Physical Therapy
Journal of the American Physical Therapy Association

The Modified Gait Abnormality Rating Scale for Recognizing the Risk of Recurrent Falls in Community-Dwelling Elderly Adults

Jessie M VanSwearingen, Karen A Paschal, Paula Bonino and Jeng-Feng Yang

PHYS THER. 1996; 76:994-1002.

The Modified Gait Abnormality Rating Scale for Recognizing the Risk of Recurrent Falls in Community-Dwelling Elderly Adults

Background and Purpose. The purpose of this study was to determine the reliability and validity of measurements obtained with a seven-item modified version of the Gait Abnormality Rating Scale (GARS-M), an assessment of gait designed to predict risk of falling among community-dwelling, frail older persons. **Subjects.** Fifty-two community-dwelling, frail older persons, with a mean age of 74.8 years (SD=6.75), participated. **Methods.** A history of falls was determined from self-report or by proxy report. The GARS-M was scored from videotapes of subjects walking at self-selected paces. Gait characteristics were recorded during a timed walk on a 6-m brown-paper walkway. **Results.** Scores obtained by three raters for 23 subjects demonstrated moderate to substantial intrarater and interrater reliability. Concurrent validity, as assessed by Spearman rank-order correlation coefficients, was demonstrated for the relationship between GARS-M scores and stride length ($r=-.754$) and for the relationship between GARS-M scores and walking speed ($r=-.679$). Mean GARS-M scores distinguished between frail older persons with and without a history of recurrent falls (mean GARS-M scores of 9.0 and 3.8, respectively). **Conclusion and Discussion.** The GARS-M is a reliable and valid measure for documenting gait features associated with an increased risk of falling among community-dwelling, frail older persons and may provide a clinically useful alternative to established quantitative gait-assessment methods. [VanSwearingen JM, Paschal KA, Bonino P, Yang JF. The modified Gait Abnormality Rating Scale for recognizing the risk of recurrent falls in community-dwelling elderly adults. *Phys Ther.* 1996;76:994–1002.]

Key Words: *Accidental falls, Assessment, Gait analysis, Geriatrics.*

Jessie M VanSwearingen

Karen A Paschal

Paula Bonino

Jeng-Feng Yang

For community-dwelling older adults, mobility is a major factor contributing to independence.[1,2] Loss of independence frequently follows a fall or injury associated with a fall.[3] The more frequently falls occur, the greater the likelihood of mortality and morbidity for the older adult. Thus, a primary objective of geriatric assessment is identifying the older person with a history of falls.[4]

Researchers[5–9] have assessed the mobility of older adults by studying distance and temporal characteristics of gait. Changes in gait have been related to a history of falls among frail older adults (adults over 60 years of age with difficulty in one to three activities of daily living[10] and decreased physiologic reserve increasing their risk of disability[11]). Among frail older adults, an increased risk for falling has been associated with decreased walking speed, decreased step or stride length,[12–14] increased step width,[15] and increased variability of stride length and width.[16]

Wolfson et al[12] developed a videotaped system for rating qualitative abnormalities of gait that may be representative of older individuals who have an increased risk for falling, the Gait Abnormality Rating Scale (GARS). The GARS was designed to provide a simple clinical assessment of gait abnormalities and for implementation in a nursing home setting where there are time constraints, limited instrumentation, and minimal financial resources for assessment. The GARS is supposed to include variables that are intended to provide a description of gait associated with an increased risk of falling. The variables in the original GARS were variability of stepping and arm movements, guardedness (ie, a lack of propulsion or commitment to stepping), weaving, waddling, staggering, percentage of time in the swing phase of the gait cycle, foot contact, hip range of motion (ROM), knee ROM, elbow extension, shoulder extension, shoulder abduction, arm–heel-strike synchrony, head held forward, shoulder held elevated, and upper trunk flexed forward. The developers of the GARS

JM VanSwearingen, PhD, PT, is Assistant Professor, Department of Physical Therapy, School of Health and Rehabilitation Sciences, University of Pittsburgh, 6035 Forbes Tower, Pittsburgh, PA 15260 (USA) (jessievs+@pitt.edu), and Consulting Physical Therapist, Geriatric Evaluation and Management Program, University Drive Veterans Administration Medical Center, Pittsburgh, PA 15261. Address all correspondence to Dr VanSwearingen.

KA Paschal, PT, is Assistant Professor and Director of Clinical Education, Department of Physical Therapy, School of Pharmacy and Allied Health, Creighton University, 2500 California Plaza, Omaha, NE 68178. She was Consulting Physical Therapist, Geriatric Evaluation and Management Program, University Drive Veterans Administration Medical Center, at the time of this study.

P Bonino, MD, is Associate Professor of Medicine and Epidemiology and Associate Chief of Staff for Geriatrics and Extended Care, University of Pittsburgh School of Medicine and University Drive Veterans Administration Medical Center.

JF Yang, PT, holds a teaching position in Department of Rehabilitation Medicine, Medical College, National Cheng-Kung University, Tainan, Taiwan. He was completing the Master of Science degree, Department of Physical Therapy, School of Health and Rehabilitation Sciences, University of Pittsburgh, when he participated in this study.

This study was approved by the Biomedical Institutional Review Board of the University of Pittsburgh.

Portions of this article were presented at the Combined Sections Meeting of the American Physical Therapy Association; February 2–6, 1994; New Orleans, LA.

This article was submitted July 5, 1995, and was accepted March 27, 1996.

Table 1.
Characteristics of Participants With and Without a History of Falls

Characteristic	Recurrent Falls (n=36)			No Recurrent Falls (n=16)			All (N=52)		
	$\overline{X}$	SD	Range	$\overline{X}$	SD	Range	$\overline{X}$	SD	Range
Age (y)	75.2	7.03	61–95	73.9	6.19	64–85	74.8	6.75	61–95
Height (cm)	147.5	8.90	115.5–160.6	149.0	5.84	135.9–156.2	148.0	8.03	115.5–160.6
Weight (kg)	79.0	15.90	48.2–107.0	84.2	14.02	60.0–119.1	80.6	15.40	48.2–119.1

suggested that the original 16-item scale be "streamlined" to 7 items by eliminating items that (1) appeared to demonstrate little difference between groups of fallers and nonfallers, (2) appeared to be difficult to rate visually, (3) generally had the lowest interrater reliabilities, and (4) were redundant with other variables.[12]

To be useful, a measure of risk for falling among community-dwelling, frail older adults should (1) be usable in settings where geriatric assessments normally take place and (2) yield reliable and valid measurements. A streamlined version of the GARS appears to be appropriate for assessment of the elderly patient if the reliability and validity for predicting falls are acceptable. Concurrent validity with walking speed and stride length and interrater reliability of measurements obtained with the original GARS have been demonstrated for a nursing home population of older adults but not for community-dwelling older persons.[12]

We chose to study the clinical use of a seven-item version of the GARS, the modified Gait Abnormality Rating Scale (GARS-M), to determine the reliability and validity of the scale for assessing fall risk among a sample of community-dwelling, frail older adults. We expected the shortened scale to have acceptable reliability because only the variables previously found to be most reliable are scored[12] in the GARS-M and the reduction in the number of items lessens the time for scoring and the number of opportunities for errors in scoring. In addition to testing the modified scale on a community-dwelling population, we also determined the intrarater reliability for multiple raters and the concordance of individual variable scores between raters (Kappa statistic).

The purpose of our study was to assess the reliability and validity of measurements obtained with the GARS-M. Interrater and intrarater reliability were determined for GARS-M scores obtained by three physical therapist raters. Concurrent validity of the GARS-M was demonstrated by comparison with quantitative measures of gait speed and stride length. Finally, construct validity of the GARS-M in the assessment of recurrent fall risk was suggested by the ability of the GARS-M score to distinguish between community-dwelling, frail older persons with a history of falls and frail older persons without a history of falls.

Method

Subjects

Participants in the study were veterans referred to the Geriatric Evaluation and Management (GEM) Program of the University Drive Veterans Administration Medical Center (Pittsburgh, Pa) for evaluation. In the GEM Program, an interdisciplinary team approach is used to assess and manage community-dwelling, frail older veterans. The target population for the GEM Program has been community-dwelling older veterans who are experiencing difficulty managing daily activities and responsibilities needed for community dwelling. Nonambulatory older veterans and those with severe dementia or acute terminal illness are generally not seen by the GEM Program team.[13,14] The Biomedical Institutional Review Board of the University of Pittsburgh approved the study of the physical assessment of ambulation and fall risk among frail older veterans and waived the requirement of informed consent, as the assessments are part of the typical evaluation of the GEM Program in which the subject had agreed to participate.

Fifty-two community-dwelling, frail older veterans referred to the GEM Program team for evaluation from December 1991 through December 1993 participated. Veterans referred to the GEM Program who demonstrated the ability to follow verbal requests for movement or tasks, had sufficient strength of the ankle dorsiflexor and plantar-flexor muscle groups to move against gravity, and ambulated without assistive devices other than a straight cane participated. Because the population seen was predominantly male and because of the difficulty of obtaining a meaningful number of female veterans (in the time period indicated, only 1 female veteran was evaluated by the GEM Program team but was excluded from the analyses in the study), subjects were male veterans only. Characteristics of the subjects, including fall status, are presented in Table 1. The subjects' mean age was 74.8 years (SD=6.75, range=61–95), their mean height was 148.0 cm (SD=8.03, range=115.5–160.6), and their mean weight was 80.6 kg (SD=15.40, range=48.2–119.1). No differences were noted for age, height, or weight between the subjects with a history of falls and the subjects without a history of falls.

Measurements

History of falls. Each subject or the caregiver accompanying the subject reported the number of times the subject had fallen in the past year to the GEM Program clinical nurse specialist in a structured interview. A fall was defined as any unexpected loss of balance resulting in coming to rest on the ground or floor.[2,17] This definition, previously used by investigators studying community-dwelling older adults,[2,17] was used because we assessed fall history by self-report or proxy report from memory and the definition is amenable to data collection by self-report or proxy report. Two or more falls a year represents a substantially greater risk of falling than that of the older person who fell once or not at all in the previous year.[2,17]

Gait analysis. Determination of the GARS-M score involved using a standard camcorder for recording the subject walking at a self-selected pace on the smooth tile surface of the hallway of an outpatient clinic. Subjects walked past the camcorder, turned around, and walked back past the camera so that anterior, posterior, and lateral views from both sides of the subject could be recorded for scoring purposes.[12] The distance walked was approximately 76 m (25 ft) in each direction, for a total distance of about 152 m (50 ft).

Videotapes of the walks were replayed on standard video-monitoring equipment, allowing for repeated playback and slow-action and stop-action viewing of the walk. This method was designed to make use of the gait rating system easy and quick to perform, as Wolfson et al[12] noted in describing the development of the scale. Scoring from the videotape record also saves the time and energy of the frail older person during the clinical evaluation. Each of the seven items of the GARS-M was scored on the criterion-based rating scale (0–3) reported for the original GARS[12] (Appendix, page 1002). In scale order, the GARS-M consisted of the following items: (1) variability, (2) guardedness, (3) staggering, (4) foot contact, (5) hip ROM, (6) shoulder extension, and (7) arm–heel-strike synchrony.

Gait characteristics were recorded as described by Wolfson et al[12] and Cerny.[18] The participants wore permanent markers attached with masking tape to the back of the heel of the shoe, with the tip of the marker just touching the floor, during a timed walk on a 6-m brown-paper walkway. Stride length and walking speed were determined from the measures of three central strides of the walk to avoid any acceleration or deceleration effects of initiating or stopping a walk.

The physical therapists were unaware of the subjects' fall status prior to recording gait performance. Thus, scoring of the GARS-M and measurement of gait characteristics occurred without the potential of rater bias because of knowledge of the subjects' history of falling.

Reliability of the GARS-M scoring. The GARS-M score was determined independently by three physical therapist raters (three of the authors: JMVS, KAP, and JFY), on two separate occasions, for a subset of the subjects, the first 23 veterans included in the study. One of the physical therapist raters (rater 1) had less than 2 years of clinical experience, whereas the other two raters had greater than 14 years of experience each and specific experience in geriatric performance-based physical assessments. Approximately 7 to 10 days separated the first and the second trials of scoring the GARS-M, with the second trial occurring at least 7 days after the first trial. Raters participated in a training session prior to the independent ratings to facilitate the consistency of scoring. The videotapes of five pilot subjects were played, using the slow-action and stop-action modes frequently while the raters discussed scoring of each of the seven variables. Training continued until agreement among all raters was reached on the scoring of each variable for all of the pilot subjects. No discussion of scoring the GARS-M occurred after completion of the training session.

Data Analysis

Intrarater and interrater reliability of the GARS-M scoring were determined by two statistical methods. Cohen's Kappa statistic (K) for determining proportion of nonchance agreement[19] was used to describe the extent of agreement for scores of each of the seven individual items. Total scores were considered aggregate data, and the reliability was described using the intraclass correlation coefficient (ICC[2,1]).[20] The total GARS-M score is a sum of the seven individual items, and the total score represents a rank ordering of risk for falling based on the number of gait abnormalities recognized and the severity of any abnormality identified. The rank ordering of the original GARS total score was previously demonstrated by the association of greater GARS scores with more abnormal gait.[12] The ICC is an appropriate reliability coefficient for demonstrating the extent to which raters indicate similar rank orderings.[21] The Kappa was designed as an index of assessment, indicating the concordance between individual ratings, and loses the ordering information contained in a scale when used for ordered data.[22]

The ratings for the GARS-M by the three raters were compared using the Kappa statistic in three ways: deter-

Table 2.
Interrater Reliability for the Modified Gait Abnormality Rating Scale (GARS-M) Generalized Across Individual Variable Scores and for the Total GARS-M Score

Raters	Trial	Individual Variable Scores: Observed Agreement	Individual Variable Scores: K[a]	Total GARS-M Score ICC[b]
1 and 2	1	.610	.417	.932
1 and 2	2	.625	.431	.944
1 and 3	1	.644	.457	.974
1 and 3	2	.641	.447	.943
2 and 3	1	.861	.789	.951
2 and 3	2	.991	.886	.993
1, 2, and 3	1	.721	.577	.968
1, 2, and 3	2	.739	.603	.975

[a] Kappa for individual variables averaged into a generalized Kappa for the entire scale.
[b] ICC=intraclass correlation coefficient.

mination of intrarater reliability (agreement between two trials of the same rater), determination of interrater reliability (agreement among three raters for the same trial), and analysis of individual item scores (agreement of scores for an item, by all raters, for both trials). The Kappa values for each of the seven gait variables rated were averaged into a generalized Kappa[23] across the entire GARS-M for the determinations of intrarater and interrater reliability.

Concurrent validity was indicated by comparison of the GARS-M scores with a "gold standard," quantitative gait characteristics (stride length and walking speed) previously associated with an increased risk of falls among older adults.[5–7] Spearman rank-order correlation coefficients (r) of the GARS-M score and stride length and the GARS-M score and walking speed were calculated to characterize the relationship between the gait measures. For the determinations of concurrent and construct validity in this study, one of the physical therapist raters (JMVS) with experience in geriatric assessment, the use of physical performance measures, and clinical gait assessment (including the GARS-M) rated all of the videotaped walks using the GARS-M criteria.

Construct validity was evaluated by the ability of the GARS-M to distinguish between older individuals with and without a history of falls, as indicated by self-report or proxy report, previously shown to be an indication of relative risk of falling again.[1,2,15] An independent t test was used to determine whether a difference existed between the GARS-M scores of older adults with a history of falls and the GARS-M scores of older adults without a history of falls.

Table 3.
Reliability of Scoring Individual Variables of the Modified Gait Abnormality Rating Scale (GARS-M)[a]

Variable	Observed Agreement	K
Variability	.812	.635
Guardedness	.758	.587
Staggering	.471	−.490
Foot contact	.641	.451
Hip range of motion	.708	.533
Shoulder extension	.753	.613
Arm–heel-strike synchrony	.656	.485

[a] Comparison of 138 scores for each item (ie, three raters, two trials, 23 participants).

Table 4.
Gait Characteristics of Participants

	Recurrent Falls (n=36)		No Recurrent Falls (n=16)		All (N=52)	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Stride length (cm)	72.12	23.44	97.24	20.45	79.85	25.24
Walking speed (cm/s)	47.19	23.52	71.55	24.40	54.69	26.15
GARS-M[a] score	9.0	4.59	3.8	3.37	7.42	4.87

[a] GARS-M=modified Gait Abnormality Rating Scale.

Results

Intrarater Reliability

Comparison of the individual scores for the seven items of the GARS-M by the same rater for two trials using the Kappa statistic yielded generalized Kappa values of agreement of .493, .583, and .676 for the three raters. The physical therapist rater (JMVS) who scored the GARS-M for the validity determinations in this study demonstrated a Kappa coefficient of agreement of .676 for intrarater reliability. According to Landis and Koch,[24] the Kappa values reported would be interpreted as an indication of moderate agreement (K=.41–.60) to substantial agreement (K=.61–.80) . A Kappa value near zero is considered chance agreement. Very high Kappa values are frequently restricted, particularly with limited variability of the data.[23] Comparison of the first and second trial scores for each of the three raters yielded ICCs for intrarater reliability for the GARS-M total scores of .968, .950, and .984.

Interrater Reliability

Comparison of the three raters' individual scores for all seven GARS-M items yielded generalized Kappa measures of agreement for interrater reliability of .577 for the first trial and .603 for the second trial. Clinical experience in observational gait analysis may have been a factor influencing interrater reliability. The two more experienced physical therapists (raters 2 and 3) demon-

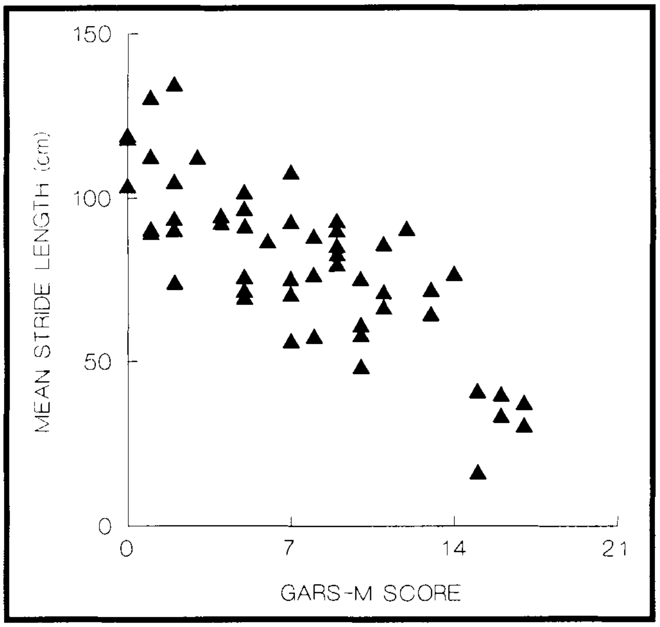

Figure 1.
Relationship between modified Gait Abnormality Rating Scale (GARS-M) score and mean stride length for community-dwelling, frail older subjects.

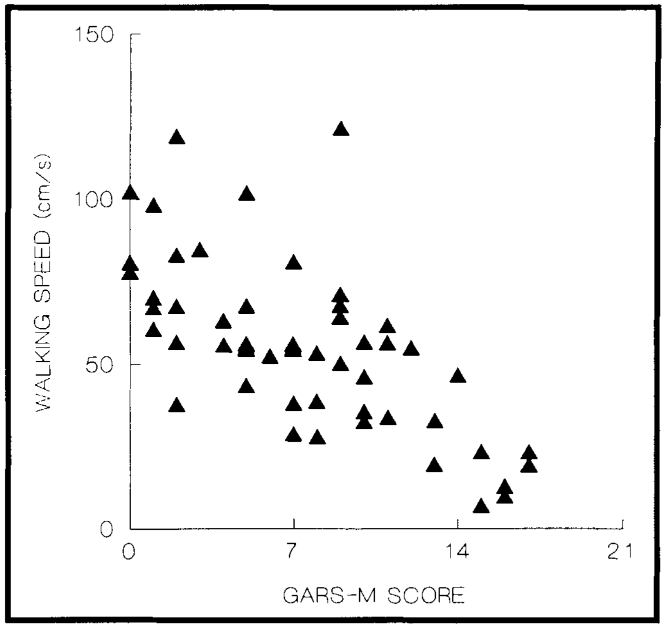

Figure 2.
Relationship between modified Gait Abnormality Rating Scale (GARS-M) score and walking speed for community-dwelling, frail older subjects.

strated higher interrater reliability for the first and second trials (K=.789 and .886) compared with the least experienced physical therapist (rater 1). The generalized Kappa values for the same comparison between the rater 1 and either of the other raters ranged from .417 to .457 for the four comparisons (Tab. 2). The ICCs for comparison of the GARS-M total scores for the three raters were .968 and .975 for the two trials. The ICCs for comparison of total GARS-M scores were highly reliable, regardless of the rater's clinical experience (Tab. 2).

Individual item scores determined by three raters for both the first and second trials were compared to describe the reliability of scoring any specific, individual item of the scale. Based on the comparison of six scores for each item, Kappa values were within the moderate agreement range for all variables, with the exception of the variable staggering. The Kappa value for staggering (K=−.490) indicated less than chance agreement for scoring of this item. Of the 138 individual scores for the variable staggering (ie, ratings of three raters, for two trials, for 23 participants), a score of zero occurred for 124 of 138 individual ratings. The low amount of variability for scores for staggering may have contributed to the poor agreement of scores for this GARS-M variable (Tab. 3).

Concurrent Validity

Mean stride length, walking speed, and GARS-M scores are shown in Table 4. Subjects with a history of falls took shorter strides ($\overline{X}$=72.12 cm) than did subjects without a history of falls ($\overline{X}$=97.24 cm). Subjects with a history of falls also walked slower ($\overline{X}$=47.19 cm/s) than did subjects without a history of falls ($\overline{X}$=71.55 cm/s). The relationship between stride length and the GARS-M scores illustrated that the subjects with shorter stride lengths showed more characteristics of risk for recurrent falls (r=−.754) (Fig. 1). A similar relationship between walking speed and the GARS-M scores existed, with slower walking speed associated with increased characteristics of the risk for falling (r=−.679) (Fig. 2).

Construct Validity

The GARS-M score distinguished between the subjects with and without a history of more than one fall in the year preceding the study. The mean GARS-M score for subjects with a history of falling ($\overline{X}$=9.0) was higher than the mean GARS-M score of subjects without a history of falling ($\overline{X}$=3.8) (t=4.583; df=2,50; P<.000).

Discussion

The results of the study indicate that GARS-M scores are reliable and provide a valid measure of some gait variables and the abnormalities associated with an increased risk of falling among community-dwelling older adults. Like the GARS[12] in the nursing home setting, the GARS-M is the first visually referenced measure of qualitative characteristics of gait with an acceptable level of reliability and validity for the evaluation of gait of community-dwelling older adults. Although observational gait-analysis methods, including videotaped methods, are the most widely used measures of gait assessment in the clinic,[25] the reliability and validity of measurements obtained with observational methods are lacking.

Unlike the findings among community-dwelling older adults reported by Wolfson et al,[12] the community-dwelling, frail older subjects at risk for falling in our study could be distinguished from those not at risk by stride length, walking speed, and GARS-M scores ($t=-3.905$; $df=2,50$; $P<.000$; $t=-3.359$; $df=2,50$; $P<.002$; $t=4.583$; $df=2,50$; $P<.000$, respectively). The ability to distinguish between persons at risk for falling and those not at risk for falling may be due in part to the relative frailty of the community-dwelling older persons studied. Our subjects generally demonstrated a shorter stride length and a slower walking speed than did subjects in other studies of gait abilities of community-dwelling older adults. The stride and speed measurements recorded for our subjects (Tab. 4) are generally between the previously reported values for community-dwelling older adults (stride length=66–83 cm, walking speed=100–120 cm/s) and nursing home residents (stride length=53–82 cm, walking speed=37–64 cm/s).[12]

The interrater reliability demonstrated for the GARS-M scores in our study was higher than the interrater reliability previously demonstrated by Eastlack et al[25] for ratings of spatiotemporal variables of gait (K=.11–.52, ICC=.19–.69). The inclusion of a training session for raters prior to data collection may be an important factor contributing to the improved reliability. In two similar studies of videotaped observational gait analysis[12,26] (including the study of the original GARS) in which training sessions for raters were conducted before data collection, the ICCs[26] and Spearman coefficients[12] for interrater reliability demonstrated were interpreted to be in the fair-to-good range, similar to the reliability demonstrated for the GARS-M scoring in our study. The opportunity to slow and stop the action and to play back the videotape repeatedly may be essential to obtain better accuracy in scoring the observational gait analysis scales. Scoring in this way from the videotape, however, does not preclude the use of the GARS-M in clinical practice. In our experience, scoring the GARS-M requires about 1 to 3 minutes per subject and can be done in the environs of the clinical setting.

Various factors contributed to the level of reliability for GARS-M scores. Scoring from a videotape of a walk reduces the potential for variance in the task that might occur if participants had to repeat the walk for the observer to complete the scoring. Therefore, we cannot project how reliability would be affected in practice by change in subject performance. Further research is needed in this area. The GARS-M consists of largely exclusive and exhaustive categories of variables. Scorings within each item are primarily criterion-based, making the differences between scores more clear to the rater. For example, the four levels of scoring foot contact each defined criteria for how the foot meets the ground, which do not overlap the other levels of scoring. Likewise, the scoring of one variable did not limit or cross over the scoring of other variables of the scale. For instance, a score of 2 in hip ROM (eg, thigh in line with the vertical) does not exclude any score for another variable, such as a score of 0 for variability (eg, fluid and predictably placed limb movements). In our ongoing experience using the GARS-M, the most difficult variable to make a score decision for is "guardedness," particularly the poorer performance ratings of the variable. Clinically, the criteria for the scores of 2 and 3 for guardedness do not always represent mutually exclusive categories of gait performance.

The lack of agreement for the scoring of the variable staggering compared with the moderate strength of agreement for the other six GARS-M variables may have occurred because of the low degree of variability of the ratings (eg, 90% of all ratings were scored zero for staggering), leading to increased chance of agreement and a low Kappa, which corrects for chance agreement.[24] The older subjects studied rarely demonstrated the gait abnormality of staggering. Reasons for the lack of staggering may include (1) the walking distance may have been insufficient for the event to occur with any frequency, (2) the smooth tile floors may have reduced the usual risk for staggering, or (3) staggering may not be common among these persons. Errors in scoring the variable are also a potential factor, but the criterion for scoring (ie, number of lurches) and the act of staggering are unlikely to be missed by raters. Although removing the variable of staggering from the scale to improve the reliability of GARS-M scores may seem warranted, in our experience, when subjects demonstrated staggering in the GARS-M assessment, they also reported having a history of falls. The validity of this variable staggering for distinguishing older adults with a history of falls encourages us to recommend including this variable in future investigations.

Conclusion

The GARS-M for rating qualitative aspects of ambulation appears to provide reliable measurements that may be valid for predicting the risk of falling in community-dwelling older adults. Because subject variability was not examined in this study, reliability of the measure when subjects are examined still needs to be determined. Using the GARS-M, older subjects known to be at risk for recurrent falls by report of fall history were distinguished from the subjects considered not at risk for falling based on self-reported fall history. Data suggest the use of the GARS-M for measuring gait qualities of older individuals and the use of these measurements for predicting the risk for recurrent falls. Further research will be needed to demonstrate whether these measurements are reliable when subjects are asked to repeat their performance and when different rater training protocols are used. Further research on the GARS-M is warranted, and further evaluation of clinimetric qualities such as responsiveness[27,28] (the ability of the GARS-M to detect a change in fall risk after intervention when clinically meaningful change has occurred) is needed. The GARS-M provides a simple way of directly observing and documenting abnormalities of gait, which may be useful in guiding interventions to reduce the risk of recurrent falls.

Acknowledgment

All of the members of the interdisciplinary GEM Program team, University Drive Veterans Administration Medical Center, Pittsburgh, Pa, were an important part of the program from which the data for this report were drawn. Their support and interest as colleagues and clinicians are appreciated.

References

1 Tinetti ME, Speechley M, Ginter SF. Risk factors for falls among elderly people living in the community. *N Engl J Med.* 1988;319:1701–1707.

2 Nevitt MC, Cummings SR, Kidd S, et al. Risk factor for recurrent nonsyncopal falls. *JAMA.* 1989;261:2663–2668.

3 Studenski S, Duncan PW, Chandler J, et al. Predicting falls: the role of mobility and nonphysical factors. *J Am Geriatr Soc.* 1994;42:297–302.

4 Robbins AS, Rubenstein LZ, Josephson KR, et al. Predictors of falls among elderly people. *Arch Intern Med.* 1989;149:1628–1633.

5 Bendall AJ, Bassey EJ, Pearson MB. Factors affecting walking speed of elderly people. *Age Ageing.* 1989;18:327–332.

6 Imms FJ, Edholm OG. Studies of gait and mobility in the elderly. *Age Ageing.* 1981;10:147–156.

7 Guimaraes RM, Isaacs B. Characteristics of gait in old people who fall. *International Rehabilitation Medicine.* 1980;2:177–180.

8 Gehlsen GM, Whaley MH. Falls in the elderly, part I: gait. *Arch Phys Med Rehabil.* 1990;71:735–738.

9 Gabell A, Nayak USL. The effect of age on variability in gait. *J Gerontol.* 1984;39:662–666.

10 Guralnik JM, Simonsick EM. Physical disability in older Americans. *J Gerontol.* 1993;48(Special Issue):3–10.

11 Buchner DM, Wagner EH. Preventing frail health. *Clin Geriatr Med.* 1992;8;1–17.

12 Wolfson L, Whipple R, Amerman P, Tobin JN. Gait assessment in the elderly: a gait abnormality rating scale and its relation to falls. *J Gerontol.* 1990;45:M12–M19.

13 Williams TF. Geriatric assessment methods for clinical decision making. Presented at the Consensus Development Conference, 1987, Bethesda, Md.

14 Winograd CH. Targeting strategies: an overview of criteria and outcomes. *J Am Geriatr Soc.* 1991;39:25S–35S.

15 Rubenstein LZ. Documenting impacts of geriatric consultation. *J Am Geriatr Soc.* 1987;35:829–830.

16 Rubenstein LZ, Stuck AE, Siu AL, Weiland D. Impact of geriatric evaluation and management programs on the defined outcomes: overview of the evidence. *J Am Geriatr Soc.* 1991;39:8S–16S.

17 Cumming RG, Miller JP, Kelsey JL, et al. Medications and multiple falls in elderly people: The St Louis OASIS Study. *Age Ageing.* 1991;20:455–461.

18 Cerny K. A clinical method of quantitative gait analysis. *Phys Ther.* 1983;63:1125–1126.

19 Cohen J. A coefficient of agreement for nominal scales. *Educational and Psychological Measurement.* 1960;20:37–46.

20 Shrout PE, Fleiss JL. Intraclass correlations: uses in assessing rater reliability. *Psychol Bull.* 1979;86:420–428.

21 Bartko JJ. The intraclass correlation coefficient as a measure of reliability. *Psychol Rep.* 1966;19:3–11.

22 McClure M, Willett WC. Misinterpretation and misuse of the Kappa statistic. *Am J Epidemiol.* 1987;126:161–169.

23 Haley SM, Osberg JS. Kappa coefficient calculation using multiple ratings per subject: a special communication. *Phys Ther.* 1989;69:970–974.

24 Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics.* 1977;33:159–174.

25 Eastlack ME, Arvidson J, Snyder-Mackler L, et al. Interrater reliability of videotaped observational gait-analysis assessment. *Phys Ther.* 1991;71:465–472.

26 Krebs DE, Edelstein JE, Fishman S. Reliability of observational kinematic gait analysis. *Phys Ther.* 1985;65:1027–1033.

27 Guyatt G, Walter S, Norman G. Measuring change over time: assessing the usefulness of evaluative instruments. *J Chronic Dis.* 1987;40:171–178.

28 Kane RA, Kane RL. *Assessing the Elderly.* Lexington, Mass: Lexington Book; 1981.

(Appendix follows on page 1002.)

Appendix.
Modified Gait Abnormality Rating Scale (GARS-M)[a]

1. Variability—a measure of inconsistency and arrhythmicity of stepping and/or arm movements
   0 = fluid and predictably paced limb movements
   1 = occasional interruptions (changes in speed) approximately 25% of the time
   2 = unpredictability of rhythm approximately 25%–75% of the time
   3 = random timing of limb movements
2. Guardedness—hesistancy, slowness, diminished propulsion, and lack of commitment in stepping and arm swing
   0 = good forward momentum and lack of apprehension in propulsion
   1 = center of gravity of head, arms, and trunk (HAT) projects only slightly in front of push-off, but still good arm-leg coordination
   2 = HAT held over anterior aspect of foot and some moderate loss of smooth reciprocation
   3 = HAT held over rear aspect of stance-phase foot and great tentativeness in stepping
3. Staggering—sudden and unexpected laterally directed partial losses of balance
   0 = no losses of balance to side
   1 = a single lurch to side
   2 = two lurches to side
   3 = three or more lurches to side
4. Foot contact—the degree to which heel strikes the ground before the forefoot
   0 = very obvious angle of impact of heel on ground
   1 = barely visible contact of heel before forefoot
   2 = entire foot lands flat on ground
   3 = anterior aspect of foot strikes ground before heel
5. Hip ROM—the degree of loss of hip range of motion seen during a gait cycle
   0 = obvious angulation of thigh backward during double support (10°)
   1 = just barely visible angulation backward from vertical
   2 = thigh in line with vertical projection from ground
   3 = thigh angled forward from vertical at maximum posterior excursion
6. Shoulder extension—a measure of the decrease of shoulder range of motion
   0 = clearly seen movement of upper arm anterior (15°) and posterior (20°) to vertical axis of trunk
   1 = shoulder flexes slightly anterior to vertical axis
   2 = shoulder comes only to vertical axis or slightly posterior to it during flexion
   3 = shoulder stays well behind vertical axis during entire excursion
7. Arm–heel-strike synchrony—the extent to which the contralateral movements of an arm and leg are out of phase
   0 = good temporal conjunction of arm and contralateral leg at apex of shoulder and hip excursions all of the time
   1 = arm and leg slightly out of phase 25% of the time
   2 = arm and leg moderately out of phase 25%–50% of the time
   3 = little or no temporal coherence of arm and leg

[a] Adapted from Wolfson et al.[11]

The Modified Gait Abnormality Rating Scale for Recognizing the Risk of Recurrent Falls in Community-Dwelling Elderly Adults

Jessie M VanSwearingen, Karen A Paschal, Paula Bonino and Jeng-Feng Yang

PHYS THER. 1996; 76:994-1002.