Characteristics and Predictors of Falls in Elderly Patients

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Background. Poor performance on mobility testing is one of a number of factors associated with increased falls in community-dwelling elderly. The significance of these associations has not previously been tested in a sample drawn exclusively from a primary care practice.
Methods. This 1-year prospective study recorded falls, fall injuries, and related factors in 120 ambulatory geriatric outpatients of a family medicine practice. The association of mobility score, physician's estimate of mobility score, physician's estimate of likelihood to fall, and other fall risk factors was assessed with whether participants fell. Subjects recorded falls and injuries on weekly postcards. Follow-up by telephone was done to ensure compliance.
Results. Thirty-seven (36%) of the 102 participants who completed the study fell once or more. There were 56 total falls, of which 27 (48%) caused injuries. Thirty-six (64% of total) falls occurred in or around the subject's home, and significantly more ($\chi^2 = 10.93$, $P < .001$) of these falls had intrinsic causes compared with falls away from home. Prestudy history of subjects' falls was significantly associated with subjects' falls during the study, although its sensitivity was only 41%. All other factors studied, including mobility score and the physician's estimates, were not significantly associated with fall status.
Conclusions. This study did not support the use of risk-factor determination to select primary care patients who should be assessed further for fall risk. The high prevalence of falls and injuries in this sample suggests that all elderly patients should be given fall prevention advice.
Key words. Aged; accidental falls; risk factors.
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Awareness of characteristics and risk factors associated with falls in elderly patients assists clinicians in making preventive interventions.[1,2] The applicability of these interventions to particular patients can be determined by appropriate history taking, physical examination, and, more specifically, mobility testing.[3,4]

Characteristics of falls in community-dwelling elderly patients that have been prospectively researched include: the site of the fall, environmental hazards, patient factors, and types of injuries. One study found that 52% of nonsyncopal falls occurred at home and that only one third of these were associated with an environmental hazard. However, such hazards were found in 61% of falls away from the residence.[5] Lach et al[6] found that 55% of falls were due to environmental factors, and 39% were related to subject-specific factors. Injuries occur in over 50% of falls,[5] with serious injuries in 11%,[7] and fractures in 3% to 6%.[5,7]

Prospective studies of noninstitutionalized older persons have associated a number of risk factors with falls. One such inquiry[7] identified sedative use, cognitive impairment, lower extremity disabilities, presence of palmomental reflex, abnormalities of balance and gait, and foot problems. Other investigations connect Parkinson's disease, history of three or more falls or a fall injury in the previous year, white race,[5] frailty,[8] and two or more stumbles, 4 or more days of bed rest, and self-report of declining health status[9] with falls. When the sexes were examined separately, falls in women were associated with the total number of drugs taken, use of drugs potentially causing orthostatic hypotension, standing systolic blood pressure <100 mm Hg, and muscle weakness; those in men were associated with stroke, arthritis of the knees, gait impairment, increased body sway, and decreased levels of physical activity.[10]

The effect of these fall-related factors on a patient's balance and gait can be analyzed by mobility testing.[11] In a study of 336 community-dwelling elderly over age 75 years, Tinetti et al[7] found that those with low mobility test scores had an odds ratio for falls that was nearly twice

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that for those with high mobility scores. Tests of mobility have been recommended for both screening and diagnostic evaluation of elderly patients.[3,4]

Our research has focused on determining the applicability of the mobility test to office patients of family physicians, a population that has previously not been studied. The first phase of this study examined the relationship between risk factors and mobility score.[12] The second phase, a prospective study that followed elderly family practice outpatients for 1 year, examined the following questions:

1. Are factors related to falls in this population similar to those found in previous studies?
2. Will those patients who do poorly on mobility testing suffer more falls in the subsequent year?
3. Can family physicians select those patients who will fall using information obtained during a routine office visit and prior knowledge of the patient?

Methods

Geriatric patients (age 65 years or older) who consecutively visited a five-physician family practice office and were ambulatory, mentally competent, and not acutely ill were eligible to participate in the study. Patients who did not have a diagnosis of dementia in their medical record and who were able to answer questions about falls were considered mentally competent.

Enrollment into the study and the gathering of initial data took place during 1 to 2 half-days per week between August 1989 and February 1990. Participants were studied using three data collection instruments at the time of enrollment. The first questionnaire, administered to the patient before the physician encounter, was to elicit information on history of falls and fall injuries, medications, problems with balance and walking, leg pain, and foot problems. On the second questionnaire, the attending physician estimated the patient's mobility score and the likelihood that the patient would fall and suffer fall injuries in the following year. Each patient's performance on maneuvers of balance and gait was then tested by one of the authors (W.A.H.) using the third instrument, a version of Tinetti's mobility test.[11] Possible scores on this mobility test ranged from a low of 0 to a high of 40.

Patients were provided with a 3-month supply of postcards at the time of the visit. Subsequent sets of postcards were mailed quarterly to the participants to complete a 1-year follow-up. On the postcards, one of which was returned each week, the participant recorded the dates of falls and whether injury occurred. A fall was defined as inadvertently coming to rest on the floor or another lower surface not as a result of syncope, seizure, stroke, or an excessive displacing force. One research associate (M.J.D.) telephoned patients within 1 week of the due date if they failed to return a postcard, or within 1 week of the return of a card reporting a fall. These follow-up telephone calls to fallers asked what the patients were doing when they fell and whether they fell to the floor, hit an object, or were injured. If participants were injured, they were asked the anatomic location of the injury, type of injury, and whether they received medical treatment.

Participants were categorized into two groups: (1) those who fell during the year they were enrolled in the study, and (2) those who did not fall. Fall status was the dependent variable for statistical analysis and the standard of validity for contingency table analysis. The measured mobility score and the physician's estimate of both mobility score and likelihood to fall were the primary independent or explanatory variables. Each fall was classified using the OASIS system as primarily: (1) extrinsic (related to environmental factors), (2) intrinsic (related to subject-specific factors), (3) non-bipedal (occurring when the subject was not in a bipedal stance), or (4) unclassifiable (because of unclear or missing information).[6]

Interval data were analyzed by two-tailed Student's *t* test and categorical data by chi-square, with an alpha of .05 accepted as significant. The measured mobility score and the physician's estimate of mobility score were dichotomized as low (<30) or high (≥ 30) for chi-square and contingency table comparisons. It was estimated that a sample size of 100 subjects would be required to achieve a power of .85 with an anticipated medium-effect size based on previous research results.[13]

Results

Of the 133 eligible patients, 120 agreed to participate in the study. Participants and decliners were not significantly different with regard to age, sex, or race. The participants' mean age was 74.7 years, and 96 (80%) were women. The sample was 94% white, 5% black, and 1% Oriental. The mean mobility score of the 120 participants was 32.7 out of a possible 40. Twenty-eight of the participants had low mobility scores (<30) and 24 of these were aged 75 years or older.

During the study period, 3 of the participants died and 15 others dropped out as a result of noncompliance or declining mental status (determined by chart documentation). Before dropping out of the study, 2 of the 18 had fallen. Of the 102 remaining participants, 21 had low mobility scores. Thirty-seven of the 102 participants recorded having sustained falls, and of these, 24 fell once

and 13 had multiple falls. The mean age of subjects who fell was 75.2 ± 7.1 years, and of those who did not, 74.5 ± 6.7 years.

There were a total of 56 falls, of which 28 (50%) were extrinsic, 27 (48%) were intrinsic, and 1 (2%) was unclassifiable. Of the falls caused by extrinsic factors: 11 were described as slips, 15 as trips, and 2 were from displacements caused by external forces. Falls related to intrinsic factors included 16 from impaired balance, 8 from cognitive impairment, and 3 from muscle weakness ("legs gave out").

Thirty (53%) of the falls occurred in the subject's residence, 6 (11%) elsewhere on the subject's property, and 20 (36%) off the subject's property. Twenty-four (67%) of the 36 falls that occurred in or around the home were classified as having an intrinsic cause, while only three (16%) of the falls that occurred away from the home were so categorized ($\chi^2 = 10.93, P < .001$). There was no significant association between age group and category of falls.

Twenty-six (48%) of the falls caused injuries, with one person sustaining two injuries from one fall. Falls on steps accounted for nine (16%) of the falls and four (15%) of the fall injuries. Only two of the fallers reported being unable to get up afterward. Injury types were 14 bruises, 6 abrasions, 5 sprains, and 3 fractures. The anatomic locations of these injuries were: head (3), arm (2), back (1), tailbone (1), hip (1), leg (5), knee (7), ankle (4), foot (1), and undetermined (2).

Table 1 lists the number of patients who fell and patients who did not fall in each of the risk-factor groups studied. These risk factors included age greater than 75 years, female sex, use of sedative medications, regular use of more than two medications, more than two diagnoses on the chart, a subjective report of lower extremity problems, or a subjective report of problems with balance or walking. Only a prestudy history of falls was statistically associated with falling during the study period using univariate analysis ($\chi^2 = 4.02, P < .045$). The sensitivity was only 41%, however, as just 15 of the 37 patients who fell had a prior history of falls. None of the risk factors were statistically associated with multiple falls.

When mobility score was cross-tabulated with fall status, the association was not statistically significant ($\chi^2 = .919, P = .225$). Contingency table analysis of the association between a low score and having at least one fall found a sensitivity of 27% and specificity of 83%. The positive predictive value was 48% in a sample where the prevalence of fallers was 37%. The association of mobility scores and multiple falls was even poorer ($\chi^2 = .3657, P = .54$). The association of Tinetti's condensed mobility score[7] with falls was also not significant for this sample. When the participants with mobility scores of 30 to 35 were removed, it was found that 48% (10 of 21) of those with lower scores fell compared with 44% (21 of 48) of those with higher scores ($\chi^2 = .766, P = .09$).

Table 1. Association of Patient Characteristics and Risk Factors with Falling

Patient Characteristics/Risk Factors	Patients Who Fell (n = 37)	Patients Who Did Not Fall (n = 65)
Mean age ± SD, years	75.2 ± 7.1	74.5 ± 6.7
Age ≥75, no. (%)	19 (51)	34 (52)
Female, no. (%)	33 (89)	49 (75)
Positive history of falls, no. (%)	15 (41)	13 (20)*
Sedative use, no. (%)	11 (30)	14 (22)
≥3 medicines used, no. (%)	19 (51)	37 (57)
≥4 diagnoses, no. (%)	15 (41)	35 (54)
Positive history of balance problems, no. (%)	12 (32)	16 (25)
Positive history of walking problems, no. (%)	9 (24)	16 (25)
Positive history of leg pain, no. (%)	13 (35)	29 (45)
Positive history of foot problems, no. (%)	9 (24)	17 (26)
Low mobility score, no. (%)	10 (27)	11 (17)
Low physician estimate of mobility score, no. (%)	11 (30)	19 (29)
Moderate or high physician estimate of likelihood to fall, no. (%)	8 (22)	17 (26)

**Significant at .05 level by chi-square.*

The physician's estimate of mobility score showed little association with falls ($\chi^2 = .000, P = 1.0$) or with multiple falls ($\chi^2 = 1.19, P = .27$). Similarly poor was the association between the physician's estimate of likelihood to fall over the subsequent year with falls ($\chi^2 = .07, P = .785$) and multiple falls ($\chi^2 = .047, P = .829$).

Discussion

In this study of elderly patients visiting a private family medicine group, 37% of the subjects fell during the 1-year period in which each was studied. This is consis-

tent with studies of community-dwelling elderly patients that were not office-based.[7,14–16] It confirms that a significant number of falls are sustained by elderly primary care patients who are ambulatory enough to make office visits.

Fall characteristics were very similar to findings in previous studies. About one half of the falls occurred in the home, and nearly one half resulted in injuries (about 5% of which were fractures). The number of falls classified as secondary to intrinsic factors and those caused by extrinsic factors were nearly equal. The causes of falls in and around the subject's home were primarily intrinsic, while those away from home were predominately extrinsic.

Previous research has indicated that physicians can identify their elderly patients who will do poorly on mobility testing,[12,17] and that poor mobility is associated with an increased rate of falls.[7] Mobility score, however, as well as physician's estimate of mobility score, physician's estimate of likelihood to fall, and other risk factors were poor predictors of falls in the present sample. In the study by Tinetti et al,[7] in which mobility testing was done by nurse researchers on subjects over the age of 75 years, a sensitivity of 80% and specificity of 50% were reported for the association between a condensed, seven-maneuver mobility test and falls.[7] This higher sensitivity and lower specificity compared with our results suggests: (1) a higher cutoff score dividing high from low mobility scores, (2) that the raters in the Tinetti study were more likely to classify performances on particular maneuvers as abnormal, or (3) that the sample was drawn from a population dissimilar to that visiting this family medicine office. The presence of one of these factors is supported by the finding that 65% of the subjects in the study by Tinetti and colleagues were given low mobility scores, whereas only 47% of subjects over the age of 75 years were given low scores in the present study. Despite the good sensitivity (74%) in that study, the positive predictive value was a modest 40% in a sample where the pretest prevalence of falling was 32%.

One explanation for the poor association between mobility score and falls is that more mobile elderly persons are exposed to greater environmental and other activity-related risks for falls. Less mobile people may be more cautious and less active, and thus limit their risk of falling. We did not find a significant difference between the number of falls in subjects with lower mobility scores (<30) compared with those with higher mobility scores (>35); however, the number of subjects compared was small. The recent study by Speechley and Tinetti,[8] in which demographic, physical, and psychological variables were used to assign subjects to frail, vigorous, or transition groups, did not support this explanation. The authors found that the frail group had more falls (52%) than the vigorous group (17%); however, serious injury occurred in 22% of falls of the vigorous subjects compared with 6% of the frail subjects.

The present study is limited by the sample size, patient enrollment method, instrument simplification, and practice population. The prevalence of falls in our study provided adequate power for the primary comparisons; however, the absolute number was too small to allow subgroup analyses such as a comparison of the effects of short and long half-life hypnotics. Another limitation was that each subject's mobility testing was done only once and on days on which they were able to make an office visit; therefore, this score may not have been representative of the patient's average mobility level. While patient compliance was facilitated by simple instruments, this limited the number of variables studied. For example, risk exposure could not be assessed because no measure of daily activities was made initially or during follow-up. Generalizability to other patient populations is limited by the fact that the majority of the subjects were white and female.

Conclusions

This study is the first description of the characteristics of falls, risk factors associated with falls, and the rate of falls in patients visiting the offices of primary care physicians. The study showed that: (1) over one third of the subjects fell, and nearly one half of fallers were injured; (2) two thirds of the falls occurred in or around the subject's home, and these usually had an intrinsic cause; (3) most falls away from home had an extrinsic cause; (4) prestudy history of falls was significantly associated with falls, although the sensitivity was low; and (5) patient mobility score, physician estimate of mobility score, physician estimate of likelihood to fall, and other risk factors were not significantly associated with falls or multiple falls.

Larger studies of community-dwelling elderly persons have associated various factors with risk of falls; however, the clinical significance of these associations remains to be established. Studies that include the longitudinal measurement of intrinsic and extrinsic risk factors for falls will allow the relationship of these factors and the effectiveness of related interventions to be further clarified. In the interim it is prudent to give advice on fall and injury prevention (Table 2) to all geriatric patients, in recognition of the high prevalence of these hazardous events in this group.

Table 2. Fall Prevention Advice for Elderly Patients

- Reduce hazards in the home, and anticipate outdoor hazards.
- Stay physically and socially active. If you increase your activity level, do it gradually.
- Avoid sudden changes in position, especially when feeling weak or unsteady.
- Wear appropriate footwear at all times. Avoid high heels and smooth soles.
- Use assistive devices (cane or walker) for ambulation if beneficial.
- Report worsening vision or hearing to your physician.
- Minimize your use of sedatives and alcohol.
- Consult with your physician when you feel ill or unsteady after taking medications.
- Work with your physician to reduce the total number of medications that you take.
- Ask your doctor for an evaluation if you are fearful of falling.

Adapted from Hindmarsh and Estes,[3] Tinetti and Speechley,[4] and Tideiksaar.[18]

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