Fall History Is an Independent Predictor of Adverse Health Outcomes and Utilization in the Elderly

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Objective: To determine whether a history of falls predicts functional decline, adverse health events, and hospitalization.

Study Design: Twelve-month prospective cohort study.

Patients and Methods: Participants were members of a Medicare managed care program. Outcomes were assessed each quarter and included functional status, healthcare utilization (hospitalization), and adverse events (hospitalizations, nursing home placement, or death). Subject healthcare utilization diaries were corroborated with health system data files.

Results: At baseline, 70% reported no falls (NF), 18% had 1 fall (F), and 12% reported 2 or more falls (RF). Fall status predicted functional decline; new ADL deficits were seen in 18% of NF, 28% of F, and 55% of RF ($P \leq .0001$). Following adjustment for baseline function, this association remained predictive (adjusted odds ratio [OR] for new ADL deficits: 3.5, $P = .007$; and for new ADL and IADL deficits: 12.0, $P = .0001$). Fall frequency was a univariate predictor of adverse events (hospitalizations, nursing home placement, or death) and of hospital utilization alone. One or more adverse event(s) occurred in 18% of NF, 22% of F, and 38% of RF ($P = .049$). Hospitalization occurred in 16% of NF, 22% in F, and 35% of RF ($P = .03$). Following adjustment for likelihood of future hospitalization (P_{ra}), these associations remained predictive for RF (adjusted OR for one or more adverse event[s]: 2.4, $P = .05$; OR for hospitalization 2.4, $P = .06$).

Conclusions: Fall history predicts decline in function, hospitalization, and adverse events among a Medicare managed care population and remains independently predictive of poor outcomes after controlling for baseline function and likelihood of future hospitalization.

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to have high rates of health services utilization, independent of associated injury.[1,3-5] In this study of a Medicare managed care population, we evaluated whether self-reported fall history can be used as a marker of future functional decline and adverse events such as nursing home placement, hospitalization, or death. We also determined whether self-reported fall history was an independent predictor for adverse outcomes by controlling for baseline functional status and hospitalization risk with a recently developed and validated measure of future hospital admission.[6,7]

··· METHODS ···

Subjects

Participants for the study were recruited between April and November 1996. Consecutive patients were screened and recruited from primary care clinics of a Veteran's Affairs network site and a Medicare Health Management Organization serving a common geographic area. This report addresses only the Medicare managed care program population because of significantly different patterns of utilization between the 2 sites.

Eligible individuals were 65 years or older, lived within 20 miles of the provider site, had received care in the system for at least 1 year, were living in the community, and met screening criteria for mental sta-

F alls are common in elderly individuals and can contribute to immediate and ongoing functional dependence and significant utilization of healthcare resources.[1,2] A history of falls is a marker of frailty and identifies Medicare recipients likely

tus and mobility. Participants had to score 24 on the Folstein Mini-Mental State Examination (MMSE)[8] to assure that they could independently maintain a utilization diary; subjects with MMSE scores between 16 and 24 could participate if they had a caregiver who could maintain the diary, and those with scores less than 16 were excluded because they were expected to have difficulty with health reporting. Mobility screening was based on walking ability. Our goal was to study a sample with a range of performance and risk of outcome events. Hence, persons who were unable to walk at least 12 feet or who were felt to be extremely fit (gait speed over 1.3 m/s) or extremely fragile (gait speed less than 0.2 m/s) were excluded.

This was a prospective cohort study in which subjects were recruited from their primary care clinic site and followed with baseline and quarterly home visits in addition to brief assessments at each primary care clinic visit. Results are presented here for the first 12 months of follow-up.

Of the 1252 subjects in the Medicare managed care population who were contacted, 385 subjects agreed to be screened. Of these subjects, 350 met all entrance criteria and 35 were excluded (8 did not meet the mobility criteria, 8 did not meet the cognitive requirement, 3 had not been in care for at least 1 year, 1 lived outside the study radius, 7 did not want home visits, and 8 were excluded for other reasons including involvement in other research studies and refusal to participate).

The sample size varied for different analyses because of missing data. Baseline fall data were missing for 2 subjects, and 9 subjects did not have baseline or incident change data for activities of daily living (ADL). Twelve-month functional status data were available for 325 subjects; cumulative reasons for data loss by the 12-month visit included 10 deaths, 5 nursing home placements, 2 moves from study radius, 6 changes of primary care providers, and 2 "other". Boult's probability of repeat admission (P_{ra}) scores (see Measures) were available on 283 subjects.

Measures

Baseline assessments included demographic characteristics, cognition (MMSE),[8] depression (Yesavage Geriatric Depression Scale),[9] social support[10] self-reported comorbid conditions, and hospitalization risk (using the P_{ra}). The P_{ra} is a validated instrument that includes 8 factors found to be the strongest predictors of future hospitalization (previous hospitalization, age, gender, global self-reported health, available social support, 6 or more physician visits in the previous year, and presence of diabetes

or heart disease).[6,7] Scores range between 0 and 1, with a risk threshold of 0.286. Patients identified as high risk (ie, scores higher than 0.286) have more claims for inpatient and outpatient services.[6,7] Baseline and quarterly assessments of functional status were obtained with the National Health Interview Survey (NHIS).[11]

Utilization was monitored through health system data files that tracked emergency department visits, hospitalizations, long-term care placement, and deaths and through similar information recorded in healthcare diaries maintained by participants or caregivers. The 2 files were merged, and any discrepancies were resolved by review of original medical documents and additional patient and provider interviews. Emergency department use was not included in our analyses because its definition was inconsistent between provider systems and patients.

Major outcomes, selected a priori, were functional status, utilization, and adverse events. Decline in functional status was based on NHIS functional status items. Personal care difficulty was defined as a report, at any quarterly home visit, of new onset of difficulty in a basic ADL (eating, dressing, bathing, toileting, grooming, and transferring) using the NHIS items. The primary measure of utilization was one or more hospitalizations. Adverse events were measured by the occurrence of any adverse event, which included hospitalizations, nursing home placement, or death. A consensus panel of 2 physicians, 2 physical therapists, and a biostatistician preselected major outcomes, including criteria for significant change, on the basis of cross-sectional data and experience. Outcome events were considered to have occurred if they were detected at any point during the 12 months of follow-up.

Analysis

The statistical analyses were designed to assess the relationship between 2 baseline measures of fall history and the 3 major outcome measures described previously. Analyses were conducted in 3 phases. Preliminary descriptive analyses of the baseline data were used to characterize the sample and to assess cross-sectional relationships between fall history and function. As a part of these analyses, Pearson chi-square tests were used to test for differences in categorical demographic characteristics as a function of fall history, and Wilcoxon rank sum tests were used to test for differences in continuous demographic characteristics as a function of fall history. Contingency tables and logistic regression models were then used to assess relationships

between fall history and longitudinal outcome measures. Initially, analyses of the relationships between fall history and each of the dichotomous outcome measures were conducted by using contingency tables with the 3-level ordinal variables as defined earlier, with formal inference based on Mantel-Haenszel statistics using standardized rank scores.

In the next stage of the analysis, logistic regression models were used to assess adjusted relationships of fall history to each of the appropriate outcome variables. The adjusted relationship of fall history to functional decline was controlled for age and baseline functional status. The adjusted relationship of fall history to hospitalization and one or more adverse event was controlled for Boult's P_{ra}. The focus of these analyses was on the potential confounding effect of these baseline predictors on the point and interval estimates of the association between fall history and outcomes. However, Wald tests from the logistic models were used to generate P values for the association between the outcomes and each predictor, including the falls variable and each of the potential covariates. Also, for each logistic regression model, the area under the receiver operating characteristic (ROC) curve was used to characterize the contributions by additional covariates.

··· RESULTS ···

Baseline Demographics and Fall Frequency

The average age of subjects at baseline was 74 years, 62% were women, and 9% were black (**Table 1**). Initial descriptive analysis revealed variability in the propensity to fall. In the year preceding evalua-

tion, 70% of the population had no falls (NF), 18% experienced 1 fall (F), and 12% reported 2 or more falls (RF). Fall rates were similar to those reported previously in the Medicare population surveyed in the Longitudinal Study of Aging.[4]

Relationship Between Fall Status and Outcomes

The pattern of utilization across the fall continuum is shown in **Table 2** and was similar to those reported previously.[4,5] Main outcome measures revealed that fall status was predictive of functional decline from baseline; new ADL deficits were seen in 17.8% of NF, 27.8% of F, and 55.2% of RF ($P \le .0001$). Fall frequency was a univariate predictor of any adverse event (hospitalization, nursing home placement, or death), which increased from 18.4% in NF to 21.8% in F to 37.9% in RF ($P = .049$). A significant difference was also noted between NF and both fall categories for hospitalizations (NF = 16.3%; F = 21.8%; RF = 34.5%; $P = .03$).

Relationship Between Fall Status and Adjusted Outcomes

A history of falls remained predictive of functional decline after adjustment for age and baseline functional status (**Table 3**). While baseline functional status dependence did demonstrate significant increased risk for future decline (OR for baseline dependence in ADL = 3.6 and OR for baseline IADL dependence = 12.0) history of repeated falls remained a significant factor after adjustment. Fall status also remained predictive of hospitalizations and any adverse event after controlling for P_{ra}. The adjusted OR for RF for hospitalization was 2.4 ($P = .06$) (**Table 4**) and the adjusted OR for one or

Table 1. Baseline Characteristics of the Sample

Population Characteristic	All Subjects n = 348	NF n = 255	F n = 61	RF N = 32	P*
Age (years), mean (SD)	74.0 (5.8)	73.9 (5.6)	73.7 (5.8)	76.1 (6.7)	.20
Female gender, n (%)	215 (61.8)	154 (60.7)	41 (67.2)	20 (62.5)	.61
Black race, n (%)	32 (9.2)	25 (9.8)	6 (9.8)	1 (3.1)	.69
Completed high school, n (%)	252 (72.0)	180 (70.6)	44 (72.1)	26 (81.3)	.95
MMSE cognition score, mean (SD)	27.7 (2.3)	27.8 (2.1)	27.7 (2.2)	27.0 (2.9)	.34
Fair or poor global health, n (%)	57 (16.3)	48 (18.8)	6 (9.8)	3 (9.4)	.45
P_{ra} score (n = 283), mean (SD)	0.29 (0.10)	0.27 (0.10)	0.30 (0.12)	0.31 (0.11)	.45

NF = no falls; F = 1 fall; RF = repeated falls; MMSE = Mini-Mental State Examination; P_{ra} = probability of repeated admission.
*The Pearson chi-square test was used to test for differences in prevalence of categorical demographic characteristics as a function of prior falls and the Wilcoxon rank sum test was used to test for differences in continuous outcomes as a function of previous falls.

Table 2. One-Year Cumulative Outcome Rates

Outcomes	All Subjects	NF	F	RF	*P*
Adverse events					
One or more hospitalizations, n (%)	61 (18.9)	39 (16.3)	12 (21.8)	10 (34.5)	.03
Deaths, n (%)	10 (3.1)	9 (3.8)	1 (1.8)	0 (0.0)	.22
Any adverse event (hospitalization, nursing home placement, death), n (%)	67 (20.7)	44 (18.4)	12 (21.8)	11 (37.9)	.049
Functional status					
New difficulty with basic ADL function, n (%)	73 (22.9)	42 (17.8)	15 (27.8)	16 (55.2)	<.0001

NF = no falls; F = 1 fall; RF = repeated falls; ADL = activities of daily living.
Of the 350 subjects originally enrolled in the study, only 323 (239 NF, 55 F, 29 RF) either had an adverse event or completed the year 1 examination with no event and could be evaluated for the adverse event outcomes. Four additional subjects had missing ADL values, so only 319 subjects were evaluated for the functional status outcome. Difference in outcome prevalence was evaluated using the one degree of freedom Mantel-Haenszel chi-square for ordinal categories.

more adverse events was 2.4 (*P* = .05) (**Table 5**). Weak correlation was noted between the P_{ra} and age (0.32) or baseline functional status (0.19).

··· DISCUSSION ···

In this study, we show that a history of falls in the preceding year is a risk factor for functional decline, adverse health events, and health services utilization among members of a Medicare managed care population. Odds ratios revealed a continuum of increasing fall risk for functional decline and health services utilization according to number of falls in the preceding year. Individuals with 1 or more falls

were 3.5 times more likely to have a subsequent decline in function and were 2.4 times more likely to be hospitalized.

Fall history remained predictive across outcomes, even in combination with a validated risk adjuster for future hospitalization.[7] Previous studies among Medicare recipients identified similar associations, but controlled only for basic demographic and independently rated health and functional status factors.[4,5] In this study, through the use of a multidomain instrument such as the P_{ra}, we have controlled for a broad range of social, demographic, and medical factors that predispose to frailty and corresponding utilization of healthcare resources.

Table 3. Fall Frequency Associated with Functional Decline

	Adjusted for Age (AUROC=0.65, n=316)		Adjusted for Age and Baseline ADL (AUROC=0.78, n=316)	
	OR (95% CI)	*P*	OR (95% CI)	*P*
Fall frequency				
NF	(Reference)		(Reference)	
F	1.7 (0.85-3.4)	ns	1.4 (0.63-2.8)	ns
RF	4.8 (2.1-11.0)	.002	3.5 (1.4-8.6)	.007
Age	1.1 (1.0-1.1)	.042	1.03 (0.97-1.1)	ns
Baseline function				
Dependent in ADL	—		3.6 (1.8-7.6)	.0004
Dependent in IADL	—		12.0 (5.5-27.6)	.0001

NF = no falls; F = 1 fall; RF = repeated falls; ADL = activities of daily living; AUROC = Area under receiver operating characteristic curve; NS = not significant.

Even after adjustment for such a broad range of factors, fall history, and in particular history of repeated falls, continued to be independently predictive of adverse events.

Self-reported fall history could therefore be a rapid and accurate marker for older adults at risk of adverse events related to falls and of decline in health or functional status. Such risk stratification would allow providers, health plans, or other entities assuming financial risk to identify individuals most likely to benefit from interventions, which can be both beneficial and cost effective when aimed at specific high-risk groups among the elderly. In both long-term care and community settings, targeted interventions for fall prevention have been successful in decreasing disability and overall costs.[12,13] Comprehensive assessment programs in high-risk older individuals have demonstrated beneficial outcomes in a variety of settings.[14,15] In addition to interventions that target falls, programs directed at specific disease states such as congestive heart failure have also demonstrated improved clinical and fiscal outcomes.[16] As numbers of the elderly increase, rapid identification of persons who can benefit from evaluation and targeted intervention will become increasingly important. We recommend routine annual assessment of fall history and fall risk for older adults after age 70.

Limitations of the Study

The sole use of a managed care population with its attendant selection bias is a limitation of this study. Because of the selection process and intended biases inherent in a prospective cohort trial, the study population may not represent an average, community-based older adult population; the absence of individuals who chose not to participate and exclusion of those who could not maintain healthcare diaries or provide subjective estimates of health and function limit the study's generalizability. Nevertheless, our recruited subjects did represent a broad range of function and had overall fall frequencies similar to those of previous national probability samples drawn from the Medicare registry.[4,5]

Another potential limitation is the use of simple recall to determine fall history. Although subjects' recall of past health events has limited validity, patterns of fall history obtained in this study are consistent with self-reported fall rates among Medicare populations.[4,5] In addition, the ease of obtaining such information within the course of usual care is a major advantage and would allow providers and healthcare systems to identify susceptible patients who could benefit from directed evaluation and intervention.

Table 4. Fall Frequency Associated with Hospitalization

	Unadjusted (AUROC=0.57, n=283)		Adjusted for Baseline P_{ra} (AUROC=0.68, n=283)	
	OR (95% CI)	P	OR (95% CI)	P
Fall frequency				
NF	(Reference)		(Reference)	
F	1.4 (0.6-2.9)	.45	1.3 (0.6-2.8)	.56
RF	2.6 (1.1-6.3)	.03	2.4 (0.9-5.8)	.06

NF = no falls; F = 1 fall; RF = repeated falls; P_{ra} = probability of repeated admission. AUROC = Area under receiver operating characteristic curve.

Table 5. Fall Frequency Associated with any Adverse Event

	Unadjusted (AUROC=0.57, n=283)		Adjusted for Baseline P_{ra} (AUROC=0.70, n=283)	
	OR (95% CI)	P	OR (95% CI)	P
Fall frequency				
NF	(Reference)		(Reference)	
F	1.2 (0.5-2.5)	.68	1.1 (0.63-2.8)	.85
RF	2.7 (1.1-6.3)	.02	2.4 (1.4-8.6)	.05

NF = no falls; F = 1 fall; RF = repeated falls; P_{ra} = probability of repeated admission; AUROC = Area under receiver operating characteristic curve.

From this analysis, it is not possible to determine whether individuals with a decline in ADL or with certain levels of health services utilization are members of a cohort who have an overall decline in health independent of fall status. Our intent is to report an easy method by which primary care providers, health plans, or other entities can identify older adults at risk for subsequent falls, health services utilization, and functional decline. We believe such individuals would benefit from further targeted assessments of future fall risk as well as from comprehensive assessment for other remediable conditions common in older adults. In this analysis, therefore, we report the number of self-reported "falls, stumbles, or trips" that occurred in the year preceding the study, although this method does not allow us to determine the cause of ADL decline or utilization. Other investigators have suggested that fall status is an important proxy for overall medical and functional status.[13] Adults 70 years and older should therefore be screened for falls, with appropriate consideration for degree of existing frailty.

In summary, the results of this study in a Medicare managed care population suggest that individuals with a history of falls, particularly a recent history of more than one fall, are at increased risk for future functional dependence, adverse events, and health services utilization that may or may not be related to the fall. These patients would benefit from comprehensive evaluation and targeted prevention or treatment programs.

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