

# Motor Impairment Predicts Falls in Specialized Alzheimer Care Units

Richard Camicioli and Lisa Licis

**Abstract:** We sought to identify clinical risk factors for falls in people with advanced Alzheimer disease (AD) in a prospective longitudinal observational study set in specialized AD care units. Forty-two patients with probable or possible AD were recruited. Age, sex, Mini-Mental Status Examination, Clinical Dementia Rating Scale, Neuropsychiatric Inventory/Nursing Home, Morse Fall Scale (MFS), modified Unified Parkinson's Rating Scale (mUPDRS), and gait parameters using a GAITRite Gold Walkway System with and without dual-task performance were examined. Time to a first fall was the primary outcome measure, and independent risk factors were identified. Participating subjects were old (non-fallers age,  $82.3 \pm 6.7$  years; fallers:  $83.1 \pm 9.6$  years;  $p = 0.76$ ) and predominantly women (36 female/6 male). Fallers did not differ from non-fallers on any parameter except the MFS (non-fallers:  $35.6 \pm 26.1$ ; fallers:  $54.4 \pm 29.8$ ;  $p = 0.04$ ), the UPDRS (non-fallers:  $4.75 \pm 3.98$ ; fallers:  $7.61 \pm 4.3$ ,  $p = 0.03$ ) and cadence (steps per minute: non-fallers:  $102.3 \pm 12.3$ ; fallers:  $91.7 \pm 16$ ,  $p = 0.02$ ). Fallers and non-fallers were equally affected by dual-task performance. The hazard ratios for MFS, UPDRS, and cadence were not affected by adjusting for age, sex, MMSE, or NPI scores. In conclusion, falls in advanced AD can be predicted using simple clinical measures of motor impairment or cadence. These measures may be useful for targeting interventions.

**Key Words:** motor impairment, extra-pyramidal signs, gait, falls, risk factors

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Falls represent a major public health problem in the elderly and are associated with an increased risk of dependency, injury, and death.<sup>1</sup> Risk factors for falls include older age, the use of multiple medications, cognitive impairment, depression, orthostatic hypotension, as well as vision, strength, balance, or gait impairment. People with Alzheimer disease (AD), the most common cause of dementia, are at a threefold increased risk of falls<sup>2</sup> and have double the fracture risk<sup>3</sup> compared with cognitively intact elderly. Risk for falls in AD patients is increased with cognitive impairment.<sup>4–6</sup> A clinical

feature common in patients advanced AD is the presence of extra-pyramidal motor impairment,<sup>7</sup> which is expected to increase risk for falls. Extra-pyramidal signs may be associated with increased mortality in AD.<sup>8,9</sup>

Studies of falls and fractures in nursing home residents have generally not focused on patients with AD and often use administrative datasets,<sup>10–12</sup> with some recent exceptions.<sup>13</sup> A study of AD patients found that reduced “vigor” was associated falls.<sup>14</sup> Variability in quantitative gait measures was associated with falls.<sup>15</sup> Extra-pyramidal signs in AD have not been examined in the specialized AD care setting as a predictor of falls. We sought to determine if motor impairment predicted falls independent of cognitive or behavioral abnormalities in advanced AD patients. In addition, we determined if quantitative gait parameters, including dual-task performance, were independent risk factors. If confirmed as prospective predictors, extra-pyramidal motor signs or quantitative gait measures might complement established predictors in identifying residents with AD at increased risk for falls. This might assist in targeting interventions aimed at preventing falls and injuries.

## METHODS

### Subjects

Forty-two patients from two Alzheimer Care Units in Edmonton, Alberta, Canada were evaluated after consent was obtained from their family members or guardians. All 86 available residents were offered participation in the study. Forty-three (50%) agreed to participate. One subject's guardians provided consent, but the participant was unwilling to participate in the gait assessment. Patients had a diagnosis of probable or possible AD.<sup>16</sup> Charts were reviewed and paid care providers were interviewed to obtain basic demographic information, medications, and fall history and to determine global function (Clinical Dementia Rating, CDR),<sup>17</sup> cognitive status (Mini-Mental State Examination, MMSE, and the Brief Cognitive Rating Scale, BCRS),<sup>18,19</sup> medical illness (Cumulative Illness Rating Scale, CIRS),<sup>20</sup> and basic functional status (ADL portion of the Older Americans Resources and Services Procedures).<sup>21</sup> Behavioral abnormalities were identified with the NPI/NH through a nursing staff interview.<sup>22</sup> A research assistant (L.L.) scored each patient using the Morse Fall Scale (MFS), a brief, validated falls risk assessment scale,<sup>23</sup> and conducted gait analysis using a GAITRite Gold Walkway System. Identification of a past history of falls (a potential risk factor for future falls) was based on chart review. Patients were also evaluated by the principal investigator (R.C.) to determine

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if the history and examination were consistent with a diagnosis of possible or probable AD.

### Examination

All patients were examined by a neurologist (R.C.) blinded to information regarding falls. A brief mental status and neurologic examination was performed to assure that the clinical findings were consistent with a diagnosis of possible or probable AD. A modified ischemic rating score (MIS) was determined to assess the risk of cerebrovascular disease.<sup>24</sup> Motor signs were rated using an abbreviated version of the motor portion of the Unified Parkinson's Disease Rating Scale (mUPDRS, range, 0–44) that has been shown to be reliable in AD<sup>25</sup> and sensitive to dopaminergic medication effects in parkinsonian patients.<sup>26</sup> The following items on the mUPDRS were rated on a 5 point scale (0 = normal; 4 = maximally impaired): facial expression, speech, rest tremor, rigidity (axially and each limb), posture, global bradykinesia, and gait.

### Gait Analysis

The GAITRite Gold Walkway System (CIR Systems Inc., Clifton, NJ) was used to obtain measures of gait speed, cadence, step length, stride length, base of support, and the variability of these parameters for each patient. The GAITRite System consists of a 15 × 3 foot mat embedded with sensors on 0.5-inch centers providing an active area of 12 × 2 feet. It also includes a computer software program that controls the walkway and analyzes the data. Each participant was asked to walk on the mat three times and used the ambulatory aid or assistance to which they were accustomed. The first walk was an unrecorded practice walk, followed by two recorded walks. The first and second walks were at a self-selected speed. On the third walk, patients were asked to count from 1 upward by ones as they walked over the GAITRite mat. The order of the walks was fixed. Data obtained for analysis include speed, cadence, stride length, and base of support. Variability in each of these parameters was also examined and recorded as the coefficient of variation.

### Follow-up

Once evaluated, the patients were followed up to 1 year through bimonthly chart reviews for any documented falls. The end point for survival analysis was time to a first fall after the initial evaluation, but chart reviews continued over the period of the study. A fall was defined as an event that resulted in a person coming to rest unintentionally on the ground or other lower level and other than as a consequence of a major intrinsic event. For consistency, falls reported by patients and not witnessed or substantiated by staff were not included. Chart reviews have been shown to be a valid means for monitoring falls.<sup>27</sup>

### Data Analysis

Subjects were prospectively classified into fallers and non-fallers. Characteristics of prospective fallers and non-fallers were compared using  $\chi^2$ , *t* tests, or analysis of variance (ANOVA). A correlation matrix was calculated to examine the relationship among the gait variables. Cox proportionate hazard models were examined using time from initial assessment to a first fall as the primary dependent measure; non-fallers

were censored at their last chart review follow-up. Age, sex, MMSE score, NPI score and motor impairment (mUPDRS total score), Morse Falls Scale (MFS), and cadence were used to identify predictors of falls. After examining predictors individually, age and sex were maintained as covariates in the final models used to report the risks for the significant predictors. Separate models included UPDRS, MFS, and cadence to examine if these were predictors, independent of age and sex. Finally, a model was examined that included both UPDRS score and cadence to examine which of these were predictors of falls risk independent of each other. We also performed an additional analysis including site as a covariate. Area under the curve for receiver operator curves was calculated for the UPDRS, cadence, MFS, MMSE, and NPI. A *p* value of 0.05 was considered statistically significant. Data were analyzed using SPSS Release 10 for Windows (SPSS Inc, Chicago, IL).

## RESULTS

Baseline characteristics of the subjects are summarized in Table 1. The 18 fallers did not differ from the 24 non-fallers on any demographic characteristic. Twenty-two participants volunteered at one site, 20 at the other. Age, sex distribution, MMSE, NPI, UPDRS scores, total follow-up, and proportion of fallers did not differ between the two sites (data not shown). Time to a fall (site 1, 0.7 ± 0.41 years; site 2, 0.41 ± 0.2 years, *p* = 0.01) and MFS score (site 1, 28.6 ± 22.7; site 2, 60.3 ± 26.3, *p* < 0.001) differed between sites. Fallers only differed from non-fallers with respect to the MFS and the total UPDRS. When individual UPDRS items were examined, groups did not differ on any of the individual items, including speech (non-fallers mean 0.21 ± 0.51; fallers mean 0.44 ± 0.71, *p* = 0.21), facial expression (non-fallers mean 0.38 ± 0.71; fallers mean 0.50 ± 0.71, *p* = 0.58), tremor (non-fallers mean 0.04 ± 0.2; fallers mean 0.06 ± 0.24, *p* = 0.84, posture (non-fallers mean

**TABLE 1.** Subject Characteristics and Clinical Measurements With no Falls and Falls Showing Mean Values ± Standard Deviation

Measure	No Falls	Falls	<i>p</i>
Age	82.29 ± 6.69	83.06 ± 9.57	0.76
Sex (female/male)	22/2	14/4	
MMSE	14.67 ± 7.20	15.78 ± 7.58	0.63
BCRS	5.43 ± 0.90	5.36 ± 1.10	0.83
CIRS	21.38 ± 2.90	21.72 ± 2.49	0.69
MIS	1.88 ± 1.30	1.72 ± 1.60	0.73
MFS	35.63 ± 26.14	54.44 ± 29.80	0.04
Modified MFS*	26.25 ± 18.07	39.17 ± 22.96	0.05
Modified UPDRS	4.75 ± 3.98	7.61 ± 4.30	0.03
OARS-ADL	7.17 ± 3.62	8.56 ± 4.20	0.26
CDR	2.29 ± 0.81	2.22 ± 0.81	0.78
NPI/NH	19.38 ± 21.80	22.56 ± 29.18	0.69

MMSE = Mini-Mental State Examination; BCRS = Brief Cognitive Rating Scale; CIRS = Cumulative Illness Rating Scale; MIS = Modified Ischemic Scale; MFS = Morse Falls Scale; OARS-ADL = Older Americans Resources and Services Procedures-Activities of Daily Living; CDR = Clinical Dementia Rating Scale; NPI/NH = Neuropsychiatric Inventory/Nursing Home version.

\*Excluding item regarding previous fall history.

0.79 ± 0.93; fallers mean 1.39 ± 1.04, *p* = 0.06), bradykinesia (non-fallers mean 0.58 ± 0.65; fallers mean 0.67 ± 0.59, *p* = 0.67) and gait (non-fallers mean 1.17 ± 0.87; fallers mean 1.22 ± 0.73, *p* = 0.83). Groups differed with respect to the sum total of the five rigidity items (non-fallers mean 1.58 ± 2.06; fallers mean 3.33 ± 3.16, *p* = 0.04). Total follow up did not differ between the groups (non-fallers mean 0.825 ± 0.224 years; fallers mean 0.753 ± 0.208 years, *p* = 0.30). Time to a first fall ranged from 2 to 208 days following initial assessment. Fallers continued to experience falls with ongoing follow up.

The majority of subjects (35 of 43) continued to be followed at the time the study ended, 6 had been transferred to a long-term care facility, 1 to another specialized AD care facility, and 1 subject died. For those who were transferred or died, the last time of observation was used in the survival analysis. Among the fallers, the average total number of falls among was 5.1 ± 3.89 falls per person per year (range, 1–9 total falls). The mean for the overall group was 2.2 ± 3.59 falls per person per year. The proportion of subjects using neuroleptics (non-fallers: 6 of 24; fallers: 4 of 18; not significant), cholinesterase inhibitors (non-fallers: 6 of 24; fallers: 5 of 18; not significant), or anti-depressants (non-fallers: 9 of 24; fallers: 8 of 18; not significant) did not differ between groups.

Gait measures are summarized in Table 2. Cadence and speed were correlated with one another (*r* = 0.55, *p* < 0.001), but cadence did not correlate with any other gait variable. Speed was correlated with steps (*r* = 0.82 left and 0.84 right, *p* < 0.001) and stride length (*r* = 0.86 left and right, *p* < 0.001). Since step and stride length are derived from each other, these were highly correlated, as expected (data not shown). Left and right base of support were highly correlated with each other (data not shown). Among the other variables, there were no consistent correlations.

Gait data for fallers and non-fallers are presented separately. There was no difference between groups, except for cadence in the undistracted walk, which was lower in the fallers. Speed and stride were not significantly different between groups. Performance of a secondary task reduced cadence in both the groups to a similar degree. Groups did not differ in secondary task performance (fallers counting mean, 10.7 ± 5.2; non-fallers mean, 10.1 ± 4.7; *p* = 0.71).

Cox models that included age (*p* = 0.89), sex (*p* = 0.26), MMSE (*p* = 0.71), or NPI (*p* = 0.64) were not statistically significant. Cox models that included the UPDRS (relative risk, 1.14; 95% confidence interval [CI], 1.03–1.27, *p* = 0.02), cadence (relative risk, 0.96; 95% CI, 0.94–0.99, *p* = 0.01), and MFS (relative risk, 1.02; 95% CI, 1.003–1.04, *p* = 0.02) separately were significantly associated falls, but when UPDRS and cadence were combined, neither remained a statistically significant predictor. The overall model that included age, sex, and UPDRS score approached overall significance (*p* = 0.09) and did not affect the risk for UPDRS; relative risks (95% CI, *p*) for the covariates were: age (1.01; 0.94–1.08, 0.73), sex (0.57; 0.18–1.8, 0.34), and UPDRS (1.14; 1.02–1.28, 0.02). Similarly, the result for cadence approached significance (*p* = 0.05); relative risks (95% CI, *p*) for the covariates were: age (0.998; 0.94–1.06, 0.94), sex (0.42; 0.13–1.34, 0.14), and cadence (0.96; 0.93–0.99, 0.01). When both were included in a third model, the overall model was significant (*p* = 0.032), but neither UPDRS nor cadence was significantly associated with falls risk. Relative risks (95% CI, *p*) for UPDRS and cadence were: UPDRS (1.10; 0.97–1.23, 0.13) and cadence (0.97; 0.93–1.31, 0.06). Site was not a significant covariate when included in the models for UPDRS or cadence. In the model that included age, sex, and MFS, the overall model approached significance (*p* = 0.1); relative risks (95% CI, *p*) for the covariates were: age (0.98; 0.92–1.05, 0.57), sex (0.95; 0.26–3.5, 0.93), and MFS (1.02; 1.002–1.05, 0.03). Inclusion of the MMSE or NPI scores as covariates did not significantly affect the relative risks for the significant predictors.

Area under the curve for receiver operator curves were as follows: UPDRS, 0.72; cadence, 0.7; MFS, 0.68; MMSE, 0.54; and NPI, 0.51.

## DISCUSSION

Motor impairment, graded using the either UPDRS or cadence, as well as the MFS score, were predictors of falling risk in moderate to severely impaired people with AD living in specialized AD care units. Thus, motor signs, which are common in advanced AD, were associated with falls risk and might contribute to the increased mortality of AD patients.

**TABLE 2.** Gait Characteristics of Subjects With no Falls and Falls Showing Mean Values ± Standard Deviation

Gait Measure	No Falls		Falls		<i>p</i>	
	Regular Walk	Distraction Walk	Regular Walk	Distraction Walk	Regular Walk	Distraction Walk
Gait speed (cm/sec)	70.16 ± 17.42	66.54 ± 21.30	62.37 ± 19.25	61.34 ± 24.94	0.18	0.47
Cadence (steps/min)	102.33 ± 12.31	97.09 ± 20.71	91.68 ± 16.03	86.51 ± 18.21	0.02	0.09
Left stride length (cm)	82.82 ± 19.22	83.24 ± 22.85	81.45 ± 19.64	83.08 ± 23.29	0.82	0.98
Left stride length variability	5.79 ± 2.95	5.25 ± 3.47	5.89 ± 3.20	5.67 ± 3.48	0.92	0.70
Left base of support (cm)	11.08 ± 3.90	10.72 ± 4.75	11.48 ± 4.52	11.01 ± 4.30	0.76	0.84
Left base of support variability	15.13 ± 10.82	24.71 ± 21.95	22.22 ± 21.58	18.06 ± 10.11	0.17	0.24
Right stride length (cm)	83.56 ± 19.81	83.33 ± 23.02	81.22 ± 18.61	82.98 ± 23.97	0.70	0.96
Right stride length variability	5.38 ± 2.67	5.25 ± 3.82	6.11 ± 3.60	4.83 ± 2.57	0.45	0.69
Right base of support	11.04 ± 4.13	10.96 ± 4.47	11.40 ± 4.78	10.81 ± 4.08	0.79	0.91
Right base of support variability	22.67 ± 21.39	23.42 ± 22.61	22.06 ± 21.16	22.72 ± 21.61	0.93	0.92

Falls are common in nursing home populations, with a rate of 1.5 falls per bed per year.<sup>10,28</sup> In our study, 43% of the subjects fell during the follow-up period, with an overall rate of falls of 2.2 falls per person per year, consistent with prior research in diverse nursing home populations. Of note, residents who experienced falls often suffered multiple falls for a rate of 5.1 falls per person per year (with a range of 1–9 total falls), highlighting the importance of identifying individuals at exceptionally high falls risk. A recent study suggested that demented patients in nursing homes have as many as 4.1 falls per person per year, which was twice the rate of nondemented residents.<sup>29,30</sup>

The MFS, which predicted falls, has been examined in various settings,<sup>23</sup> but its validity and strength as a predictor have been recently disputed.<sup>31,32</sup> Area under the curve for the UPDRS, cadence, and the MFS were similar, while the MMSE and NPI offered no utility in the prediction of falls.

The two units examined had favorable staffing with similar care philosophies and environmental layouts. Time to a fall and MFS score differed between the two sites, but no other patient characteristics differed. Inclusion of site as a covariate did not alter our main findings. The falls risk of the subjects in our study was in the range of patients who had had interventions in previous nursing home clinical trials,<sup>33,34</sup> consistent with the hypothesis that specialized care units may help maintain mobility in patients with AD.<sup>35</sup>

People with AD have decreased stride length and gait speed.<sup>36</sup> Results for cadence differ between studies.<sup>37,38</sup> In contrast to a previous study, we did not find that gait measures, other than cadence, differed between fallers and non-fallers or were predictors of falls.<sup>15</sup> Differences in populations, sample size, and methods for gait assessment may contribute to this discordance.

Measurement during performance of a secondary task while walking did not improve the prediction of falls. Dual-task performance affects gait in patients with AD,<sup>6</sup> a finding that may be related to decline of frontal lobe function that can be prominent in AD, especially in advanced disease.<sup>39,40</sup> It is possible that the counting task “paced” patients while they walked. We used a simple counting task because our pilot work in this population indicated that advanced AD patients could not reliably perform more difficult secondary tasks. While apparatus such as used in this study are needed to properly assess variability in gait, we conclude that decreased cadence, which can be measured using simple equipment, should be further examined as a predictor of falls.

Motor signs, as rated by the UPDRS, may be nonspecific in patients with AD and may not be indicative of extrapyramidal dysfunction in all patients.<sup>41</sup> Although marked gait abnormalities are unusual early in the course of AD, one third of patients with severe AD had gait abnormalities in a pathologic study, and these may overlap with other motor findings.<sup>42</sup>

A major strength of our study was that it prospectively evaluated patients meeting criteria for possible or probable AD. Evaluation of predictors was blinded to falls status. Our study highlights the importance of motor impairment, consistent with previous studies in the ambulatory elderly,<sup>43</sup> frail elderly<sup>44</sup> and the psychogeriatric population.<sup>45</sup>

Limitations of our study include the relatively small sample size and that only half of the potential participant's families consented to evaluation. Moreover, our population was predominantly female. Nevertheless, our sample size was based on previous research and predicted numbers of events. Assessments were only obtained at baseline; consequently, clinical features may have changed over time in the participants. Measurement of change over time would be of interest in future studies. We did not have detailed assessment prior to institutionalization and did not obtain autopsy confirmation of the diagnosis. Multiple pathologies often coexist with AD and do not detract from our conclusion that the expression of motor features is predictive of falls risk in patients with a clinical diagnosis of possible or probable AD.

## CONCLUSION

Our study suggests that motor signs are associated with an increased risk of falls in patients with AD. This might improve targeting of interventions for preventing injuries in patients with AD. Additional autopsy studies examining patients with advanced AD will be needed to identify the pathologic basis for motor impairment and extra-pyramidal signs in patients with dementia.

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## REFERENCES

1. Tinetti ME. Clinical practice: preventing falls in elderly persons. *N Engl J Med.* 2003;348:42–49.
2. Morris JC, Rubin EH, Morris EJ, et al. Senile dementia of the Alzheimer's type: an important risk factor for serious falls. *J Gerontol.* 1987;42:412–417.
3. Melton LJ 3rd, Beard CM, Kokmen E, et al. Fracture risk in patients with Alzheimer's disease. *J Am Geriatr Soc.* 1994;42:614–619.
4. Buchner DM, Larson EB. Transfer bias and the association of cognitive impairment with falls. *J Gen Intern Med.* 1988;3:254–259.
5. Buchner DM, Larson EB. Falls and fractures in patients with Alzheimer-type dementia. *JAMA.* 1987;257:1492–1495.
6. Camicioli R, Howieson D, Lehman S, et al. Talking while walking: the effect of a dual task in aging and Alzheimer's disease. *Neurology.* 1997;48:955–958.
7. Mitchell SL. Extrapyramidal features in Alzheimer's disease. *Age Ageing.* 1999;28:401–409.
8. Stern Y, Liu X, Albert M, et al. Modeling the influence of extrapyramidal signs on the progression of Alzheimer disease. *Arch Neurol.* 1996;53:1121–1126.
9. Haan MN, Jagust WJ, Galasko D, et al. Effect of extrapyramidal signs and Lewy bodies on survival in patients with Alzheimer disease. *Arch Neurol.* 2002;59:588–593.
10. Rubenstein LZ, Josephson KR, Robbins AS. Falls in the nursing home. *Ann Intern Med.* 1994;121:442–451.
11. Kiely DK, Kiel DP, Burrows AB, et al. Identifying nursing home residents at risk for falling. *J Am Geriatr Soc.* 1998;46:551–555.
12. Girman CJ, Chandler JM, Zimmerman SI, et al. Prediction of fracture in nursing home residents. *J Am Geriatr Soc.* 2002;50:1341–1347.
13. Koutsavlis AT, Wolfson C. Elements of mobility as predictors of survival in elderly patients with dementia: findings from the Canadian Study of Health and Aging. *Chronic Dis Can.* 2000;21:93–103.

14. Brody EM, Kleban MH, Moss MS, et al. Predictors of falls among institutionalized women with Alzheimer's disease. *J Am Geriatr Soc.* 1984; 32:877–882.
15. Nakamura T, Meguro K, Sasaki H. Relationship between falls and stride length variability in senile dementia of the Alzheimer type. *Gerontology.* 1996;42:108–113.
16. McKhann G, Drachman D, Folstein M, et al. Clinical diagnosis of Alzheimer's disease: report of the NINCDS-ADRDA Work Group under the auspices of Department of Health and Human Services Task Force on Alzheimer's Disease. *Neurology.* 1984;34:939–944.
17. Morris JC. The Clinical Dementia Rating (CDR): current version and scoring rules. *Neurology.* 1993;43:2412–2414.
18. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state": a practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res.* 1975;12:189–198.
19. Reisberg B, Ferris SH. Brief Cognitive Rating Scale (BCRS). *Psychopharmacol Bull.* 1988;24:629–636.
20. Parmelee PA, Thuras PD, Katz IR, et al. Validation of the Cumulative Illness Rating Scale in a geriatric residential population. *J Am Geriatr Soc.* 1995;43:130–137.
21. Camicioli R, Wild K. Scales for the assessment of the elderly with dementia. In: Herndon RM, ed. *Handbook of Neurologic Rating Scales.* New York: Demos Vermande, 1997:125–160.
22. Wood S, Cummings JL, Hsu MA, et al. The use of the neuropsychiatric inventory in nursing home residents: characterization and measurement. *Am J Geriatr Psychiatry.* 2000;8:75–83.
23. Morse JM, Black C, Oberle K, et al. A prospective study to identify the fall-prone patient. *Soc Sci Med.* 1989;28:81–86.
24. Rosen WG, Terry RD, Fuld PA, et al. Pathological verification of ischemic score in differentiation of dementias. *Ann Neurol.* 1980;7:486–488.
25. Bennett DA, Shannon KM, Beckett LA, et al. Dimensionality of parkinsonian signs in aging and Alzheimer's disease. *J Gerontol A Biol Sci Med Sci.* 1999;54:M191–M196.
26. Camicioli R, Oken BS, Sexton G, et al. Verbal fluency task affects gait in Parkinson's disease with motor freezing. *J Geriatr Psychiatry Neurol.* 1998;11:181–185.
27. Kanten DN, Mulrow CD, Gerety MB, et al. Falls: an examination of three reporting methods in nursing homes. *J Am Geriatr Soc.* 1993;41:662–666.
28. Rubenstein LZ, Josephson KR. The epidemiology of falls and syncope. *Clin Geriatr Med.* 2002;18:141–158.
29. Shaw FE. Falls in cognitive impairment and dementia. *Clin Geriatr Med.* 2002;18:159–173.
30. Van Doorn C, Gruber-Baldini AL, Zimmerman S, et al. Dementia as a risk factor for falls and fall injuries among nursing home residents. *J Am Geriatr Soc.* 2003;51:1213–1218.
31. O'Connell B, Myers H. The sensitivity and specificity of the Morse Fall Scale in an acute care setting. *J Clin Nurs.* 2002;11:134–136.
32. Eagle DJ, Salama S, Whitman D, et al. Comparison of three instruments in predicting accidental falls in selected inpatients in a general teaching hospital. *J Gerontol Nurs.* 1999;25:40–45.
33. Ray WA, Taylor JA, Meador KG, et al. A randomized trial of a consultation service to reduce falls in nursing homes. *JAMA.* 1997;278:557–562.
34. Becker C, Kron M, Lindemann U, et al. Effectiveness of a multifaceted intervention on falls in nursing home residents. *J Am Geriatr Soc.* 2003; 51:306–313.
35. Saxton J, Silverman M, Ricci E, et al. Maintenance of mobility in residents of an Alzheimer special care facility. *Int Psychogeriatr.* 1998;10: 213–224.
36. Alexander NB, Mollo JM, Giordani B, et al. Maintenance of balance, gait patterns, and obstacle clearance in Alzheimer's disease. *Neurology.* 1995; 45:908–914.
37. Visser H. Gait and balance in senile dementia of Alzheimer's type. *Age Ageing.* 1983;12:296–301.
38. O'Keefe ST, Kazeem H, Philpott RM, et al. Gait disturbance in Alzheimer's disease: a clinical study. *Age Ageing.* 1996;25:313–316.
39. Perry RJ, Hodges JR. Attention and executive deficits in Alzheimer's disease: a critical review. *Brain.* 1999;122:383–404.
40. Nakamura T, Meguro K, Yamazaki H, et al. Postural and gait disturbance correlated with decreased frontal cerebral blood flow in Alzheimer disease. *Alzheimer Dis Assoc Disord.* 1997;11:132–139.
41. Kurlan R, Richard IH, Papka M, et al. Movement disorders in Alzheimer's disease: more rigidity of definitions is needed. *Mov Disord.* 2000;15: 24–29.
42. Ala TA, Frey WH 2nd. Validation of the NINCDS-ADRDA criteria regarding gait in the clinical diagnosis of Alzheimer disease: a clinicopathologic study. *Alzheimer Dis Assoc Disord.* 1995;9:152–159.
43. Nevitt MC, Cummings SR, Kidd S, et al. Risk factors for recurrent nonsyncopal falls: a prospective study. *JAMA.* 1989;261:2663–2668.
44. Lipsitz LA, Jonsson PV, Kelley MM, et al. Causes and correlates of recurrent falls in ambulatory frail elderly. *J Gerontol.* 1991;46:M114–M122.
45. de Carle AJ, Kohn R. Risk factors for falling in a psychogeriatric unit. *Int J Geriatr Psychiatry.* 2001;16:762–767.