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Case Study

Falling Down: Assessing the Risk of Falls in Older Adults

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Educational Objectives

1. To provide an overview of the problems associated with falling in older adults.
2. To outline the strengths and weaknesses of the various screening tools used for effective evaluation of an individual's fall risk.
3. To highlight the benefits of assessing physiological function when screening for falls risk.

Background: The Problem of Falls

For persons over 65 years of age, the likelihood of a fall in the following year is a staggering one-in-three chance. While the immediate consequences of suffering a fall are obvious (i.e., injury), the long term effects of a fall can be just as problematic (Stevens, 2006). Following such an adverse event, many people become physically inactive; can have a slow, unsteady gait; exhibit loss of muscle strength; fatigue easily; develop a fear of falling; and, inevitably, show a further increased risk of falling. All these outcomes are viewed as markers for the descent into physical frailty (Fried et al., 2001).

Clearly, identifying those variables which can lead to increased risk of falling is of paramount importance. However, we lack full understanding of the critical factors that are strongly predicative of falls in high-risk populations. Part of the reason for this is the sheer number of risk factors that can contribute to a fall, with over 400 being linked with falls in adult populations (Close, Lord, Menz, & Sherrington, 2005). Even something as simple as an individual's fear of falling is an issue of great concern. It has been reported that nearly 13 million (36%) older American adults (ages 65+) were moderately or very afraid of falling, illustrating that developing a fear of possibly suffering an adverse event is strongly linked with actual falls (Boyd & Stevens, 2009).

Sorting through this volume of risk factors to identify one or two key measures is not a simple task. Some variables identified as significant risk factors, such as increasing age and/or the emergence of neurological disease/damage, do not provide much in the way of direct benefit to the person who suffers a fall and/or the clinician, since they cannot be easily modified. The most commonly used clinical screening measure of a future fall is whether a person has fallen previously, with studies reporting that the likelihood of a person falling in the future increases dramatically if he or she has fallen previously (Close et al., 2005; Lord, Sherrington, Menz, & Close, 2007). However, this basic screening measure does not identify the older person who has not fallen but may be at increasing risk, a significant proportion of older adults. Further, this measure provides little guidance or detail as to the cause of any previous fall. If the ultimate aim of preventing falls is to identify the person at risk and intervene before the adverse event occurs, then the use of previous falls history as an initial screening tool is of limited use.

Inside This Issue:

Consequently, for researchers, clinicians and the involved person, the key measures are arguably those that are both strongly linked to falls and have the potential to be affected or altered. Of the numerous fall risk factors identified, those of greater significance tend to be impaired balance, mobility, and gait, with age-related deterioration of postural stability considered to be the primary underlying cause (Gillespie, et al., 2009). Consequently, most screening tools and interventions have been designed to target variables such as balance, walking dysfunction, reactions, and muscle weakness, since they are modifiable and likely influenced by tailored interventions.

How to Assess the Chance of Falling

Given the wide range of possible risk factors, the majority of screening tools have been designed to focus on intrinsic factors (i.e., those relating to physical and/or cognitive status of the person) rather than extrinsic measures (i.e., those within the environment such as weather or ground conditions). The more commonly used assessment tools, which have also undergone rigorous scientific evaluation, include: the Berg Balance Scale (BBS); the six minute walk test (6MWT); the Performance Oriented Mobility Assessment (POMA); Timed Up and Go (TUG); the Functional Reach Test; and the Physiological Profile Assessment (PPA) (Lord et al., 2007).

Of these tests, the BBS is the most popular and widely used falls-risk assessment tool in clinical settings. This test, initially developed as a simple indicator of balance function in stroke patients and older adults, involves measuring the ability of the person to maintain balance during tasks such as sitting, standing, transfers, reaching, leaning over, turning, and stepping. Despite its wide use, the capacity of the BBS to predict the likelihood of a future fall is unclear and there is also concern that it may provide less detailed information about subtle changes in a person's balance, which may limit its effectiveness when used on highly functional older adults with less severe deficits. In a similar way, the POMA involves functional assessments of balance and mobility during everyday tasks. While this screening tool was originally developed to evaluate the falls risk of frail older adults dwelling within nursing and/or assisted living facilities, it has been widely adopted to assess older individuals in community settings. The POMA measures general balance function (e.g., sitting, sit-to-stand transfers, standing, external perturbation, turning tasks) and gait separately (e.g., gait initiation and straight-line walking) and is reported as an accurate predictor of fallers and non-fallers in older adults with chronic disabilities.

There are a variety of falls risk tests which focus singularly on walking. An underlying rationale for many of these tools is that most falls happen under dynamic conditions, that is, when the person is moving through a given environment. The 6MWT is a simple test that requires a long, unobstructed walkway (usually indoors), but no exercise equipment or advanced training. This test measures the total distance that a person can quickly walk on a flat, hard surface in a period of six minutes. A variant of this evaluation, the timed 25 m walk test, has also emerged, although this tool is primarily used in clinical populations where the individual may have difficulty walking for longer periods of time and/or where the testing space is not large enough for the person to walk for long periods or distances. The TUG test is a quantitative test that measures the time required to stand up from a chair, walk three meters, turn around, walk back to the chair, and sit down again. As older individuals with reduced postural stability and/or muscle strength are known to move slower, a longer time to complete the TUG has been used to indicate a heightened falls-risk. In general, this test provides the most benefits for screening frail or unwell older adults and is widely used as a quick preliminary test of falls-risk in hospital settings. The applicability and ease of use of this test has been widely recognized in clinical settings, and it is recommended by the *American Geriatrics Society* and the *American Academy for Orthopedic Surgeons* as a basic screening test (Beauchet et al., 2011; Gillespie et al., 2009).

All of these tests provide initial screening information to identify people at risk who warrant more detailed assessment of gait and balance function. There are some obvious advantages of these tools: they require little training or specialized equipment, and most can be performed quickly in many clinical environments without excessive restrictions on space. However, while they provide some general indication of risk, most only measure overall performance (such as the time taken or number of steps) or provide subjective assessments of a person's balance and walking ability. Consequently, there is no objective information gained about the individual's movements nor are there any specific assessments of the physiological systems which could be responsible for any impairment in postural and gait control. More importantly, none of these tests identify specific physiological factor(s) that could be targeted to reduce risk of falling.

Benefits of the Physiological Profile Assessment (PPA)

To address these concerns, Lord and colleagues developed the Physiological Profile Assessment (PPA) (Lord et al., 2007). This screening assessment differs philosophically from the other falls-risk tools in that it does not directly measure the ability of a person to perform an everyday movement. Instead, it is based on the assessment of key physiological processes related to postural control, covering tests of visual function, proprioception (the sense of one's place in the environment), peripheral sensation, leg muscle strength, hand and foot reaction time, standing balance, postural coordination, and leaning balance (to assess the limits of balance). The underlying rationale for this test is that accumulated deficits or impairments in the physiological systems related to postural control will lead to a reduced ability to maintain balance during everyday activities. Therefore, an advantage of the PPA is that it provides quantitative information about the potential causes of instability so that a targeted, individualized intervention strategy can be developed. Once a physiological profile for a given person is formed, the test scores are weighted and combined to produce a standardized falls-risk score ranging from -2 (a very low risk category) to +4 (very marked risk). The resultant score and selected physiological markers are also compared to age and gender matched normative data, providing a detailed evaluative comparison for the individual. One further advantage of this screening tool is that it has a strong predictive capability. For example, a person with a falls-risk score of one or greater has a 60% risk of a future fall, whereas someone with a falls-risk score of less than one has a risk near 10%.

In summary, the Center for Brain Research and Rehabilitation at ODU recommends using the PPA in conjunction with other appropriate tools to provide a more comprehensive and informative assessment of general balance and gait function for people at risk. The following case studies provide examples of how to utilize the PPA in conjunction with other screening and measurement tools to assess the risk of falling. Based upon the information gained from these measurement tools, we construct a targeted intervention for each person.

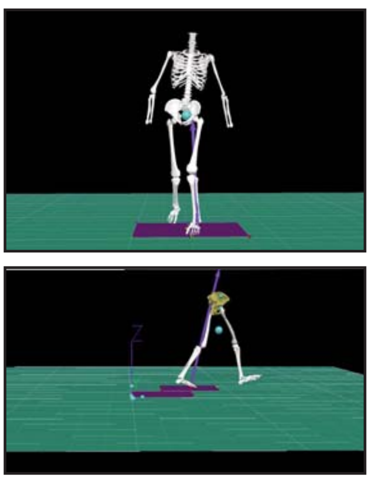
Case Study #1

Kathleen, a 58-year-old woman diagnosed with early onset Parkinson's disease (PD) 10 years ago, came to our Center exhibiting many of the common motor disorders associated with PD, including mild tremor in her hands and fingers when they were held by her side (in a resting position), a slight slowness when having to start a movement, and smaller steps, almost shuffling, when walking. She was taking medication for her symptoms, which tended to alleviate most of her movement issues. Over the past two years, Kathleen had begun to notice problems with her general balance, reporting that she felt more unstable and unsure of her abilities, especially when walking. Kathleen also said she was more worried about the possibility of falling, especially when walking in crowded environments where she wasn't sure she had the ability to navigate around people safely. We asked if she had experienced a fall in the last 12 months and she reported she had fallen twice, an outcome which put her at a greater risk of falling again.

We performed a falls risk assessment on Kathleen using the physiological profile assessment (PPA) and evaluated her fear of falling using the self-reported questionnaire (the modified falls efficacy scale). We also performed a comprehensive assessment of her walking ability using a VICON motion capture system. This system, which is comprised of a series of synchronized high speed cameras and force plates embedded within the walking surface, allows us to measure objectively the movement about specific joints while the person per-

Model demonstrating reflective markers for VICON system.

forms the specified movement. We place a series of reflective markers on specific anatomical landmarks of the person and track the relative motion of the markers. We use these to produce avatars or representations of an individual's movement. By these means, we gained accurate and reliable measures of the amount of the force produced and the degree of motion about each joint while Kathleen performed a series of walking tasks. As mentioned, the PPA provides a comprehensive assessment of different physiological systems, such



Avatars representing specific patient's movement profile.

as strength, reactions, sensation, proprioception, vision, and general balance ability. Based upon the collective sum of these measures, Kathleen was shown to have an overall falls risk value of 1.35, which put her in the “moderate” risk of falling category in the next year (this equates to approximately a 60% likelihood). The main factors which contributed to her increased risk were significantly decreased leg strength, slightly impaired proprioception, and increased amount of whole body sway. The results of the fear of falling questionnaire highlighted her lack of confidence and anxiety when walking in certain environments, especially outside but also within certain rooms in her house.

For the gait tests using the motion capture system, Kathleen’s general ability was within normal limits when walking in the unrestricted laboratory testing space. However, when we made the walking task more challenging by placing two or three fixed obstacles within the walking pathway which required her to walk around, Kathleen’s gait pattern changed dramatically. Under these more challenging conditions, her cadence decreased, the range of motion for each lower limb joint was reduced, and she appeared more hesitant when having to avoid objects in her path. On one single trial, Kathleen experienced an episode of “freezing,” where she literally stopped half way through the walking task and only continued after a period of 10-20 seconds. It was obvious that the combination of her decline in leg strength and her perception of the difficulties of walking through this challenging environment contributed to her increased falls risk.

Based upon these results, we designed a specific six-week intervention for Kathleen that focused primarily on improving her leg strength, lower limb range of motion, and working on her balance and posture under more challenging situations. Following the intervention, she reassessed for her falls risk and walking ability using the same measurement tools. Her falls risk score dropped to 0.87 which was also reflected by improvements in leg strength and lower limb proprioception. When re-assessed for her walking ability, there was still a tendency to slow down under more challenging conditions, but there were no episodes of freezing. Kathleen also reported that she felt more comfortable and confident in performing this task.

Case Study #2

David is a 69-year-old male who had been diagnosed eight years ago with type-2 diabetes. As part of our screening process, David self-reported that he had fallen once in the past year, and that he had developed mild-to-moderate neuropathy (loss of sensation) in his legs. In addition to his concerns over his balance and walking ability, he stated that he was less active than he used to be and that he had put on weight over the past year (subsequent measures revealed that David had a body mass index (BMI) of 34). We performed a falls risk assessment on David using the PPA, assessed his fear of falling using a standardized set of questions, and measured his general balance and walking ability using the timed-up-and-go (TUG) test.

Based upon the results of the PPA evaluation, David had an overall falls risk value of 2.15, which put him in the “high” risk of falling category. Further analysis of the individual physiological measures revealed a number of factors which contributed to this high score, including significantly decreased leg strength, slower reactions (for both the hand and foot), impaired sensation within the lower limb, decreased awareness of where his lower limbs were in space (proprioception), and an overall increase in his amount of sway when standing. The results of the TUG test confirmed previous observations, that he was significantly slower to perform this task than would be expected for someone of his age.

In this case, we recommended that David enroll in our eight-week supervised balance training program. This program, performed three times a week for 40 minutes each session, consisted of a series of basic balance exercises, yoga exercises, and light resistance training. The aim of this program was to target and improve his balance skills, lower limb strength, and limb motion. At the end of the eight week training program, David was reassessed using the same battery of tests. The results of the post-training assessments were encouraging; David exhibited significant improvements in his leg strength, amount of postural motion and, interestingly, faster reaction times. In the simplest context, reaction time measures the time a person takes to react to an unexpected stimulus. In regard to everyday actions, the ability to react quickly and appropriately to sudden changes in the environment to prevent a trip or slip is essential for optimal balance and stability.

Consequently, the significant improvements seen in David's reaction times and strength translated to an overall improvement in balance and a reduction in falls risk (his actual score fell to 1.12). Further, his general walking ability improved dramatically, with his TUG scores now within the typical range of someone of his age. David felt the training was enjoyable and beneficial, and noted he felt more active and energetic (the benefits were also reflected in his BMI, which now was under 30). While David's falls risk score still placed him within the "moderate" falls risk category, improvements in general balance and walking ability were clearly seen after the intervention.

Conclusion

One of the keys to preventing a fall is being able to identify accurately those persons who are at greatest risk. There are a variety of assessments commonly used to screen for falls-risk. For the majority of these clinical tools (i.e., TUG, POMA and BBS), their strengths lie in screening of older adults who are at higher risk of falling, such as those that are frail or have disease-related impairments. In comparison, the Physiological Profile Assessment (PPA) affords a number of advantages in that it can provide more detailed information about the overall risk and the underlying physiological reasons for any decline in balance function. This information can, in turn, be used to develop a more individualized course of intervention to prevent a future fall. This latter point highlights one further issue about falls: falling can be considered a very individual problem. Even within a single cohort of people, individuals can often exhibit varying risk factors and fall at different points in their lifetimes. So, while there is still a need for quantitative and unbiased assessments for predicting falls, we must remember that the screening is primarily the first tool for identifying those at risk. The key is to gain insight into the unique properties which underlie falls for a given individual. A comprehensive falls risk assessment also requires time; unfortunately, there is no quick and easy tool that will work for all persons at risk. Ideally, individualizing the assessment by incorporating physiological measures in combination with functional movement assessments may provide the best means by which to tease out the underlying reasons for falls.

Study Questions

1. What are some of the major issues and health concerns with assessing falls in the older adult?
2. What are the benefits and limitations of many of the clinical assessments of falls risk?
3. Why is the individual assessment of physiological function essential for understanding falls risk?

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