#3427 RCT falls elderly

The Value of Assessing Falls in an Elderly Population

A Randomized Clinical Trial

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Objective: To measure the effects of a specialized postfall assessment intended to detect causes and underlying risk factors for falls, and to recommend preventive and therapeutic interventions.

Design: Randomized, controlled trial.

Setting: A long-term residential care facility for elderly persons.

Subjects: Within 7 days of a fall, 160 ambulatory subjects (mean age, 87 years) were randomly assigned to receive either a comprehensive postfall assessment (intervention group, $n = 79$) or usual care (control group, $n = 81$).

Intervention: The postfall assessment included a detailed physical examination and environmental assessment by-a nurse practitioner; laboratory tests; electrocardiogram; and 24-hour Holter monitoring. Probable cause or causes for the fall, identified risk factors, and therapeutic recommendations were given to the patient's primary physician.

Measurements and Main Results: Through use of the assessment, many remediable problems (for example, weakness, environmental hazards, orthostatic hypotension, drug side effects, gait dysfunction) were detected. At the end of the 2-year follow-up period, the intervention group had 26% fewer hospitalizations ($P < 0.05$) and a 52% reduction in hospital days ($P < 0.01$) compared with controls. Patients in the intervention group had 9% fewer falls and 17% fewer deaths than controls by 2 years, but these trends were not statistically significant.

Conclusions: Our study suggests that falls are a marker of underlying disorders easily identifiable by a careful postfall assessment, which in turn can reduce disability and costs.

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Falls account for substantial morbidity, mortality, and immobility among elderly persons, particularly among those living in institutions. Each year about one third of elderly persons living at home will fall, whereas in nursing homes annual rates have been reported at between 0.6 to 3.6 falls per bed (1, 2). Approximately 10% to 20% of these falls result in serious injury and 2% to 6% result in fractures (1). The importance of falls lies both in their potential to cause morbidity and in their role as a possible marker for pre-existing morbidity.

Many studies have identified specific causes for falls (for example, syncope, drop attacks, postural hypotension) (1-3) as well as many epidemiologic risk factors associated with falling (for example, advanced age, female sex, drugs, weakness, poor balance, gait disorders) (4-10). On the basis of these studies, specific diagnostic assessments have been advised to identify "high-risk" patients (for example, aspects of the physical examination such as vision and muscle testing, medication profiling, Holter monitoring, gait testing, environmental assessment) (4, 5, 8, 9). Although it is logical to assume that persons prone to falling can benefit from a focused diagnostic assessment and preventive interventions—both to prevent further falls and to reduce the frailty and morbidity associated with falls—no controlled trials have been done to test the validity of this assumption.

The purpose of this randomized controlled trial was to determine whether a careful postfall assessment, coupled with referrals for specific treatment and preventive interventions, is a beneficial strategy among frail, institutionalized, elderly persons who have fallen. The assessment was designed to uncover general health problems as well as specific conditions and risk factors contributing to falls. Specific beneficial outcomes hypothesized to result from this intervention included reduction in recurrent fall rates, decreased morbidity related to falls and associated conditions (such as injuries, hospitalization), and decreased mortality. Another important objective was to determine which parts of the diagnostic assessment are most valuable in evaluating the patient who falls.

Methods

Patients

Subjects were recruited at the Jewish Homes for the Aging of Greater Los Angeles (JHA), a 732-bed long-term residential care facility providing multiple levels of care. Residents at the JHA have a wide spectrum of functional abilities and disabilities; they range from

functionally independent persons who live in the board-and-care areas to persons dependent to varying degrees on nursing care in the skilled nursing areas. All residents enter the JHA while they are still able to function at the board-and-care level. Movement to a level of increased care occurs when the resident requires closer supervision. Most residents (75%) are women and the mean age is 88 years. Medical care is provided by seven community internists, two staff geriatricians, and two nurse practitioners.

All known falls at the JHA are recorded on nursing incident reports by the staff member who witnesses the fall or who learns of the fall from the resident or other witnesses. For the purpose of this study, a fall was defined as an event, reported either by the faller or a witness, resulting in a person inadvertently coming to rest on the ground or another lower level, with or without loss of consciousness or injury. During the randomization phase of the study, the research nurse practitioner recorded all the fall incident reports from the previous day in a log book and determined, using pre-established criteria, the appropriateness of residents ("fallers") for the study. To be included in the study, the resident must have fallen within 7 days of the time the nurse practitioner received the report. Residents were excluded from the study if they were unable to walk; unable to be evaluated within 7 days of the fall due to acute illness, hospitalization, or a delay in receiving the incident report; suffering from a dementia severe enough to preclude cooperation; or unable to understand English. To avoid bias in selecting patients, the nurse practitioner screened fallers in strict chronological order of their fall date up to the 7-day limit. Residents not already in the study were rescreened after any subsequent fall. The nurse practitioner interviewed each eligible faller and obtained informed consent from those willing to participate in the study, using a written consent form approved by the human subjects protection committees of the university and the JHA.

Before randomization, the nurse practitioner administered a questionnaire to each eligible faller. The questionnaire included a detailed "fall history," designed to elicit specific data relevant to the fall, which is often omitted from the incident report and the medical record; standardized functional status scales validated for institutionalized elderly persons—the Lawton Activities of Daily Living and Instrumental Activities of Daily Living Scales (11); a validated screening test for cognitive impairment—the Kahn mental status questionnaire (12); and a basic assessment of current mobility status. In addition, the nurse practitioner carefully reviewed the medical record to determine active medical diagnoses and any medications taken within 48 hours before the fall. The nurse practitioner also interviewed nursing staff and witnesses to verify information obtained by fallers whom she judged to be unreliable. Eligible fallers were then randomly assigned to either the intervention or control group, using computer generated, randomly sequenced cards in sealed envelopes.

Immediately after randomization, patients assigned to the intervention group received the postfall diagnostic assessment. This assessment was based on principles of geriatric assessment (13) and was designed to uncover risk factors associated with falls (4-10) as well as problems of a more general nature. Because we were attempting to identify the most useful components of the postfall assessment, we included those assessments and laboratory tests that are typically done by clinicians as well as several others that have been recommended in the literature. Our assessment consisted of a complete physical examination, including a detailed quantitative neurologic and musculoskeletal assessment, visual acuity screening (Snellen chart), extended pulse and blood pressure assessment with attention to postural changes, assessment of footwear and foot problems, and a quantified balance and gait assessment using a 26-point version of the Tinetti scale (14). Laboratory tests were then done, including a complete blood count, urinalysis, creatinine, electrolytes, calcium, hepatic enzymes, serologic test for syphilis, and free thyroxine index. A standard 12-lead electrocardiogram was obtained as well as 24-hour ambulatory cardiac (Holter) monitoring. Finally, the nurse practitioner did a careful environmental assessment of the resident's room and other relevant areas to identify potential hazards (for example, lighting, bed height, obstacles, floor condition).

The nurse practitioner was thoroughly trained in the use of the protocol by the physician investigators. The first ten cases were assessed independently by both the nurse practitioner and the physician investigators, and overall agreement for judgmental items on the physical examination was over 90%. Throughout the study, after the nurse practitioner's diagnostic assessment, one of the physician investigators reviewed all the data collected and re-evaluated the resident if there was a questionable finding. This evaluation resulted in a list of the diagnostic impressions, which included the most likely primary cause for the fall, potentially contributing diseases and risk factors, and other findings of medical importance. The research team decided on the primary cause after carefully discussing all clinical information and gave a list of recommendations to the resident's primary care physician in a written report.

It took an average of 3 weeks from the incident fall for the primary care physician to review the research team's final recommendations. The intervention was a one-time occurrence. The nurse practitioner did not become involved in the treatment of subjects nor did she provide any further recommendations to the primary care physicians during the course of the study. Residents in the control group did not receive the assessment and no recommendations were transmitted. The JHA primary care physicians were aware that a "falls prevention study" was being done; however, these physicians knew few of the study details and played no direct role in the study itself other than to respond to the recommendations.

Follow-up data were collected for both intervention and control subjects at 3-month intervals for 1 year after randomization. Data collected included subsequent falls, hospitalizations, survival, level of care, fall-related injuries, mobility status, and medications. Two-year data were collected on subsequent falls, hospitalizations, and survival. We delayed the comparative follow-up period for subsequent falls and hospitalizations until 3 weeks after randomization to allow time for the pri-

mary care physicians to review and act on our recommendations and to separate effects of immediate fall-related morbidity from subsequent problems. Data on physician compliance with study recommendations and specific therapies instituted were collected for subjects in the intervention group. Data on physician evaluation and treatment were also documented for control group patients.

A comparison group of 309 non-fallers was identified retrospectively and included all ambulatory residents who had not fallen during the 12-month randomization period but who otherwise met the same eligibility criteria as fallers. This group represented 93% of the total number of non-fallers. Non-fallers were followed prospectively for 1 year to document mortality and hospital utilization.

Statistical Analysis

Pre- and post-test differences between the intervention and control groups were compared using the z-test of proportions for categoric variables (for example, living location, percentage of subjects hospitalized) and the *t*-test for equality of means for continuous variables (such as number of recurrent falls, number of medications). The Wilcoxon signed-rank test for nonparametric data was used to test for differences in survival, in the mean number of hospital days, and in hospital admissions for each group at 12- and 24-month follow-up. For all tests, *P* values were calculated with two-tailed rejection regions.

Results

Initial Findings and Interventions

Randomization of JHA residents began in October 1985 and continued through September 1986. During that 12-month period, 704 residents lived at the JHA—54% in board-and-care beds and 46% in skilled nursing beds. A total of 920 falls, involving 373 residents (53%), were documented by nursing incident reports. During that same period, 331 residents did not fall, of whom 93% were ambulatory. The annual fall rate for this period was 126 falls per 100 beds. Of the 373 residents who fell, 160 (43%) were ultimately randomized into the study (79 intervention subjects and 81 controls). Figure 1 depicts the final screening classifications for all fallers and the derivation of study subjects from residents at the JHA.

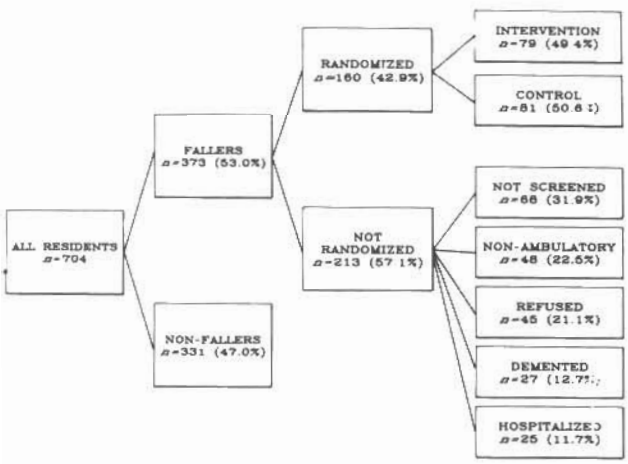

Figure 1. Derivation of randomized subjects from all residents at the Jewish Homes for the Aging (n = 704).

To determine if the study group was representative of all eligible JHA fallers, data were compared between the study group and those fallers who had refused to participate in the study or those who had not been screened because the nurse practitioner did not receive the incident report within 7 days of the fall. There were no significant differences between these groups with regard to demographic variables, functional status, types of medical conditions, living location, or types of falls.

Analysis of the 213 initial variables collected at randomization revealed no significant differences between the intervention and control groups with the exception that intervention subjects had a slightly greater number of active medical problems than controls (4.7 compared with 4.2; $P < 0.05$), and a few more intervention subjects were taking an antibiotic medication (17.7% compared with 3.7%; $P < 0.01$). The major variables are presented in Table 1. The study population consisted of almost equal proportions of subjects living in board-and-care and in skilled nursing beds. The mean age of the randomized subjects was 87 years and 85% were women. Board-and-care residents tended to be fully functional in the basic activities of daily living and showed only mild impairment of mental status. Skilled nursing care residents generally were unable to complete more than three of the six basic activities of daily living, and had moderate impairment of mental status.

Eighty percent of subjects fell indoors, most often in their own rooms. Most falls were attributed on the incident reports to "losing balance" (44%) or an environmental "accident" (22%) (for example, slipping or tripping due to an identified hazard). Although nearly half the subjects experienced a minor injury from the fall, only 2% sustained a fracture. Overall, 76% percent of those randomized had fallen in the previous year.

On the basis of the findings from the postfall assessment, the nurse practitioner and the physician investigators tried to decide the most likely cause of each intervention subject's fall as well as any other contributory fall risk factors. As shown in Table 2, generalized weakness, environmental hazards, and orthostatic hypotension were felt to be the most frequent primary causes of falls. Each intervention subject had a mean of two additional contributory risk factors. The most prevalent risk factors identified were gait and balance disorders, poor vision, generalized weakness, and orthostatic hypotension.

A mean of 2.1 active medical problems for which a recommendation was given were identified for each intervention subject (Table 3). Ninety percent of subjects had at least one active problem identified, of which most (91.9%) were new findings that had not been previously evaluated or treated. These new findings ranged from undetected chronic problems, such as muscle weakness and gait disorders, to acute problems, such as

Table 1. *Comparison of Study Subjects at Randomization**

Variable	Group	
	Intervention (n = 79)	Control (n = 81)
Demographic		
Age, y	86.8 ± 0.58	87.9 ± 0.65
Female, %	83.5	86.4
Level of care, %		
Board and care	49.4	53.1
Nursing care	50.6	46.9
Medical		
Medical problems, n	4.7 ± 0.19	4.2 ± 0.15†
Recorded medical problems, %		
Coronary heart disease	65.2	66.2
Hypertension	40.6	45.1
Arthritis	37.7	35.2
Cataracts	26.1	16.9
Dementia	13.0	15.5
Depression	13.0	18.3
Diabetes	13.0	11.3
Prescription drugs, n	3.7 ± 0.28	3.5 ± 0.24
Daily prescription drug doses, n	6.4 ± 0.54	6.0 ± 0.45
Functional and mental status		
Activities of daily living scale (range, 0 to 6)	4.6 ± 0.15	4.5 ± 0.16
Instrumental activities scale (range, 0 to 8)‡	4.3 ± 0.20	4.6 ± 0.19
Mental status scale (range, 0 to 10)	6.0 ± 0.33	6.2 ± 0.30
Use assistive device to ambulate, %	69.6	75.3
Fall-related variables		
Falls in previous year, n	1.1 ± 0.18	1.4 ± 0.22
Location of current fall, %		
Own room	41.8	35.8
Bathroom	6.3	16.1
Other inside	34.2	27.2
Outside	17.7	20.9
Time of fall		
Midnight to 6 am	13.9	13.6
6 am to noon	22.8	29.6
Noon to 6 pm	30.4	34.6
6 pm to midnight	32.9	22.2
Injury from fall, %		
None	48.1	61.7
Minor (bruise, sprain)	46.8	37.0
Major (fracture)	5.1	1.2
Presenting complaint, %		
Lost balance	48.1	39.5
Accident	17.7	25.9
Dizziness	15.2	13.6
Fell out of bed	5.1	9.9
Legs gave way	3.8	4.9
Syncope	1.3	0
Unknown	8.9	6.2

* Where appropriate, values are expressed as mean ± SE.
† $P < 0.05$. (All other listed comparisons are nonsignificant.)
‡ Scale administered to board-and-care subjects only.

infections, dehydration, and adverse drug effects. The remaining active problems detected were previously known to the physician but it was felt that further evaluation or a change in management was indicated (for example, work-up of incontinence, gait training for a patient with Parkinson disease). Almost all of these findings stemmed from the focused history and physical examination. Relatively few findings that required treatment or monitoring were detected from laboratory tests alone: Four subjects were treated for urinary tract infections; three were found to be hyperkalemic; one had elevated thyroid hormone levels; one had a very elevated leukocyte count that led to the diagnosis of pneumonia; and one had a positive stool guaiac test as a result of undiagnosed colonic polyps. Three subjects were found from Holter monitoring to have cardiac arrhythmia requiring treatment (hospitalization, pacemaker, antiarrhythmics); however, all of these subjects had symptoms or signs suggestive of cardiac dysrhythmias.

Overall, 93% of the intervention subjects were thought by the investigators to need some type of treatment or intervention. A mean of 2.8 recommendations were made for each subject. The types and numbers of recommendations given to the primary care physicians and their compliance rates are presented in Table 4. Recommendations for specific rehabilitation therapies, such as muscle-strengthening exercises, gait training, or evaluation for an assistive device, given to 60% of intervention subjects, were the most common recommendations. Further diagnostic evaluation of positive laboratory results or abnormal physical findings was advised for 46% of subjects. Hospitalization was advised for one subject with dehydration and another with congestive heart failure. Recommendations for environmental alterations were made for 45% of subjects. These included lowering the bed height, increasing lighting, removing throw rugs and other hazards, obtaining a raised toilet seat, and installing grab bars. Many subjects (43%) were also felt to need medication changes, the most common being withdrawing a diuretic.

Overall, skilled nursing subjects received more recommendations than board-and-care subjects (3.2 compared with 2.4, $P < 0.05$). Skilled nursing subjects tended to receive more recommendations for rehabilitation therapy (69.2% compared with 51.4%) and environmental alterations (53.8% compared with 35.1%) than board-and-care subjects.

Physicians and other caregivers complied with nearly 62% of the recommendations, and 41% of intervention subjects received all of the recommended interventions. Compliance rates were slightly higher among board-and-care subjects than among skilled nursing subjects (68.5% compared with 57.3%). Recommendations for environmental changes had the lowest compliance rate; however, actual implementation of these changes was often beyond the control of the physician and, in some cases, was resisted by residents (for example, two residents refused to use the prescribed toilet seats).

We reviewed the medical record of each control subject to document any fall-related diagnostic work-up and treatment received independent of our study. Only 40% of the controls were examined by a physician or nurse practitioner after their fall. Of those examined, only half received any kind of specific evaluation, such as laboratory tests or a neurologic or cardiac examination to determine the cause of the fall; the other half were examined only for fall-related injuries. Physical therapy, primarily for treatment of injuries, was prescribed for about one sixth of the controls. Only one environmental alteration—to lower a bed height—was made. The percentage of control group subjects who were evaluated after their fall was slightly higher during

Table 2. *Most Likely Primary Cause of Falls and Secondary Risk Factors Identified during the Falls Assessment for 77 Intervention Group Subjects**

Problem	Primary Cause	Possible Contributing Risk Factors
	n (%)	
Weakness, generalized	24 (31.2)	24 (31.2)
Environmental hazard	21 (27.3)	4 (5.2)
Orthostatic hypotension	12 (15.6)	20 (26.0)
Acute illness	4 (5.2)	8 (10.4)
Gait or balance disorder	3 (3.9)	38 (49.4)
Drug effect	3 (3.9)	13 (16.9)
Weakness, focal	3 (3.9)	
Poor vision	2 (2.6)	25 (32.5)
Drug reaction	1 (1.3)	
Arrhythmia		5 (6.5)
Neuropathy		16 (20.8)
Diminished cognition		6 (7.8)
Urinary tract infection		5 (6.5)
Arthritis		4 (5.2)
Other†		11 (14.3)
Unknown	4 (5.2)	
Total	77 (100)	179

* Two experimental subjects refused to be examined.
† The "other" category includes depression, incontinence, parkinsonism, aortic stenosis, hypoglycemia, hypokalemia, and blood disorders.

the intervention period than during the pre-intervention period (40% compared with 33%), which may represent a mild spillover effect from the study.

Outcomes

Follow-up data on subsequent fall rates showed no significant difference between the two groups (Table 5). Seventy-one percent of the intervention group and 75% of the control group fell at least once during the year after randomization. By the end of the second year of follow-up, 81% of intervention and 84% of control subjects had fallen. The mean number of subsequent falls at 12 months (2.5 compared with 2.6) and 24 months (4.1 compared with 4.5) after randomization was also similar for the two study groups. Multiple analyses were done to try to identify any subgroups that might have shown a differential intervention effect on fall rate (for example, skilled nursing compared with board-and-care subjects; subjects who fell once compared with those who fell several times); no differences could be found among these subgroups although sample size clearly limits subgroup analysis. Interestingly, among intervention group subjects, physician compliance with recommendations did not significantly correlate with fall recurrence. There were also no differences between the groups in the incidence of serious fall-related injuries during the 1-year follow-up period. Most falls did not result in serious injury. Only seven (9%) of intervention subjects and five (6%) of controls had a fracture and two subjects in each group sustained a laceration that required sutures.

On the other hand, the intervention group had a large reduction in hospitalization (Table 5 and Figure 2). One-year hospital utilization rates showed that intervention subjects were significantly less likely to be hospitalized (29.1% compared with 44.4%; $P < 0.05$), had fewer hospital admissions (mean, 0.37 compared with 0.70, $P < 0.05$), and used fewer hospital days (3.5 days compared with 6.7 days, $P < 0.05$) than controls. The differences in hospitalizations and hospital days between the intervention and control groups were more pronounced among subjects in the skilled nursing beds—20.0% compared with 47.6% and 2.1 days compared with 9.2 days for intervention and control subjects, respectively. Significant differences in hospital utilization rates continued through the second year of follow-up and were even more dramatic: Fewer intervention than control subjects were hospitalized (45.6% compared with 61.7%, $P < 0.05$), and they used less than half as many hospital days (5.9 compared with 12.3, $P < 0.01$). The 2-year hospital utilization rates for fallers in the intervention group approximated those for the comparison group of non-fallers: 40.8% of non-fallers were hospitalized over 2 years, with a mean of 0.66 admissions and 5.4 hospital days (Figure 2).

We reviewed the hospital admission records to determine the reasons for hospitalization within the first year of follow-up. The most common reasons for admission were acute infections (31%), cardiac conditions (26%), and fractures (17%). Most admissions (87%) were emergent. There was a reduction in admissions of virtually all major types for the intervention group; there was no apparent specific type of hospitalization that was selectively reduced.

Mortality rates during the follow-up period did not differ significantly between the two groups (Table 5). By 24 months after randomization, 21.5% of intervention subjects and 25.9% of controls had died. Causes of death did not differ. The two most frequent causes of death were acute myocardial infarction (44%) and res-

Table 3. *Major Active Problems Discovered in Post-Fall Assessment for Which Treatment Recommendations Were Made among 77 Assessed Patients**

Problem	New Active Problems Discovered	Previously Known Problems Needing Reevaluation
	n (%)	
Muscle weakness	37 (48.0)	3 (3.9)
Postural hypotension	31 (40.3)	1 (1.3)
Gait or balance disorder	29 (37.7)	3 (3.9)
Medication problems†	24 (31.2)	0
Infection	9 (11.7)	0
Dehydration	5 (6.5)	0
Metabolic disorder	4 (5.2)	0
Chronic condition in poor control	4 (5.2)	0
Arrhythmia	3 (3.9)	0
Miscellaneous	2 (2.6)‡	6 (7.8)§
Total	148	13

* Two subjects refused the assessment.
† Included in this category were adverse drug effects, inappropriate or unnecessary drugs, and incorrect dosages.
‡ Included in this category were weight loss and a positive stool guaiac test for occult blood.
§ Included in this category were impaired vision and hearing, incontinence, and vertigo.

Table 4. *Recommendations Given to Primary Care Physicians for 76 Intervention Subjects and Physician Compliance Rates**

Type of Recommendation	Subjects Given Recommendation	Recommendations	Physician Compliance with Recommendation	
			Yes	No
	n (%)	*n*	*n* (%)	
Rehabilitation therapy	46 (61)	66	44 (67)	22 (33)
Further diagnostic work-up	35 (46)	44	27 (61)	17 (38)
Monitor blood pressure		13	5	8
Laboratory tests		11	9	2
Specialized consultation		7	4	3
Hospitalization		2	2	0
Miscellaneous		11	7	4
Environmental changes	34 (45)	42	21 (50)	21 (50)
Medication change	33 (43)	42	28 (67)	14 (33)
Withdraw				
Diuretic		18	11	7
Psychoactive drug		8	5	3
Antihypertensive drug		3	2	1
Oral hypoglycemic drug		2	0	2
Miscellaneous drug		6	5	1
Add				
Anti-arrhythmic drug		2	2	0
Miscellaneous drug		3	3	0
Other recommendations†	18 (24)	18	12 (67)	6 (33)
Total		212	132 (62)	80 (38)

* Two subjects refused the assessment, and one subject died before the assessment was completed.
† Other recommendations included new shoes, support hose, new glasses, podiatric care, increase in fluid intake, and assistance with ambulation.

piratory failure (22%). In contrast to the two groups of fallers, the non-faller comparison group had a much lower mortality rate. Only 10.7% of the ambulatory non-fallers died during the 24-month follow-up period.

At 12 months after randomization there were no differences between the two study groups in the number of prescribed medications taken or the percentage of subjects having moved to a higher level of care. There was also no significant difference in crude mobility status at 12 months, although slightly more control than intervention subjects were no longer ambulatory (17.1% compared with 12.9%); more detailed measures of mobility were not obtained at follow-up.

Discussion

We studied the effects of a post-fall assessment on fall rates, morbidity, hospitalization rates, and mortality of a group of frail, institutionalized, elderly persons. Although the intervention did not result in significant reductions in mortality or recurrent falls, 1- and 2-year hospitalization rates were reduced significantly. These results indicate strongly that falls can be viewed as a marker for serious, often unrecognized, underlying illnesses and disabilities. A post-fall geriatric assessment can uncover diverse problems and risk factors, many of which are amenable to therapy. The postulate that falls delineate a particularly high-risk subgroup especially likely to benefit from an assessment is supported by the fact that fallers as a group had a substantially higher risk for hospitalization and mortality than did non-fallers. In addition, in a previous study (4), we found that an identical assessment of matched non-fallers ($n = 70$) showed significantly fewer fall-related risk factors and unrecognized illnesses and disabilities than found among fallers.

Over 95% of the problems we found were identified from the history and physical examination alone and did not require a high technology diagnostic evaluation. The blood tests and urinalysis uncovered few additional problems. Neither the electrocardiogram nor Holter monitoring revealed any significant arrhythmias in asymptomatic subjects. This finding confirms an earlier study indicating the lack of usefulness of Holter monitoring in assessing fallers without suspected disorders (15). The fact that the examination was done by a nurse practitioner following a protocol indicates the relative low cost and practicality of this intervention that required less than an hour of the nurse practitioner's time.

Our therapeutic recommendations were directed toward treating active problems, minimizing potential risks (such as drug effects), and correcting hazardous environments. They required no changes in policy, only a minimal increase in staff time, and no unusual costs. The relatively high compliance rates with our recommendations among staff physicians, compared with those of other consultation studies (16), suggests that the problems identified could be easily addressed.

The reduction in hospital admissions among the intervention group confirms our hypothesis that identification and treatment of illnesses and risk-factors associated temporally with a fall can have far-reaching effects on the total health of the individual. This finding is similar to the remarkable successes of other types of geriatric assessment and treatment programs for frail, elderly populations that have not specifically targeted patients with a recent fall (17-20). Indeed, falls are only

Table 5. *Comparison of Outcome Data between Intervention and Control Subjects at 1 and 2 Years after Randomization*

Variable	1-Year Outcomes			2-Year Outcomes		
	Intervention (n = 79)	Control (n = 81)	95% CI of Percent Difference	Intervention (n = 79)	Control (n = 81)	95% CI of Percent Difference
Subsequent falls						
Subjects with falls, *n (%)*	56 (70.9)	61 (75.3)	− 9.3 to 18.1	64 (81.0)	68 (83.9)	− 8.9 to 14.7
Mean falls per subject*	2.49 ± 0.36	2.63 ± 0.40		4.09 ± 0.53	4.51 ± 0.53	
Hospital utilization						
Subjects hospitalized, *n (%)*	23 (29.1)	36 (44.4)†	0.6 to 30.0	36 (45.6)	50 (61.7)†	0.8 to 31.4
Mean admissions per subject*	0.37 ± 0.08	0.70 ± 0.11†		0.66 ± 0.10	1.25 ± 0.15‡	
Mean days per subject*	3.48 ± 0.91	6.67 ± 1.17†		5.92 ± 1.12	12.27 ± 1.64‡	
Mortality, *n (%)*	12 (15.2)	6 (7.4)	− 1.9 to 17.6	17 (21.5)	21 (25.9)	− 8.8 to 17.6

* Values are expressed as mean ± SE.
† $P < 0.05$, intervention group compared with control group.
‡ $P < 0.01$, intervention group compared with control group.

one indicator of patients who might benefit from geriatric assessment (21, 22).

An objective of this study was to reduce the number of recurrent falls. Although there was a trend for intervention subjects to have fewer falls (9.3% fewer by 2 years; CI, −8.9 to 14.7), it did not reach statistical significance. There were no published data on the effect of a fall intervention program to aid us in calculating our initial sample size. On the basis of our knowledge of the incidence of falls and the prevalence of related risk factors, we felt that a 25% reduction in falls would be a reasonable estimate of a possible intervention outcome. If this had proved true, our sample size of 160 would have been sufficient to detect such a difference with a power of 0.90. With the much smaller observed difference of 9.3% in the number of falls, however, the calculated power is only between 0.20 and 0.25. If a fall intervention program can only be expected to show a 10% reduction in falls, future studies will need to include much larger sample sizes to achieve a power of 0.90.

There are several possible explanations for the lack of major effect on subsequent fall rates. First, almost 50% of intervention subjects received active rehabilitation therapy to increase mobility and independence. To the extent that this therapy was successful, it could have increased the subjects' active time at risk for falls. In contrast, only 14% of control subjects received any rehabilitation. Second, although it is fairly easy to identify patients who are at risk for falling (4-10) and to determine the reasons why they fall, it is very difficult to prevent falls in most frail, institutionalized, elderly persons. Many risk factors are not reversible or only minimally so. Among our intervention subjects, only 10% had an initial fall that was clearly the result of a reversible acute condition, such as pneumonia or orthostasis, and only 13% had a fall caused by a clearly preventable environmental hazard. In these cases, primary and secondary preventive measures (for example, withdrawing a drug, removing hazards, or treating pneumonia earlier) might prevent similar kinds of falls. However, most intervention subjects fell as the result of interacting and progressive chronic conditions (such as poor vision combined with weakness and a gait disorder) for which only tertiary preventive measures (such as muscle strengthening, assistive devices) could be readily applied. These measures were not entirely effective in preventing falls, due to the advanced stage of the problem, the presence of other chronic conditions, or a lack of compliance by subjects. It is possible that other, more vigorous programs of active gait training and muscle strengthening than we were able to provide might have been more effective. Such approaches remain to be tested.

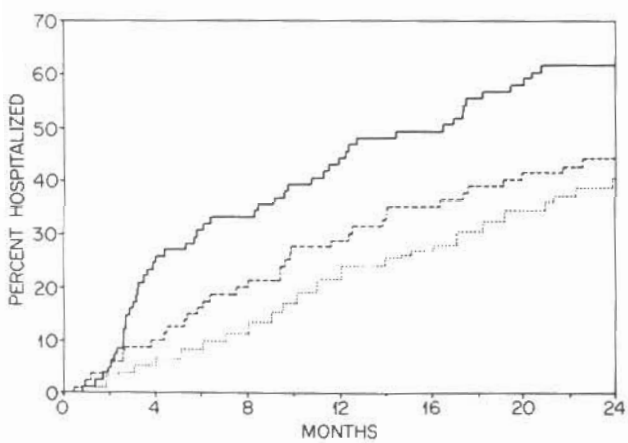

Figure 2. Comparison of hospitalization patterns for nursing home residents during the 2 years after randomization: fallers in the control group (n = 81), solid line; fallers in the intervention group (n = 79), broken line; ambulatory residents who did not fall during the entire study period (n = 309), dotted line.

A final explanation may be related to the high standard of usual care at the JHA. The baseline fall rate at the JHA was lower than those reported at most other long-term care institutions (1). Moreover, although less than half of the control group received no more than a brief check for injury after they fell, this rate is not atypically low among long-term care residents who are known to their physicians. Examination rates at nonacademic nursing homes would probably be even lower. We feel that a similar intervention in institutions that do not have on-site physicians, nurse practitioners, or ac-

ademic involvement might show greater effects on fall rates.

On the basis of our observations, however, we feel it is unlikely that most currently conceived fall-prevention programs can dramatically reduce fall rates without using measures that substantially curtail mobility. Although restriction of activity may be an appropriate intervention for those residents who are acutely ill or severely mentally impaired, we do not consider this preventive measure to be justified for most institutionalized fallers without careful consideration of the risks of immobility (for example, functional decline, incontinence, decubiti, confusion) (23) and the effect on quality of life.

Fallers had a higher mortality rate than non-fallers in our study population. This finding has been previously reported (2) and is consistent with the concept of falls as a marker for disease and risk. Nonetheless, our intervention did not have a significant effect on mortality in our population. This finding may be due to the major emphasis our program placed on reducing morbidity and risk for functional deterioration rather than on preventing death per se.

Because this study took place in an institutional setting, it may not be generalizable to noninstitutionalized elderly persons. In addition, a few subgroups of fallers were not studied, such as nonambulatory residents and those hospitalized after the fall. A survey of the falls among nonambulatory residents revealed that their falls were most often the result of confusion (attempting to walk without assistance or climbing over bedrails) and probably would be more amenable to nursing interventions. Fallers who were hospitalized or acutely ill were not readily available for our assessment. However, these subjects were relatively few; only 9 of the 373 faller subjects (2.4%) were hospitalized for fall-related injuries, and 16 (4.3%) were hospitalized for an acute illness. Moreover, all of these subjects received at least an admission assessment in the hospital. Because over 90% of falls do not result in serious injury requiring hospitalization, we believe that our study subjects represent the most typical fallers: those who do not have an obvious reason for falling, such as syncope, stroke, heart attack; are not seriously injured; and are not ordinarily assessed after a fall. The nurse practitioner may have missed some transient abnormal findings due to the delay between the time of the fall and randomization. However, the average time between the fall and the post-fall assessment was only 3 days, which is probably no longer than would be expected in an institution without on-site physicians. Because the determination of fall status was made by incident reports, it is likely that some falls were not reported. These falls, however, would generally be of a less serious nature. Finally, the program was a multifaceted intervention, and we do not know what part was most responsible for the effects.

If these effects on reduced hospital use can be corroborated elsewhere, the implications of our study results for national long-term care policy could be immense. Approximately 50% of the 1.5 million nursing home residents nationwide fall each year and, based on our study data and published reports, over 40% of such institutionalized fallers are hospitalized at least once annually with an average stay of more than 6 days (1). We found about a 50% reduction in the annual number of hospital days among our intervention group. If we extrapolate this finding to the national nursing home population, it would represent a reduction of about a million hospital days per year or a savings of over $600 million nationally at a conservative hospital-cost estimate of $700 per day (24). Although formal cost-benefit anlaysis is beyond the scope of this paper, estimated costs of a 1-hour standardized assessment of institutionalized fallers done by a nurse practitioner followed by our recommended interventions (including further diagnostic evaluation, limited rehabilitation, environment or medication modifications) averaged less than $300 per patient. These costs are substantially less than the estimated savings from reduced hospitalizations, which, using the above estimates, averaged more than $800 annually per institutionalized faller.

The results of this randomized trial strongly indicate that all ambulatory institutionalized patients who fall should receive a thorough postfall assessment (4). This assessment can done cost-effectively by a nurse practitioner. A brief reassessment should be done after subsequent falls to identify any new problems. The routine use of laboratory tests, electrocardiograms, and Holter monitoring is not recommended as part of the fall assessment except when there is a specific clinical indication or suspicion. Although falls may not be easily prevented, these data show clearly that falls indicate the presence of important treatable conditions and that some of the disability and costs associated with falls may be obviated by a thorough assessment. Future controlled trials are needed to determine whether more specific interventions, such as muscle strengthening or gait training, aimed at patients known to be at high risk for falling will show greater effects on reducing the incidence of falls.

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References

1. **Rubenstein LZ, Robbins AS, Schulman BL, Rosado J, Osterweil D, Josephson KR.** Falls and instability in the elderly. *J Am Geriatr Soc.* 1988;**36**:266-78.
2. **Perry BC.** Falls among the elderly: a review of the methods and conclusions of epidemiologic studies. *J Am Geriatr Soc.* 1982;**30**: 367-71.
3. **Nickens H.** Intrinsic factors in falling among the elderly. *Arch Intern Med.* 1985;**145**:1089-93.
4. **Robbins AS, Rubenstein LZ, Josephson KR, Schulman BL, Osterweil D, Fine G.** Predictors of falls in elderly people. Results of two population-based studies. *Arch Intern Med.* 1989;**149**:1628-33.
5. **Blake AJ, Morgan K, Bendall MJ, et al.** Falls by elderly people at

home: prevalence and associated factors. *Age Ageing*. 1988;**17**:365-72.
6. **Granek E, Baker SP, Abbey H, et al.** Medications and diagnoses in relation to falls in a long-term care facility. *J Am Geriatr Soc*. 1987;**35**:503-11.
7. **Janken JK, Reynolds BA, Swiech K.** Patient falls in the acute care setting: identifying risk factors. *Nurs Res*. 1986;**35**:215-9.
8. **Nevitt MC, Cummings SR, Kidd S, Black D.** Risk factors for recurrent nonsyncopal falls. A prospective study. *JAMA*. 1989;**261**: 2663-8.
9. **Tinetti ME, Williams TF, Mayewski R.** Fall risk index for elderly patients based on number of chronic disabilities. *Am J Med*. 1986; **80**:429-34.
10. **Tinetti ME, Speechley M, Ginter SF.** Risk factors for falls among elderly persons living in the community. *N Engl J Med*. 1988;**319**: 1701-7.
11. **Lawton MP, Brody EM.** Assessment of older people: self-maintaining and instrumental activities of daily living. *Gerontologist*. 1969; **9**:179-86.
12. **Kahn RL, Golfarb AI, Pollack M, et al.** Brief objective measures for the determination of mental states in the aged. *Am J Psychiatry*. 1960;**117**:326-8.
13. **Rubenstein LZ, Campbell LJ, Kane RL.** *Clinics in Geriatric Medicine: Geriatric Assessment*. Philadelphia: W.B. Saunders; 1987.
14. **Tinetti ME.** Performance-oriented assessment of mobility problems in elderly patients. *J Am Geriatr Soc*. 1986;**34**:119-26.
15. **Rosado JA, Rubenstein LZ, Robbins AS, Heng M, Schulman BL, Josephson KR.** The value of Holter monitoring in evaluating the elderly patient who falls. *J Am Geriatr Soc*. 1989;**37**:430-4.
16. **Allen CM, Becker PM, McVey LJ, Saltz C, Feussner JR, Cohen HJ.** A randomized, controlled clinical trial of a geriatric consultation team. Compliance with recommendations. *JAMA*. 1986;**255**:2617-21.
17. **Rubenstein LZ, Josephson KR, Wieland GD, English PA, Sayre JA, Kane RL.** Effectiveness of a geriatric evaluation unit. A randomized clinical trial. *N Engl J Med*. 1984;**311**:1664-70.
18. **Rubenstein LZ.** Comprehensive geriatric assessment. In: Solomon D, moderator. New issues in geriatric care. *Ann Intern Med*. 1988; **108**:724-7.
19. **Rubenstein LZ.** Geriatric assessment: an overview of its impacts. *Clin Geriatr Med*. 1987;**3**:1-15.
20. **Rubenstein L.** The clinical effectiveness of multidimensional geriatric assessment. *J Am Geriatr Soc*. 1983;**31**:758-62.
21. **Rubenstein LZ, Wieland GD, Josephson KR, Rosbrook B, Sayre J, Kane RL.** Improved survival for frail elderly inpatients on a geriatric evaluation unit (GEU): who benefits? *J Clin Epidemiol*. 1988;**41**: 441-9.
22. **Winograd CH, Gerety MB, Brown E, Kolodny V.** Targeting the hospitalized elderly for geriatric consultation. *J Am Geriatr Soc*. 1988;**36**:1113-9.
23. **Evans LK, Strumpf NE.** Tying down the elderly. A review of the literature on physical restraint. *J Am Geriatr Soc*. 1989;**37**:65-74.
24. **Helbing C, Keene R.** Use and cost of short-stay hospital inpatient services under Medicare, 1986. *Health Care Financ Rev*. 1989;**10**: 93-109.