of fear of falling and self-imposed limitations on physical activity.[5;13;15;52] It is an understandable "chicken and egg" issue where one component naturally increases the other. Although we will discuss them as separate risk factors, please remember they (and many others) are intimately interconnected in the older adult.

A decrease in physical activity is associated with an increased fall risk[13;48;57-60] and, conversely, an increase in physical activity is associated with a decreased risk of falls in community-dwelling older adults.[43-47;61] Despite the small increase in fall risk associated with some types of physical activities, the overall benefits are far greater.[46;47;62] Based upon these findings, the FRAST will include a self-assessment of

physical activity level as part of determining overall fall risk and will advise participation in age-appropriate exercise programs for sedentary individuals. These recommendations are based upon the American College of Sports Medicine's Current Comments on Exercise and the Older Adult.[54]

Internal Factors: Polypharmacy (Figure 1, item 5): Many physiologic changes as we age affect both pharmacokinetics and pharmacodynamics which increases the inherent risks imparted by polypharmacy (defined as more than four prescription medications taken simultaneously).[63] In older adults, fall risk increases with increase in medication use.[64] A systematic review reported in 2007 by Hartikainen, Lonnroos and Louhivouri[11] concluded that central nervous system (CNS) drugs, especially psychotropics, seem to be associated with an increased risk of falls. Huang et al also found that the prescription of four or more medications was associated with an increased risk of falls.[65] While specifically studying cardiac and analgesic drugs, Leipzig et al reported that older adults taking more than three or four medications were at increased risk of recurrent falls. As a result of the incidence of falls and their consequences in this population, programs designed to decrease medication use should be evaluated for their impact on fall rates.[66] These results are echoed in many other recent studies.[11;21;64;65;67-72] Even the use of over-the-counter non-steroidal anti-inflammatory drugs (NSAIDs) has been shown to increase fall risks for older adults.[70]

The pharmacy profession has certainly responded to the need to critically assess polypharmacy in older adults.[65;67;73] Gallagher and O'Mahony have created and validated the Screening Tool of Older Persons potentially inappropriate Prescriptions[74] to be utilized with the Screening Tool to Alert doctors to Right. The combination of the two

instruments is designed to afford a comprehensive appraisal of older patients medications, i.e. errors of prescribing commission could be identified at the same time as errors of omission.[74] Pharmacist-led medication reviews have been studied and proposed as an effective adjunct to routine health care[73] and will be included in the FRAST recommended intervention for identified polypharmacy risk.

Based upon the findings of these studies, the FRAST will include use of 1-4 prescription medications to impart medium fall risk and the use of five or more medications to impart high fall risk. Although this is an effective screening method, careful considerations of medication interactions and specific drug use must be referred to either the pharmacist or PCP for consideration. This recommendation will be made on the FRAST interventions.

Internal Factors: Vision: (Figure 1, items 6 and 7): As we age, many adults have opted to use multifocal glasses and/or contact lenses to assist with the need for both reading and far vision lenses. As we mature into our 60's, these lenses markedly increase our fall risk. Lord found that multifocal glasses may add to fall risk because near-vision lenses impair distance-contrast sensitivity and depth perception in the lower visual field.[75;76] Studies published in 2007 specifically studied the effect of multifocal glass lenses on the stepping and toe clearance of older adults. Johnson et al concluded that because of increased within-subject variability in vertical toe clearance when wearing multifocal spectacles, elderly individuals may be at greater risk of falling when negotiating steps and stairs[77] Abdelhafiz and Austin recommend that measurement of visual functions such as visual acuity, contrast sensitivity and depth perception may identify older people at risk of falls and hip fracture.[78] They further added that

interventions may have the potential of improving visual function and preventing falls in older people.[78]

In a recent study of patients over the age of 65 having sustained hip fractures, Grue et al found that patients with hip fractures frequently have hearing, vision and combined impairments.[79;80] Dayhew and Lord in 2001 also concluded that impaired vision is an important and independent risk factor for falls. Adequate depth perception and distant-edge contrast sensitivity appear to be important for maintaining balance and detecting and avoiding hazards in the environment.[75;76] In addition, they found that recurrent fallers had decreased vision on all visual tests. These findings were echoed again by Abdelhafiz and Austin in 2003 stating that visual impairment, although not routinely assessed, is an important risk factor for falls and hip fracture in older people.[78] Based upon these findings, the FRAST will assign a higher fall risk for those with vision problems and/or wearing multifocal lenses (glasses or contact lenses).

Internal factors: Dizziness: (Figure 1, item 8): Self-reported dizziness is a concern for fall risk in adults over the age of 65. Dizziness is a lay-term describing many symptoms (lightheadedness, vertigo, etc.) with a wide variety of etiologies (vestibular, orthostatic hypotension, hypoglycemia, CNS dysfunction, etc.). In 2009, Ekwall et al published results which stated dizziness was associated with an increased risk of falling. Falls in the last 3 months were reported in 31% of the subjects with dizziness compared to 15% among those without ($p<0.001$).[61] In another study by Agrawal et al, it was found that from 2001 through 2004, 35.4% of US adults aged 40 years and older (69 million Americans) had vestibular dysfunction. Odds of vestibular dysfunction increased significantly with age and participants with vestibular dysfunction who were clinically

symptomatic (i.e. reported dizziness) had a 12-fold increase in the odds of falling.[81] While studying fall risk in patients using beta-blocker eye drops, Ramdas found that the main outcome measures were a positive falls history and the presence of orthostatic hypotension.[82] Other researchers have echoed with findings demonstrating that dizziness and vertigo are important public health care issues.[19;83-85] Given the strong evidence cited, the FRAST will inquire about self-reported dizziness and will assign a heightened fall risk rating for a current complaint of dizziness.

Internal Factors: Gait & Assistive Devices (Figure 1, item 9): Many older adults require assistive devices to walk safely and independently.[43] In the FRAST assistive devices will include all forms of canes and walkers. Older adults commonly self-prescribe assistive devices for a variety of reasons. Brooks et al[44] found that of 70 patients interviewed, only 71% of the assistive devices being used had been prescribed. In Sheehan and Millicheap's study, [45] which evaluated the use of canes, 38% were used incorrectly, 44% were of incorrect length, and 54% were in poor condition. Joyce and Kirby[46] concluded that prescribed assistive devices were underutilized and needed to be fit correctly. A correctly prescribed, fit, and used assistive device may result in a lower fall risk; however, a self-prescribed, misfit, or inappropriate assistive device may result in a higher fall risk.[43] For these reasons, FRAST includes this item that imparts high fall risk both for those who use an assistive device that was not prescribed and fit for them and for those who cruise along furniture and walls and may benefit from the use of an assistive device.

Internal Factors: Risk Taking Behaviors (Figure 1, item 10): Although fear of falling can result in a higher fall rate, what about the opposite end of the spectrum –

unbridled risk-taking behavior? In considering unintentional falls, the author and one advisor were curious about the role of risk-taking behaviors as a personality trait in fallers vs. nonfaller. This is not an identified fall risk factor in older adults in the current literature. However, if immature brain development can increase risk-taking behaviors in adolescent males,[86] can neurocognitive decline associated with aging result in a similar situation in older adults? A number of studies have identified the increase in HIV positive older adults which has been tied to increased risk-taking behavior in this population.[87] Traffic accidents are higher in adults over the age of 65 which may reflect decline in judgment, reaction time or an increase in risk-taking.[88] Boggio et al studied transcranial brain stimulation in adolescents and in older adults in regard to its effect on risk-taking behavior; and[89] found opposite effects in the two groups with the adolescents showing a decrease in risk-taking with stimulation, while the older adults showed an increase. In Lighthall's study of young adults, it was determined that stressful events increased risk taking behaviors in men, but decreased them in women.[90] Of note, none of these studies considered if the subjects were aware of their demonstrated increase in risk-taking. Although risk-taking behavior is not identified as a fall risk factor in older adults, it may be worthwhile to study. The FRAST will therefore include risk-taking behavior as a possible fall risk factor, gather data and later look at its relation to fall history.

Identification of a validated objective test to quantify risk-taking behavior in this population was unsuccessful. The computer game and psychometric test, Balloon Analogue Risk Task (BART), does exist for use in adolescents and young adults but is not validated for use in any other population.[91] The FRAST will ask each subject to self-rate their risk-taking behavior. Engaging in risky behavior will be correlated with a high

fall risk and will prompt a discussion with the PCP to ascertain if further intervention is warranted.

Internal Factors: Fear of Falling (Figure 1, item 13): Falls increase fear of falling and fear of falling increases fall risk. Fear of falling often leads to self-imposed restriction of physical activity which further heightens fall risk. Fear of falling may be experienced even without a fall.[92;93] This entangled web of cause and effect is very easily understood but very challenging to reverse. In studying the prevalence and correlates of fear of falling and avoidance of activity, Zijlstra et al found that fear of falling was increased with advancing age, female gender, perceived poor health and history of falls.[60] Kempen studied fear of falling as it relates to multiple psychosocial parameters and found that severe fear of falling was associated with old age, female sex, limitations in activity of daily living, impaired vision, poor perceived health, chronic morbidity, falls, low general self-efficacy, low mastery, loneliness, feelings of anxiety and symptoms of depression.[16]

Since fear of falling results in a significant increase in fall risk[5;13;94;95], it is important that we be able to quantify this experience objectively. The original Falls Efficacy Scale (FES) was developed and reported by Tinetti in 1990;[96] as an instrument to measure fear of falling, based on the operational definition of this fear as 'low perceived self-efficacy at avoiding falls during essential, nonhazardous activities of daily living.' Subjects who reported avoiding activities because of fear of falling had higher FES scores, representing lower self-efficacy or confidence, than subjects not reporting fear of falling. The FES did not include community-level activities, so was updated in 1996 as the Modified Falls Efficacy Scale (MFES) which was studied and validated by

Hill and Schwarz et al in 1996.[97] The Falls Efficacy Test – International (FES-I) also added more community and higher level tasks[98;99] and was then also validated in a shorter form, the Short FES-I. [100] Additionally, the FES-I and short FES-I have been slightly modified in an Italian version.[101] For the purposes of the FRAST, we have selected the MFES since this valid and reliable instrument is aimed at our target population of community-dwelling older adults in the U.S.

Internal Factors: Depression (Figure 1, item 14): The occurrence of depression in later life is well documented[15;102-104] as is the knowledge that it is commonly not recognized and/or oftentimes will go under treated.[102;103;105;106] Geriatric depression may be misinterpreted as fatigue, dementia, or simple "normal" aging. Many aspects of advancing years – loss of spouse and/or friends, decreases in vision and hearing, nocturia, sleep disturbance, pain, lack of physical activity – may all contribute to depression. According to the National Institute of Mental Health, of every 100,000 people ages 65 and older, 14.2 died by suicide in 2006. This figure is higher than the national average of 10.9 suicides per 100,000 people in the general population. In addition, Crowther et al point out that rural older adults have fewer services and poorer mental health than their urban counterparts. [107]

Working with the Veterans Administration, Means et al found that elderly fallers have poorer psychosocial status when compared to a group of nonfallers.[108] Of note, this group found depression in male fallers where other studies' findings have focused on women.[109-111]

Measuring depression presents its own inherent challenges. Many psychometric scales that measure depression ask about suicidal ideation and therefore should be

administered only by trained psychologists or clinicians. A well-validated and commonly used measure, the Geriatric Depression Scale (GDS) [24;112] and the short form of the GDS[113;114] do not. The GDS-short, also known as the "Mood Scale", asks a short series of "yes/no" questions resulting in a score range from 0-10, with a higher score indicating greater depression and, therefore, a heightened fall risk. The FRAST has chosen to use the Mood Scale to safely screen for depression.

Internal factors: Balance: (Figure 1, item 15) Many physical changes associated with aging have a negative effect on balance.[115] Cognitive slowing may impact reaction times,[116] leg weakness may limit postural stability,[115] and degenerative joint changes might limit motion needed to reestablish equilibrium.[117-119] Multiple studies have demonstrated that diminished balance is associated with heightened fall risk; [120-126] and that improved balance following intervention is associated with a lower fall risk.[127-130] Balance must be screened as part of the FRAST.

Choosing the best objective instrument to assess balance in older adults was difficult. Over the years we have developed, studied, and updated many balance assessment tools; [41;120;125;131]and we have established their validity, reliability and sensitivity for certain populations.[132]

However, the goal of this project was to identify a validated balance test, designed specifically for community-dwelling older adults, which can be safely and reliably administered and scored by unskilled support personnel with minimal training often working with both limited time and space.

Many different instruments were considered. The Tinetti Balance Test[8] is a well-known objective measure used by many PTs in assessing fall risk in older adults. It is

designed for community-dwelling older adults and takes about 10-15 minutes to complete. However, the tool requires an assessment of gait and also that the patient be "nudged" and therefore requires the skills of a clinician. The Berg Balance Scale (BBS), has also been shown to be valid and reliable.[9] However, a few of the test items require the patient to attempt to stand with eyes closed, reach forward with outstretched arms or to retrieve an object from the floor while standing. While these tasks are performed, the tester is timing the patient. Again, this test requires the skills of a clinician.

Two of the balance tests met the stated qualifications; the TUG[10;133;134] test and the Five-Times-Sit-to-Stand Test(FTSS).[135] Shumway-Cook found the TUG to be a sensitive and specific measure for identifying community dwelling adults who are at risk for falls.[7] In addition, she added that the TUG is quick and simple to administer and also measured functional mobility. In her study published in 2000, it was found that older adults who take longer than 14 seconds to complete the TUG have a high risk for falls.[7] Herman, Giladi and Hausdorff found that the TUG also exhibited some psychometric assessment capabilities which were not found in the BBS or the Dynamic Gait Index (DGI); adding an indirect cognitive measure. [136] In a recent research report, Desai et al found that of the clinical tests considered, only the TUG was able to differentiate between the faller and nonfaller groups.[121] Morris and Harwood concluded that combining the factors of previous falls with a prolonged time on the TUG test was able to predict falls with high specificity. [137]

The FTSS[135;138] is also a simply administered measure that could be easily used in the primary care office. By combining the FTSS with a history of falls, living alone, being a woman and taking $\geq$ 4 medications, a French study[138] was able to categorize older

community dwelling adults into 3 fall risk categories. However, the study did not have any specific inclusion or exclusion criteria other than age >64 years (living situation was not defined), single fallers and non fallers were combined into one group, and all subjects resided in one small geographic area and received all health care at one facility. The combination of these factors might limit the ability to generalize these results to the population of community-dwelling older adults in the U.S. For these reasons the FTSS will not be included as part of the FRAST. Based upon the simplicity, safety and evidence supporting the TUG's ability to reliably discern between fallers and nonfallers, the TUG will be used to screen balance in the FRAST.

External Factors: Home & Living Situation (Figure 1, item 12): About half of all falls happen in the home**.** Hazards in the home are a well recognized risk factor for falls in the older adult. Making the home safer is listed by the CDC as one of the four most important things a person can do to decrease their fall risk.[26] Studies demonstrate that these home hazard assessments need to be accompanied by education, facilitation of modifications, consideration of the person and home interface and follow-up.

An Australian study done with nurses looking for specific fall hazards in the home found that all homes had at least one fall hazard. The most prevalent were floor rugs and mats, step-overs, steps and trailing cords.[139] Unfortunately, Stevens et al concluded that performing the home assessments and correcting certain pre-selected hazards did not result in a reduction of falls. They attributed this lack of fall prevention to the fact that this was a one-time intervention.[140] However, it might also be argued that it was not effective simply because it only addressed one of the many factors that are known to create fall risk in older adults. In 2003, Nikolaus and Bach found that home

intervention based on home visits to assess the home for environmental hazards, providing information about possible changes, facilitating any necessary modifications and training in the use of technical and mobility aids was effective in a selected group of frail older subjects with a history of recurrent falling.[139] And in a study of occupational therapists assessing for home hazards, Cumming et al concluded that home visits by occupational therapists can prevent falls among older people who are at increased risk of falling[140] However, the effect may not be caused by home modifications alone. Home visits by occupational therapists may also lead to changes in behavior that enable older people to live more safely in both the home and the external environment.[140] It should be noted that this study did not compare the intervention being done by occupational therapists with other health care providers.

The last study to be considered in our discussion was done in Sweden, Germany and Latvia and published by Iwarsson et al in 2009. This study considered the "person-environment fit" rather than just looking at a predetermined list of fall hazards. The group found that the person-environment fit problem variable was a stronger fall predictor than number of environmental barriers even after controlling for confounders. They concluded that much of the inconclusiveness of the data in the relationship between environmental hazards and falls in the previous falls literature could be due to the neglect of person-environment fit.[141]

These studies certainly highlight the need for a carefully completed home hazard assessment done by a therapist as part of an effective abatement of fall risk. However, the FRAST is being designed as a screening tool and home safety will be based upon a self-assessment of home hazards. A larger group of home hazards will result in a score of

higher fall risk as well as prompt the PCP to consider a referral for physical therapy or occupational therapy to complete a thorough and individualized home assessment. In our health care system, however, one must be aware that the therapist's home assessment does not include money or time for remediation of the identified problems. Communities will have to address a method to assist older adults in completing the fall risk abatements. Advocates will have to consider legislation to update building codes (i.e. create SmartHomes[142-144]) to assure livability as the owner ages.

External Factors: Sidewalks, traffic and adverse weather : A great deal of time and attention is afforded to falls within the home, but as public health advocacy results in increased physical activity levels, we must also look at the city/county infrastructure as it relates to safety for pedestrians.[145;146] Decrease in social contact in older adults may be a result of limited access to the community due to loss of driving, lack of access to public transportation and/or poor sidewalk maintenance creating a fall risk. During inclement weather, all of these factors combine with shorter days and colder weather and may contribute to depression. Access to the community must be made possible to assure successful aging-in-place. Therapists performing home visits should also consider factors that may hinder access to and from the home into the community.

Use of anti-slip devices on shoes have been demonstrated to decrease outdoor falls.[145] Longer crosswalk times can allow for safer crossing and limit pedestrian and vehicle accidents.[146] Older adults should be made aware of who to contact in the local public works department to have their sidewalks and crosswalks updated and maintained. Use of hip protectors may decrease fracture occurrence if one does fall.[147] Due to the

difficulty in reliably quantifying the outdoor environment, we will consider social contact to reflect an older adult's ability to access the community.

External Factors: Social Support & Contact (Figure 1, item 11): Social isolation is very familiar to many adults as they age. Loss of spouse, friends, employment, expendable income, and independent driving can all lead to "captivity" at home. This "shrinking world" phenomenon may lead to physical inactivity, cognitive decline and heightened fall risk.[14;16;148;149] Stanley et al found that the experience of loneliness was a pressing issue for elders in Australia;[150] and needed to be considered separately from social isolation.

Conversely, Peel, McClure and Hendrikz considered if healthy psychosocial factors were protective, that is, prevented older adults from falls resulting in hip fractures.[151] They found that the factors that significantly protect against fall-related hip fractures are currently being married, living in present residence for five years of more, having private health insurance, using proactive coping strategies in response to stress, having a higher level of life satisfaction and engagement in social activity in older age.[151] For many reasons, increased social contact is correlated with lower fall risk.[151;152]

In the literature, measurement of social contact is primarily accomplished by keeping a social activity log or by self-reports.[153;154] Since the FRAST is a screening tool, self report is the most efficient method. Subjects will be asked "In the past week, how socially active have you been?" The response indicating fewer social contacts will correlate to a higher fall risk and will trigger a recommendation for referral to Aging Services to consider social activities and support services.

FRAST total score: In addition to examining each fall risk individually, the FRAST will be scored for overall fall risk. The composite score may indicate a high fall risk even if many risk factors are individually only scored as medium fall risk. The recommended actions for an overall high score will include a multidisciplinary fall prevention program. A score of 0-5 out of 30 (0-5/30) will result in general fall prevention education given in to the older adult. A score greater than five, i.e. 6+/30, will result in a referral to the adult's PCP for further review and consideration of actions to be taken to abate their individual issues resulting in heightened fall risk.

We have now highlighted the evidence regarding each of the significant components of fall risk for community-dwelling older adults as well as proposed methods for objective measurement of each. Recommendations are included for appropriate interventions to be considered by the PCP to proactively address each aspect of heightened fall risk based upon individual needs. It will be necessary for staff – perhaps from local public health or aging service departments - in each geographic area to develop a list of appropriate providers and programs to provide the recommended services.

Many fall risk factors were considered and not included in the FRAST. Other studies have looked at executive control deficits[155] as a fall risk factor, but later studies indicated these functions were already tested by the TUG test.[136] Silva et al concluded that lumbar muscle strength and osteoporosis were intrinsic risk factors for falls[156] but only women were included in the study and these risk factors have not been widely studied. Gait disorders have been recognized by many[32;41;157] but would be difficult to assess by minimally trained staff. As in other "composite" items, we will consider the

TUG to be an indirect measure of lower extremity muscle strength, gait quality, and speed. All-in-all, the most common, significant, and widely studied risk factors have been selected for inclusion in the FRAST.

Actions Recommended: The last column of the FRAST provides the PCP with recommended actions to abate specific fall risk factors. These recommendations are derived from routine practice that reflects the current norms across the United States. However, geographic location, third-party payor guidelines, availability of staff and expertise of individual practitioners will most certainly effect which provider(s) are utilized in each situation. Literature regarding referral patterns is very limited and primarily focused upon PCP referral patterns to specialist physicians.[158;159] The majority of recommendations in the FRAST are based upon the clinical expertise of the authors and colleagues in the University of Montana's College of Health Professions & Biomedical Sciences.

Dissemination: Creating the FRAST is perhaps the simplest piece of the puzzle in effectively addressing the public health issue of unintentional falls in community-dwelling older adults. The population projections for this age group give us a pressing timeline for our interventions. Getting the FRAST out to the PCP offices, health departments, and public events is challenging, but doable. Convincing busy primary care offices to add this screening routinely in their preventive care will be a great challenge. However, the need has been well documented. Rubenstein et al found that community physicians appear to under-detect falls and gait disorders. They concluded that adhering to guidelines may improve outcomes in community-dwelling older adults.[41] It is important to be aware of a study of rehabilitation professionals published in 2001 which

found that rehabilitation clinicians appear aware of strong predictors of fall risk but require cueing to consistently use them.[160] As physical therapy evolves into a doctoring profession[161] and we assume a greater role as PCPs, utilization of tools like the FRAST will enrich our comprehensive screening and preventative care for older adults. As new legislation results in further CMS updates, we will continue to advocate for increases in third-party reimbursement for preventative care.[162]

In considering effective and comprehensive fall prevention for older community-dwelling adults, one must consider all of the people involved with each older adult in their health care and wellness decisions. For an active and vital person, the first contact point for education is directly to that individual along with their spouse/significant other and peer group. The job of health prevention is shared between public health education and health care delivery.

Once the older adults with heightened fall risk are identified, we will all – therapists, pharmacists, optometrists, social workers, public health officials, city/county infrastructure staff - have to be ready to meet their needs in abating that risk. Creating local coalitions of service providers for older adults is of paramount importance to facilitate meeting these goals while avoiding duplication of efforts. City and county-wide plans must include the acquisition and offering of evidence-based, multidisciplinary fall prevention programs[127-130] such as A Matter of Balance©[163], Stepping-On©[164;165] and T'ai Chi.[53;166-170] We will need to orchestrate advocacy efforts to fund necessary changes such as sidewalk maintenance, affordable transportation alternatives to independent driving and programs that provide social support. Special attention must be given to groups

separated due to geographic distance, cultural and language differences or health disparities.

METHODS

Research Design: Study to validate the FRAST was performed using an observational study design since no experimental intervention was delivered to subjects.[171] Observational studies are also referred to as natural experiments or quasiexperiments.[172] The intention of the study was not to change fall risk but simply to validate if the FRAST was able to discern between fallers and non-fallers based upon the subjects' self-reported fall history. Due to time and money constraints, longitudinal study was not feasible and data collected for this early pilot study was retrospective. Since information was gathered via self-administered questionnaire at one point in time, this study is classified as a cross-sectional design. [172] The inherent weakness of this design is in the subject's ability to accurately recall and report historical events. This limitation confounds the ability to consider covariates effecting outcomes. However, the selection of the cross-sectional, observational, research design allows for rapid collection of data with minimal inconvenience or risk to the subjects at minimal cost.

Research to validate the FRAST's ability to discern between fallers and non-fallers in community-dwelling, older adults aged 65+ was carried out in Montana during 2010 in multiple sites. The research project applied for prior approval from the University of Montana's (UM) Institutional Review Board (IRB) through the Office of the Vice President for Academic Affairs (Appendix A). Approval for IRB protocol number 101-10 was received on April 19, 2010 for a one-year period (Appendix B). A number of IRB amendments to this protocol were subsequently submitted and approved that allowed for a variety of sites and dates as well as small edits to the forms.

Recruitment: Recruitment of subjects was primarily through posting of flyers (Appendix B) and word of mouth in groups and locations throughout the community. This included an exercise class for older adults at the local YMCA, recreation programs at a retirement center, a training class for retired volunteers through the Area Agency on Aging, a seniors' church group that had requested fall prevention education, a health fair marketed to older adults in a shopping mall, and a T'ai Chi class at the senior center. Events were held on weekdays at times that did not conflict with meals, sleeping, or high levels of community traffic. Schedules were chosen that coincided with other scheduled events that older adults were known to attend. Peer-leaders were identified and contacted in each instance to help in promoting the event to their peers. All events were successful attracting an average of 22.2 volunteers per site.

Study Environments & Scheduling: All test sites had similar characteristics which included the following:

- Central community location in an accessible public building
- Locations served by public transportation
- Availability of ample, free, and well-maintained parking
- Easy access to restrooms, snacks, and drinks
- Space for adequate tables and chairs for at least 30 people
- Space to safely mark out and perform the Timed-Up-and-Go (TUG) test
- Location of other activities aimed at the study population
- Dates when dry weather would be expected

For each site, contact was made with on-site staff who agreed to post approved flyers and promote study participation.

Screening: All volunteers were screened using the following inclusion/exclusion criteria:

- **Inclusion criteria**: All study participants had to meet ***all*** of the following inclusion criteria:
    - Adult over the age of 64 as of the day of testing.
    - Living independently in the community with or without family
    - Able to ambulate independently and safely with or without assistive device (cane, walker, crutches)
    - Able to read, understand, and physically complete the FRAST questionnaire using a paper-and-pencil format
- **Exclusion criteria**: People were excluded from the study if they met ***any*** of the following exclusion criteria:
    - Not yet age 65 on the day of testing
    - Residing in assisted living facility, skilled nursing facility, or requiring on-going physical care from others
    - Unable to safely ambulate independently (including transfers) with or without an assistive device; and/or preferring to use wheeled and seated mobility.
    - Unable to read, comprehend, manage a pencil or pen, or otherwise unable or unwilling to complete the FRAST questionnaire.
    - Not wishing to participate.

Participants who met the inclusion/exclusion criteria were then given the informed consent to review and the opportunity to ask questions regarding the study.

After signing the forms and having the consent form witnessed, the subjects were given the FRAST questionnaire to complete. In all situations, at least 2 research staff assistants were readily available to respond to questions and offer assistance.

The FRAST forms: One complete FRAST packet included (Appendix C):

1. The FRAST grid: A 15-item questionnaire (development described previously). For each item, the subject selected the best response from that row corresponding to low, medium, or high fall risk. (See Figure 1: FRAST grid) Three items on this FRAST grid required completion of the attached scales (Appendix C).
2. The Modified Falls Efficacy Scale (MFES) assessed the subject's fear of falling. The score on this scale was used to respond to item 13.
3. The short form of the Geriatric Depression Scale, also known as the "Mood Scale". Results of this scale were used to respond to item 14.
4. After the paper-and-pencil scales were completed, each subject was given the TUG test of gait and balance as described in the review of literature. The score on the TUG test was used to respond to item 15.

As indicated on the grid, responses in the low risk column were each scored zero points, those in the medium risk column were each scored one point and those in the high risk column were each scored two points. Total score was calculated by adding the score on all 15 items. Given that age and gender were scored, the lowest possible score is 2 out of 30 points (2/30) and the highest possible score was 30 out of 30 points (30/30). A score over 5/30 was considered to indicate a fall risk high enough to warrant review with the subject's PCP.

The mean contact time across all sites and subjects was 23 minutes with a range of 18 minutes up to 45 minutes. At the first two data collection sites, a social work graduate student conducted exit interviews with willing subjects. Feedback regarding their experience with the FRAST was generally positive expressing great interest in fall risk and fall prevention. Almost all subjects related stories of their own falls and/or those of friends and relatives. Many requested referral to fall prevention programs which were currently very limited in each of the geographic areas. Specific comments regarding the FRAST instrument included:

- The instrument was too long on too many pages
- The "type" or font size was too small
- Front and back printing on the pages made it difficult to manage the packet
- Scoring the FRAST was difficult

Feedback from these early participants resulted in modification of form printing from two-sided to single-sided, increase of font size, retyping of supplemental forms to condense pages, and offering to score the packet for subjects after testing.

At the completion of testing, all participants were offered copies of the consent forms, copies of their completed CDC form on home safety, medication reviews, and fall prevention (Appendices D-F). Those subjects scoring above a 5/30, relating a fall history, and/ or other concerns, were advised to consult with their PCP. When programs were available, appropriate subjects were referred to evidence-based fall prevention programs including T'ai Chi Moving for Better Balance[173], Matter of Balance[163] and/or Stepping On.[164]

DATA ANALYSIS

The intended use of the multifactorial FRAST was to provide minimally-trained personnel a valid, simple screening tool for assessment of fall risk in independently ambulatory (with or without assistive device), community-dwelling adults aged 65+ and to facilitate referral to and interpretation by the primary care practitioner (PCP). When referral was indicated, the FRAST would guide the PCP with targeted intervention recommendations to abate their patient's individual fall risk. The FRAST was developed as a screening tool and is not intended to diagnose individual fall risk factors.

Data were collected at five community sites in Montana during 2010. A total of 121 older adults volunteered. From the group of volunteers, a total of 111 met the inclusion/ exclusion criteria. During the testing, 12 were disqualified due to a combination of cognitive issues, difficulty reading forms, and/or failing to complete the forms in their entirety. A total of 99 subjects completed the FRAST and have been included as subjects in the data.

The original research question to be answered was: Can the FRAST discern between fallers and non-fallers amongst independently ambulatory, community-dwelling adults aged 65+? In order to improve the question's specificity, it was edited to read: Is a history of falls in independently ambulatory, community-dwelling adults aged 65+ related to a higher score (greater than 5 out of 30) on the FRAST?

The null hypothesis (H_0) for this study was: A history of falls in independently ambulatory, community-dwelling adults aged 65+ and a higher score (greater than 5/30) on the FRAST are independent of each other. If this null hypothesis were found to be true, this would indicate that the FRAST did ***not*** discern between fallers and non-fallers

in the target population. The alternative hypothesis (H_a) for this study was: A history of falls in independently ambulatory, community-dwelling adults aged 65+ and a higher score (greater than 5/30) on the FRAST are dependent on each other. If the alternative hypothesis were found to be true, this would mean that the FRAST was able to discern between fallers and non-fallers within the target population.

The greatest risk of misinterpretation of the FRAST results was in false negatives; i.e. to assure an older adult that they did not need to discuss fall risk with their PCP when they actually did have an elevated fall risk. For this reason, a lower cut-off score was selected resulting in a greater number of false positives; i.e., too many referrals to PCP's. On the FRAST a score of two denoted the lowest discernible fall risk and a score of 30 indicated the highest fall risk. A mid-point cut-off score of 16 would have allowed someone with a number of risk factors to go undetected; therefore, a low cut off score of five was selected. For subjects scoring five or below on the FRAST, they would not be automatically referred to the PCP for further fall prevention interventions. For older adults scoring above five, a referral to the PCP with a copy of the FRAST and recommended fall risk abatement strategies would be made. All older adults were provided fall prevention educational pamphlets regardless of their FRAST score.

Subjects were categorized as a "Faller" if they reported previous falls on the FRAST in item 2; and as a "Non-faller" if they reported no previous falls in the same item. Each subject's FRAST was reviewed for completion and scoring was checked for accuracy. Based upon the total score on the FRAST (0-30 out of 30), the questionnaires were then categorized as scoring between 0-5, scoring 6-30, or incomplete. Five

incomplete questionnaires were dropped from the subject pool. Initial data is tabulated in Table 1.

Table 1: Observed Data for FRAST

	FRAST Score 0-5	**FRAST Score 6-30**	**Marginal Row Totals**
Faller	1	57	58
Non-faller	15	26	41
Marginal Column Totals	16	83	**N=99**

If we assume for the moment that the null hypothesis is correct, we can calculate the **expected cell counts** of each cell by multiplying the row total by the column total and dividing by the grand total.[86] This has been done in Table 2 below.

Table 2: Expected Data for FRAST given H_0

	FRAST Score 0-5	**FRAST Score 6-30**	**Marginal Row Totals**
Faller	58x16/99=9.37	58x83/99=48.62	58
Non-faller	41x16/99=6.62	41x83/99=34.37	41
Marginal Column Totals	16	83	99

Now we are able to compare our observed data with the expected data we would see if the null hypothesis were in fact true. We do this by looking at the numeric

difference between the two values for each cell.[174] If the differences between the observed data and the expected data are NOT significant, then the null hypothesis is upheld. But, we if are able to demonstrate a significant difference between them, then the alternative hypothesis is supported and the null hypothesis is "thrown out".[174] We have calculated the differences in Table 3 below.[175]

Table 3: Differences between observed and expected data

	Expected Data	**Observed Data**	**Difference**
Fallers scoring 0-5	9.37	1	8.37
Fallers scoring 6-30	48.62	57	-8.38
Non-fallers scoring 0-5	6.62	15	-8.38
Non-fallers scoring 6-30	34.37	26	8.37

In order to apply the Chi-square test, the expected count for each cell must be greater than or equal to five.[174] Checking the values in Table 2, we can see that all cell values are greater than five and we have met the conditions to perform the Chi-square test. We are now able to calculate the Chi-square test statistic. For each cell, we have done the following:[176]

1. Subtracted the observed cell count from the expected cell count (Table 3)
2. Squared the results from step one to make the number positive

3. Divided the result from step two by the expected cell count
4. Summed the result from step 3 for all cells to attain the Chi-square test statistic

The results of the Chi-Square statistic are shown in Table 4 below.

Table 4: Calculating the Chi-Square Statistic

	FRAST Score 0-5	**FRAST Score 6-30**	
Faller	$8.37^2/9.37=7.48$	$-8.38^2/48.62=1.44$	
Non-Faller	$-8.38^2/6.62=10.61$	$8.37^{2/}34.37=2.04$	
			Total = 21.57

We must now compare our Chi-square statistic with that of a table of the same degrees of freedom.[174;176] Our two-by-two table has 1 degree of freedom. This is calculated by the following formula:

Degrees of Freedom (df) = (rows-1)(columns-1) = (2-1)(2-1)=1

In the Chi-square table for df=1, the closest value to our chi-square statistic of 21.57 is7.88 in the p=0.005 column. This p value of 0.005 is less than the typical level of alpha = 0.05, so we reject the H_0 and accept the H_a. The study has demonstrated that a history of falling ***is*** associated with a score on the FRAST that is greater than five.

RESULTS & DISSEMINATION

Complete analysis of data presented indicated that the FRAST instrument is a valid screening tool for use in independently-ambulatory (with or without assistive device), community-dwelling adults aged 65+ to discern between fallers and non-fallers. Based upon the data analysis, we have rejected the null hypothesis (H_0) which stated: "A history of falls in independently ambulatory, community-dwelling adults aged 65+ and a higher score (greater than 5/30) on the FRAST are independent of each other." Had the null hypothesis been upheld, this would have indicated that the FRAST did ***not*** discern between fallers and non-fallers in the target population. However, the alternative hypothesis (H_a) for this study was upheld which stated: "A history of falls in independently ambulatory, community-dwelling adults aged 65+ and a higher score (greater than 5/30) on the FRAST are dependent on each other." The alternative hypothesis being upheld indicated that the FRAST was able to discern between fallers and non-fallers within the target population.

Dissemination: It was felt that the instrument had value for screening and fall prevention education and has therefore been copyrighted (Appendix O) and partially disseminated.

The primary goals of dissemination included:

1. Increased awareness of the public and health care practitioners of the need to proactively prevent falls in older community-dwelling adults.
2. Promotion of effective fall screening and prevention in the primary care office to identify potential fallers before the first injury fall.

3. Provision of simple and readily available interventions for the PCP to utilize in abating fall risks that are based upon each individual's identified needs.

The identified stakeholder groups included:

1. Older adults and their families/support systems
2. PCP's providing primary care for older adults
3. Public and community health care leaders
4. Public and private, for-profit and not-for-profit organizations serving older adults
5. Third-party payer systems including health insurance companies, Centers for Medicare and Medicaid Services (CMS) and others.

The primary methods of dissemination across all groups included:

1. Presentations to a variety of groups (Appendix J, K, L, M)
2. Senior Health Fair and fall prevention community events (Appendix A, B flyers)
3. Printed and televised media coverage
4. Website development and publication (http://www.co.missoula.mt.us/healthpromo/FallPrevention/index.htm)
5. Peer-reviewed journal publication[177]
6. Participation and facilitation of community, state and national collaborations for fall prevention efforts (Appendix N)

Early work in fall prevention by this author has been previously described.[177] Creation of and/or working with the Missoula Fall Prevention Project, the Falls Free Coalition of the National Council on Aging (NCOA) and projects with the Montana State Department of Health and Human Services provided foundation for this independent study.

Older Adults: The key to successful lifestyle changes in older adults has been demonstrated to be most effectively met with peer-group education and support.[163] Dissemination of the FRAST began with direct education of the community-dwelling older adults in Missoula. In April of 2010, a private church-based Missoula organization invited the author, mentor and other students to discuss fall prevention awareness to their 23 members. Epidemiology of falls based upon the CDC WISQARS data was presented along with extensive education regarding fall prevention. Pamphlets published by the CDC and the NCOA were distributed and questions were entertained. Some of these participants later became involved in data collection of the FRAST. The FRAST has been tested in a number of small groups of community dwelling older adults around Missoula. Whenever testing has occurred, education in fall prevention has been included. The individual results of the FRAST were given to interested participants to share with their families and/or PCP's for follow-up. In this way, older adults, their support systems and their PCP's were contacted regarding the FRAST.

Other routes to directly access the older adults include their media of choice. According to the Newspaper Association of America 66% of adults over the age of 55 still read the newspaper on a daily basis.[178] Public health education campaigns via the newspaper will still reach the majority of this population and/or their peers. Knowing

this, Greg Oliver, Director of Health Promotion for the Missoula City-County Health Department (MCHHD), contacted the local Missoulian newspaper and placed a 'Boomer to Boomer' article on fall prevention. Working with Mr. Oliver, I was permitted to provide input and editing for the manuscript that was run just before the national Falls Prevention Awareness Day on September 23, 2010. In addition to the newspaper, the author contacted a local TV news station, KECI, who agreed to run an interview to highlight fall prevention and education needs in Missoula. On September 23, 2010, KECI interviewed Mary Thane, a local physical therapist working with the Stepping On© fall prevention program. Both the newspaper article and the TV interview encouraged the public to access a new website for fall prevention located within the Missoula City-County Health Department's (MCCHD) website which is available for review at: http://www.co.missoula.mt.us/healthpromo/FallPrevention/index.htm. The MCCHD website contains vital links to fall statistics, fall prevention education in Missoula as well as the FRAST. This webpage was created in August of 2010 as part of this project and contains a hyperlink to the author's email for inquiries. To date, I have been contacted by one PCP who expressed interest in using the forms in his practice as well as a public health nurse planning to use the FRAST in a local health fair.

***PCP'S*:** Dissemination of the FRAST to PCP's has been postponed until the tool has been validated. When the tool is validated with studies published in a peer-reviewed journal, dissemination will begin. In the meantime, groundwork has included presentation at the Montana Gerontology Society's annual meeting in April of 2010 and the Montana Public Health Association poster session in September of 2010. A few PCP's were present at each of these meetings. Roman Hendrickson, MD from the Dillon,

MT area, has expressed interest in bringing the FRAST to the critical access hospitals and family practice annual meeting.

***Public & Community Health Leaders*:** The FRAST has been well received by Greg Oliver, Director of Health Promotion for the MCCHD, Ms. Bobbi Perkins, Injury Prevention Specialist at the Montana State Department of Health & Human Services (DPHHS) and many members of the NCOA's Falls Free Coalition. As previously mentioned, the FRAST has been added to the MCCHD's website for direct public dissemination with all forms ready for downloading. Ms. Perkins has forwarded the link for the FRAST to all participants in the state's fall prevention programs. Within the group's phone calls for the NCOA's Falls Free Coalition, this author has been able to discuss the tool and its development with national experts. This author was invited to join the CDC Fall Expert Panel. At a recent meeting of the panel which convened in Atlanta, GA, December of 2010 the FRAST was introduced.

Organizations Serving Older Adults: Collaboration building between potential service competitors presents definite challenges. In the past 18 months, the author has had the opportunity to observe and learn from Greg Oliver as he has carefully orchestrated bringing both for-profit and not-for-profit service providers to the table to work together. Although the local coalition group is still in its infancy, great strides have been made. The Missoula Fall Prevention Project has applied for and attained a state DPHHS grant to offer evidence-based fall prevention education to older Montanans. The Stepping On© program[164] has been well received and should grow in its reach as more instructors are trained.[164] As the program develops, the FRAST may be adopted for pre-

class prioritization of participants as it is anticipated that class slots may not meet the demand.

Missoula Aging Services (MAS) has sent out the FRAST within its newsletters, encouraging area seniors to self-administer the assessment and discuss their results with their family and/or PCP. Missoula Aging Services also helped the author to set up a FRAST test site with their "adopt a grandparent program" participants. The firemen of Missoula County have expressed interest in being trained in the FRAST for use with repeat fallers in their districts. Two independent living retirement centers have welcomed us to use the FRAST with their residents and have asked for annual screenings. Montana Gerontology Society published an article written by this author describing the FRAST with the MCHHD website link in their fall 2010 newsletter. The Community Medical Center's Senior Health Fair scheduled in October of 2010 included the FRAST and fall prevention education. Overall, community partners have been open and supportive to assisting with wide-spread dissemination of the FRAST.

The need for proactive fall prevention is slowly receiving the necessary recognition in and around Missoula County, the state of Montana and throughout the United States. It is critical that the momentum achieved in the past 12-18 months continue in order to assure the programs' future sustainability. The need for the MCHHD as well as the University of Montana's School of Public and Community Health to act as a buffer between the hospitals is imperative to avoid polarization of the community.

Future Research & Dissemination: The work described in this dissertation is a small beginning to a new career for the author. In January of 2011, the author joined the faculty at Touro University – Nevada (TUN) as an assistant professor in the School of

Physical Therapy. Teaching responsibilities include primary teaching of courses including neurorehabilitation and geriatric management. Within these courses there will be great opportunity to instill these concepts of fall risk assessment and abatement in developing professionals. Plans to develop interdisciplinary courses will expand the number and disciplines of graduate students trained in fall risk assessment, fall prevention, and proactive management of older adults who have fallen. In addition to classroom teaching, research projects are already underway.

In the realm of service, the author continues activity with the CDC's Fall Panel, the National Council on Aging's (NCOA) Falls Free Coalition, and the geriatric and neurology sections of the American Physical Therapy Association (APTA). In addition, the author has begun to create "Nevada Goes Falls Free" a new state member of the NCOA's Falls Free Coalition. In April of 2011 the author will present nationally at the Aging in America conference of the American Society on Aging (ASA) 2011 in San Francisco.

CONCLUSIONS

Fall risk for community-dwelling older adults is indeed a multifactorial, public health problem requiring immediate action from all health care providers. Providing the primary care practitioner with a simple, reliable, objective screening tool which includes targeted intervention recommendations is imperative. The FRAST was developed as a screening tool and is not intended to diagnose individual fall risk factors. However, once individual risks are identified, the FRAST provides recommended targeted interventions to abate that particular fall risk. The FRAST tool is administered safely, quickly and by low-cost, minimally-trained office staff with follow-up by the PCP. This manuscript has presented the evidence upon which the new FRAST is based, reported studies to validate the tool, and discussed current and future plans for dissemination of the tool including research.

The FRAST has been shown to discern between fallers and non-fallers in the target population of independently ambulatory (with or without assistive device), community-dwelling adults aged 65+. Each component of the FRAST (Figure 1) represents one of the fall risk factors that have been demonstrated to significantly impact overall fall risk of community-dwelling older adults. The interrelated effect of many of these risks has been clearly demonstrated. Assessing fall risk using any one criterion would certainly result in missing heightened fall risk in a significant portion of the target population. Further, it is necessary to address each risk factor individually in order to select targeted interventions for each individual; resulting in the most effective fall prevention.

Comprehensive dissemination of the FRAST has begun and will continue at local, state, and national level. No matter which tool(s) we select to assess fall risk, it is of paramount importance that we each accept the responsibility of not only performing the screening in our own practice, but in facilitating the public dissemination and adoption of this clinical practice.

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