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Simple Balance and Mobility Tests Can Assess Falls Risk When Cognition Is Impaired

Kathryn A. McMichael, RN, MSN,

Department of Psychiatry, University of Pittsburgh School of Medicine, Pittsburgh, PA

Joni Vander Bilt, MPH,

Department of Medicine, University of Pittsburgh School of Medicine, Pittsburgh, PA

Laurie Lavery, MD,

Department of Medicine, University of Pittsburgh School of Medicine, Pittsburgh, PA

Eric Rodriguez, MD, and

Department of Medicine, University of Pittsburgh School of Medicine, Pittsburgh, PA

Mary Ganguli, MD, MPH

Department of Psychiatry, University of Pittsburgh School of Medicine, and the Department of Epidemiology, University of Pittsburgh Graduate School of Public Health, Pittsburgh, PA

Abstract

Simple balance tests can help assess falls risk, particularly in cognitively impaired elderly who have elevated falls risk and might not accurately recall previous falls.

In 2006, almost 500 million people worldwide were aged 65 years of age or older. The National Institute on Aging projects that by 2030, this number will increase to 1 billion and represent 1 of every 8 persons in the world.¹ Health problems of the elderly therefore constitute rapidly growing public health concerns. Falls are a particularly prevalent health problem among the elderly and are associated with significant morbidity and mortality. In the United States, among those aged 65–74, falls cause 48% of unintentional nonfatal injuries, and 23.4% of unintentional fatal injuries.² These proportions are even higher among those 75 years and older, in whom falls make up 71.2% of unintentional nonfatal injuries and 39.3% of unintentional fatal injuries.² More than a third of the population 65 years of age or older falls each year, and half of these falls are recurrent.³ As the U.S. population ages, the total direct cost for falls is expected to be \$43.8 billion by the year 2020.⁴

Although falls are a preventable source of morbidity, health care utilization, and functional decline in older adults, only 34% of elderly patients receive any type of fall evaluation.^{5,6} In 2001, an expert panel on falls prevention⁷ recommended that all older patients in all health care settings be asked whether they have fallen in the past year, with affirmative responses triggering mobility testing using a measure such as the Get Up and Go (GUG) test.^{8,9} New guidelines, updated in 2006 but still unpublished, recommend screening questions and risk assessment followed by multifactorial assessment in those identified as at risk for falls.¹⁰ One key quality measure recommended in the Physician Quality Reporting Initiative (PQRI),

published by the Centers for Medicare and Medicaid Services in 2007, is the screening of all individuals aged 65 and over for falls risk in all health care settings.¹¹

Although hospitalized elderly appear to be at the highest risk of falls (2.9 to 13 falls per 1000 bed days),^{12,13} there is growing consensus that falls risk should also be assessed routinely in ambulatory care settings. There is also increased emphasis on recognizing subgroup differences in falls risk, for example, between community-dwelling persons and long-term care residents, and between cognitively intact and cognitively impaired elderly.¹⁰

Falls risk factors in the elderly include common age-associated deficits such as decreased mobility, visual impairments, arthritis, depressive symptoms, orthostasis, cognitive impairment, gait or balance impairment, muscle weakness, and the use of a higher number of prescription medications, with varying risks associated with individual classes of drugs.^{3, 14-16}

The ultimate purpose of assessing falls risk is, of course, to reduce falls and injury rates by incorporating safety interventions and adequate protective strategies into the nursing plan of care.¹⁷ As noted by Kelly et al.,¹⁵ nurses play a pivotal role in developing fall prevention strategies. In many care settings, nurses assess falls risk by asking patients about previous falls and risk factors for falls. In institutional settings, for example, patients are placed on "fall alert" if the assessment, which usually includes possible cognitive impairment, indicates risk of falling. However, in all health care settings, self-reported information can be inaccurate in older adults with cognitive impairment, and often patients are not accompanied by an informant who can provide corroborating information. Thus, brief objective tests of gait and balance could usefully complement the routine nursing assessment of the elderly patient.

The ideal assessment tool should be easy, quick, reliable, and accurate for identifying patients at risk.¹⁵ The Romberg test¹⁸ and the GUG test^{8,9} are familiar tools for identifying balance impairments and detecting falls risk. The Romberg sign for sensory ataxia was initially described by Moritz Heinrich von Romberg¹⁹ as a means of detecting neurosyphilis. It is now more generally used to determine abnormalities of proprioception (ie, joint position sense or sense of posture).¹⁹ For this test, the patient stands with feet together and arms by the side for 15 seconds to observe for sway or break in position. Because impaired proprioception can be overcome by visual or vestibular feedback,¹⁹ the Romberg test is performed first with both eyes open and then with eyes closed. The GUG test⁸ assesses gait and balance abnormalities by having the patient rise from a chair, walk a designated distance, and return to the chair and be seated. Further details are provided under Methods. We used the original nontimed version of the GUG test, because balance and mobility, rather than motor speed, were the focus of our inquiry. This version provides a satisfactory clinical measure of balance for the elderly population,⁸ although it has been subsequently modified in various ways by other researchers, including the creation of a timing component.^{9,14,20}

We tested the hypotheses that scores on the Romberg and GUG tests would be associated with falls risk, after adjusting for potential confounders, in older adults with and without cognitive impairment, within a clinical epidemiology study of a primary care population. If the hypothesized associations were present, nurses can use these tests to identify at-risk patients objectively with the goal of preventing future falls, particularly when a reliable history of previous falls cannot be obtained.

Methods

Design

Sampling and recruitment—The Steel Valley Seniors Survey²¹ was conducted in an economically depressed small-town region of Southwestern Pennsylvania. Fifteen primary care physicians in the general vicinity provided access to their patients and medical records, contingent on informed consent from the patients. These physicians were not a random sample but rather a subgroup of interested area physicians whose practices included considerable numbers of elderly patients. All patients aged 65 or older visiting participating physicians during the 2-year recruitment period were requested by office staff to consider talking with the researchers. All who agreed were interviewed by research staff who recruited them into our study, obtaining written informed consent using procedures approved by the University of Pittsburgh Institutional Review Board. Participants who could not understand the consent form were deemed unable to consent by the research nurse.

Baseline data collection—Data were collected by 6 trained research nurses with previous clinical geriatrics experience in either home health or hospice care. Training by the study geriatrician (ER) included thorough instruction and supervised practice in simple balance and mobility testing. At the office visit, each participant provided the nurse with basic demographic and contact information and underwent cognitive screening with the Mini-Mental State Examination (MMSE).^{22,23} Consent was also obtained for participants to be contacted at home if selected for further assessment. Those with MMSE scores at or below the standard clinical cut-point of 24 were contacted by telephone to request an in-home visit for a more detailed assessment. For comparison, the same assessment was provided to a randomly selected subgroup of participants, with MMSE scores of 25 or higher, who had visited the same physician within the same month as a participant with MMSE <24.

The baseline in-home assessment consisted of a standardized semistructured interview acquiring information related to health history (including falls history), medication use, a brief general physical, and neurological examination (including balance and mobility assessment), among other items (see Measures).

Follow-up data collection—All surviving participants who had baseline home visits were also invited to undergo annual follow-up home visits during which the entire assessment was repeated. For these analyses, subjects were considered lost to follow-up if they completed the baseline home visit but not the next 2 follow-up annual assessments.

Measures

Outcome variable—Falls History—The outcome of interest for this report was participants' self-reports to the nurse regarding falls during the preceding year, at the baseline home visit, and at the subsequent 2 annual assessments. Based on this history, we divided the sample into 2 groups: those reporting no falls and those reporting 1 or more falls. From a clinical perspective, falls prevention strategies do not differentiate between single and multiple falls because any one fall can have a debilitating effect on an individual's health.

Primary Explanatory Variables: Balance and Mobility Measures

Romberg Test—As summarized in Box 1, the nurse instructed the participant to stand with feet together, arms at the side, and eyes open while the nurse observed for substantial postural sway or break in position, after being reassured that the nurse would stand close by to catch the individual should he or she start to fall. Next, the nurse asked the participant to maintain that position and close his or her eyes for 15 seconds. Individuals with normal balance may sway slightly upon closing their eyes, but it is usually minimal, and they do not break position.

The Romberg sign is present, that is, the test is positive (abnormal) if the sway is considerable and the participant breaks position.¹⁹ Participants unable to stand with feet together with eyes open were considered untestable. For the current analyses, we combined the Romberg positive and untestable groups as “abnormal Romberg” test because, according to Bickley,²⁴ the inability to stand with feet together either with eyes open or closed could be indicative of cerebellar ataxia and places these subjects at risk for falling.

GUG Test—The nurse first identified the most unobstructed area in the home where the participant could walk for 10 feet, measuring and marking the distance on the floor with tape. The participant was instructed to sit back in a firm upright chair and then rise from it, without using his or her arms for support, so that leg strength could be assessed. The participant then walked for 10 feet before returning to the chair, so that gait abnormalities such as shuffling, ataxia, or apraxia could be observed. Participants who could not perform the full task, who needed their arms to rise, or who used assistive devices to walk were coded as abnormal. Reliability in administration and scoring of the balance tests was established among the research nurses by practice and supervision during training and reestablished annually to prevent drift.

Covariates: Additional variables analyzed in relation to reported falls included demographic characteristics (age, sex, education) and cognitive functioning (MMSE score categorized as <25 vs. ≥25). We also examined 2 measures of overall morbidity: self-rated health (categorized as “excellent,” “very good,” or “good” versus “fair” or “poor”) and total number of regularly taken prescription medications. Both are robust measures that correlate highly with morbidity²⁵ and mortality.²⁶ Number of medications is also associated with falls risk.^{3,15, 16} These covariates represent potential confounders that could distort the observed relationship between balance and mobility tests and falls if not controlled for in our multivariable models.

Statistical Methods

Data were analyzed using SAS.²⁷ The 2 falls groups (no falls, ≥1 fall), 2 Romberg groups (abnormal, normal), and 2 GUG groups (abnormal, normal) were first compared on their demographic and health characteristics using chi-square tests for categorical variables and *t* tests for continuous variables. An a priori *P* value of <.05 was considered statistically significant.

Logistic regression models were established to examine both cross-sectional and longitudinal associations. The outcome variable was baseline falls (during preceding year, as reported at baseline) in the cross-sectional models, and cumulative future falls (falls reported at first and second follow-up, combined) in the longitudinal models. The explanatory variables were baseline Romberg and GUG, each of which were first examined separately and then in a model adjusted for age, sex, education, and self-rated health. The longitudinal analyses, which modeled future falls, also included baseline falls as a covariate.

To explore further the association among cognitively impaired participants, we repeated these analyses using dummy variables to create 4 possible combinations of the 2 variables: Romberg (normal and abnormal) versus higher MMSE (≥25) and lower MMSE (<25). A similar analysis was conducted for GUG (normal and abnormal) versus higher MMSE (≥25) and lower MMSE (<25). Odds ratios and 95% confidence intervals were calculated. Given concerns that cognitively impaired individuals might not report falls accurately, a post hoc analysis was conducted to examine the relationship of MMSE (higher vs. lower) with abnormal Romberg and GUG tests among those who did not report falls.

We calculated the sensitivity, specificity, positive predictive value, and negative predictive value for Romberg and GUG for the 2 groups of future fallers (no falls, ≥1 fall) to determine

the ability of these 2 tests to predict falls. These were calculated as follows: *Sensitivity* [True Positives / (True Positives + False Negatives)], or the proportion of those who had at least 1 fall in the following 2 years who had an abnormal test result at baseline; *Specificity* [True Negatives / (True Negatives + False Positives)], or the proportion of those who did not fall in the following 2 years who had a normal test at baseline. In the more clinically relevant situation of assessing fall risk, predictive values provide the probability that falls will or will not occur. Thus, we calculated the *Positive Predictive Value* [True Positives / (True Positives + False Positives)] or the probability of future falls when the baseline test is abnormal, and *Negative Predictive Value* [True Negatives / (False Negatives + True Negatives)], or the probability of no future falls when the baseline test is normal.

Results

Overall Sample Characteristics

Of 1107 primary care patients aged 65 years or older screened in the primary care offices, 358 received the detailed in-home clinical assessment, as reported previously in detail.²¹ Women constituted 68.7% of the sample, and 66.8% had at least a high school education or the equivalent (GED). Their mean (SD) age was 77.5 (SD 6.7; range 65-95 years) (see Table 1).

Characteristics of Fallers

At baseline, of the 358 participants, 112 (31.3%) reported falling at least once during the preceding year. The range of reported falls was 1-7, except for 1 outlier who reported falling 30 times because of a balance problem following a stroke. Compared with those without reported falls, the fallers had significantly greater proportions with abnormal Romberg tests and abnormal GUGs, were less educated, and had a greater proportion taking 4 or more prescription medications at the time of the assessment (Table 1).

Characteristics of Participants with an Abnormal Romberg Test

Compared with the normal Romberg test group, participants with an abnormal Romberg test results were significantly older, included a greater proportion of women, and were less likely to have at least a high school education. They were also significantly more likely to have abnormal GUG tests, to score <25 on the MMSE, to rate their health as fair or poor, to be taking 4 or more prescription medications, and to report falls (Table 2).

Characteristics of Participants with an Abnormal GUG Test

The group with abnormal GUG results was significantly older and more likely to be female than the normal GUG group. Unlike the Romberg groups, the 2 GUG groups did not differ in education. The abnormal GUG group had significantly higher proportions with abnormal Romberg results and with scores <25 on the MMSE. They were also more likely to rate their health as "fair" or "poor," to be taking 4 or more prescription medications, and to report falls more often than the normal GUG group (Table 2).

Cross-Sectional Analyses

Logistic regression models used baseline falls (ie, self-reported falls during the preceding year) as the outcome variable and either the Romberg or the GUG test as the independent variable. Both abnormal Romberg and GUG tests were significantly associated with concurrent falls, even when adjusted for age, sex, education, and self-rated health (Table 3).

Longitudinal Analyses

Baseline Romberg and GUG tests as predictors of future falls—In longitudinal analyses, baseline self-report of falling was a significant predictor of future falls (ie, falls

reported at the next 2 annual assessments). In univariate analyses, abnormal baseline Romberg and GUG tests were both significant predictors of future falls over the subsequent 2 years. In the multiple logistic regression models, after adjusting for previous falls (at baseline), sex, age, education, and self-rated health, an abnormal baseline GUG remained a significant predictor for future falls, but an abnormal baseline Romberg test did not (Table 3).

Prediction of Future Falls in Cognitively Impaired and Unimpaired Subgroups

—Logistic regression models were fitted with 4 possible combinations of 2 variables: Romberg (normal and abnormal) and MMSE (low and high). A similar model was fitted with the GUG test in place of the Romberg. Having either an abnormal Romberg or an abnormal GUG was a significant predictor of future falls in the low MMSE group. However, after controlling for age, sex, education, self-rated health, and previous falls, only the GUG test remained a significant predictor of future falls in the low MMSE group (Table 4).

Relationship of cognition to GUG and Romberg tests—The preceding results raised the question of whether cognitively impaired individuals were failing to report falls accurately. A post hoc analysis was conducted, limited to participants who did not report falls, examining the relationship of MMSE (high vs. low) with abnormal Romberg and GUG tests. Among these 246 reported nonfallers, both balance and mobility tests were abnormal in a significantly higher proportion (23.7%) of those with low MMSE scores (<25) than the 10.1% of those with normal MMSE scores (chi-square 5.11, $P = .02$).

Sensitivity, specificity, positive and negative predictive values: These were calculated for no falls versus any falls over the subsequent 2 years, in relation to baseline Romberg and GUG tests. For future falls over the next 2 years, although the 2 balance tests had similar sensitivity, the GUG had higher specificity, positive predictive value, and negative predictive value than the Romberg (Table 5).

Discussion

In a sample of 358 ambulatory primary care patients aged 65-95 years, 2 brief, simple assessments of balance and mobility, the Romberg and GUG tests, were each significantly associated with falls reported both concurrently and over the subsequent 2 years. Although sensitivity of both tests was low, specificity and predictive value of each of them was high enough to warrant consideration as a nursing assessment tool to help identify those at risk for future falls.

A widely quoted article by Tinetti³ covers the scope of the clinical problem, the evidence on risk factors, assessment and interventions, guidelines, and areas of uncertainty. A comprehensive review of the literature on falls risk factors and risk assessment is not warranted here, given excellent reviews already published.^{3,12,15,28} The 2001 guidelines encourage a distinction between modifiable and nonmodifiable risk factors,⁷ some of which may be considered epiphenomena of the underlying conditions causing falls but could still be useful in identifying those at risk. A systematic literature review¹² revealed few prospectively validated studies of falls risk. Frequently reported risk factors include gait instability,^{3,12} balance problems,³ previous falls,¹² cognitive impairment,^{3,29} agitated confusion,¹² urinary frequency and incontinence,¹² daytime somnolence,³⁰ and overall number of prescription drugs.^{12,16} Specific drugs and drug classes implicated include digoxin, diuretics, class 1A antiarrhythmics,^{3,16} sedative-hypnotics,¹² antidepressants, neuroleptics, benzodiazepines, and anticonvulsants,³ although the literature on drug groups is inconsistent.¹²

The literature includes a variety of assessment tools for falls risk. The original nontimed GUG was found clinically satisfactory and had good reliability and validity.⁸ Other versions include

the timed GUG,^{9,14} which had good reliability, and the expanded GUG,²⁰ which was sensitive but time-consuming and required a multimemory stopwatch. Other tests include the Functional Reach^{9,13,14} and Morse Fall Scale, although nurses' clinical judgment has been found as helpful at predicting falls as either of these.¹³ Current guidelines^{3,10} do not recommend any particular test over the others but emphasize the need for multilevel, multifactorial assessment (ie, a history of falls followed by simple balance testing followed by a more detailed assessment). Oliver¹² suggested that we need either to develop better screening tools for routine use with all older adults or pay closer attention to the common risk factors to identify those patients with the greatest risk. Cognitive function is mentioned repeatedly as a risk factor for falls and as a factor to consider in falls risk assessment.^{3,12,29}

Our study extends the current literature on balance and mobility tests in falls risk assessment by examining the role of cognitive impairment in this relationship. Those with cognitive impairment may have poor recollection of their own falls history.³¹ In an ambulatory or other health care setting where cognitive status is not always known, and when a reliable informant is not always available, the routine use of these quick tests in nursing assessments could improve falls risk assessment and thus potentially reduce the number of falls. In our study, the GUG test remained a significant predictor for future falls in the cognitively impaired (low MMSE) group after adjusting for potential confounders. However, the GUG test requires both more time and more instruction to perform than the Romberg. Also, those with cognitive impairment may have more motor and praxis deficits as well, making the GUG the more challenging test for this group.

Despite the association of reported falls with abnormal results on these tests, we emphasize that a normal balance and mobility test does not imply absence of falls risk. Test results should be interpreted in the context of the full nursing assessment, with all relevant individual characteristics taken into consideration. The purpose of identifying patients with elevated falls risk is to target them for interventions to prevent falls, not to dismiss the possibility of falls risk in other patients.

Our finding that those taking many (4 or more) medications were at a greater risk of falling than those taking fewer medications is consistent with that of an earlier meta-analysis.¹⁶ This finding could reflect balance problems caused by specific drugs, by overmedication, or by the conditions for which the multiple medications are prescribed.

Our study participants were ambulatory primary care patients assessed in their homes, and our results may therefore not generalize completely to older adults in other settings, such as acute and long-term care. Similarly, results from our small-town Pennsylvania community sample of predominantly white older adults may not be typical of other populations. Our nontimed version of the GUG test is not directly comparable to the more standard version^{14,20,32} because our focus was not on speed of task completion.

Falls were assessed by self-report, and participants with poor recall may have underreported their previous falls. We explored this possibility in post hoc analyses limited to those with low MMSE scores who had reported no falls. Our finding that a substantial proportion of these cognitively impaired patients had abnormal mobility tests suggests that they may in fact have underreported falls. However, this only reinforces our interpretation that the use of objective mobility tests may be particularly valuable in cognitively impaired patients. Thus, a nurse should not rely on self-reporting of falls history in elderly patients especially if cognitive impairment is suspected. Although cognitive impairment alone should alert the nurse to place this patient on fall risk alert, cognition itself is quite often not assessed at the time falls risk assessment is typically performed.

The purpose of falls risk assessment is to prevent future falls. A review of prevention strategies is beyond the scope of this article, but similar to falls risk assessment, effective intervention strategies are multifactorial and based on the risks identified in the given individual.^{33,34} Components of multifactorial intervention strategies can include health and environmental screening, exercise training, environmental modification, and withdrawal of culprit drugs.^{14, 28,33} Exercise training programs have received particular attention in the literature with a previous meta-analysis demonstrating a 12% reduction in fall risk with exercise.³⁵ Several specific exercise programs that have reduced falls risk are listed in Table 6. However, the effectiveness of physical training for falls prevention in cognitively impaired older adults is less clear.³⁶

Baker⁵ reported that barriers to falls risk management included lack of awareness of fall morbidity and preventability, inadequate referral patterns, perceived lack of expertise and Medicare coverage, and lack of a federal mandate. The recently published PQRI parameters¹¹ should help to address the latter.

Nurses, whether working in the community or in the hospital or nursing home, play an important role in prevention of falls in the elderly.¹⁵ Prevention of falls among elderly individuals with cognitive impairment who are a particular high risk for falls needs to remain a research priority.⁴⁵ In the current climate of increasing emphasis on quality assurance and patient safety among an ever-expanding geriatric population, 2 simple mobility tests offer a potential approach to improving patient outcomes. Future research should determine prospectively whether the Romberg or GUG tests (or both) are useful additions to the nursing assessment in the acute and long-term care settings to identify fall risk and whether improved detection actually reduces the number of falls.

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