A Randomized Trial of a Consultation Service to Reduce Falls in Nursing Homes

Wayne A. Ray, PhD; Jo A. Taylor, RN, MPH; Keith G. Meador, MD, MPH; Purushottam B. Thapa, MBBS, MPH; Anne K. Brown, OTR, MS; Henry K. Kajihara, OTR; Claudia Davis, TNSN, RNC; Patricia Gideon, RN; Marie R. Griffin, MD, MPH

Context.—Falls are a major health problem in nursing homes, but no interventions have been shown to prevent falls in nursing home residents.

Objective.—To evaluate an intervention program designed to prevent falls and associated injuries in high-risk nursing home residents.

Design.—Randomized controlled trial.

Setting and Participants.—Seven pairs of middle Tennessee nursing homes with 1 facility in each pair randomly assigned to the intervention. Facilities had 482 (261 control, 221 intervention) residents who qualified for the study because they had high risk of falls and a potential safety problem that could be addressed by the intervention.

Intervention.—Comprehensive structured individual assessment with specific safety recommendations that targeted suboptimal practices for environmental and personal safety, wheelchair use, psychotropic drug use, and transferring and ambulation. Facility staff were encouraged to implement the individual recommendations and to improve overall facility safety.

Main Outcome Measures.—The mean proportion of recurrent fallers and incidence rate of injurious falls in the facility in the year following the intervention.

Results.—The mean proportion of recurrent fallers in intervention facilities (43.8%) was 19.1% (95% confidence interval, 2.4%-35.8%) lower than that in control facilities (54.1%, $P=.03$). Intervention facilities had a nonsignificant trend toward a lower mean rate of injurious falls (13.7 vs 19.9 per 100 person-years, reduction of 31.2%, $P=.22$). Subgroup analyses suggested greatest benefits for residents for whom the recommended interventions were carried out or who had 3 or more falls in the preceding year.

Conclusion.—The high rate of falls and related injuries in nursing homes should not be viewed as inevitable, but as outcomes that can be substantially improved through structured safety programs.

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FALLS, FALL-RELATED injuries, and the resulting adverse clinical, social, and economic consequences are a major public health problem in nursing homes. Of the estimated 1.7 million nursing home residents in the United States,[1] approximately one half fall annually,[2-4] twice the rate for persons dwelling in the community,[5-7] and 11% sustain a serious fall-related injury.[3,4,8,9] The growing number of nursing home residents[10] underscores the need to develop and implement preventive programs for this vulnerable population.

Current research in community-dwelling elderly suggests that focused intervention programs can materially decrease fall risk. Tinetti and colleagues[11] reported a 31% reduction in the incidence of falls for high-risk elderly receiving a multifactorial intervention program. A planned meta-analysis of the National Institute on Aging–sponsored Frailty and Injuries Cooperative Studies of Intervention Techniques (FICSIT) reported 10% and 17% reductions in falls associated with exercise and exercise with balance interventions, respectively.[12]

However, development of programs that reduce the risk of falls and associated injuries in nursing home residents has been less successful. In the FICSIT study, the interventions implemented at the 2 nursing home sites did not reduce fall rates.[12] In a randomized controlled trial conducted among nursing home fallers, geriatric assessment did not reduce risk of falls.[13] The objective of our study was to conduct a randomized controlled trial of an intervention program we specifically designed to prevent falls and associated injuries in high-risk nursing home residents.

For editorial comment see p 595.

METHODS

Intervention: The Falls Consultation Service

Rationale.—Among nursing home residents, fall risk is thought to increase with host functional impairment,[14] unsafe behavior,[15] and environmental hazards.[16] We focused on modifying behavioral and environmental factors because it may be difficult to improve function sufficiently to prevent falls in very frail nursing home residents[17] and because institutional settings provide an opportunity to efficiently implement safety interventions. Our intervention targeted 4 specific safety domains: environmental and personal safety,[16,18] wheelchairs,[4,19] psychotropic drugs,[15,20-23] and transferring and ambulation.[4,9,24] The Falls Consultation Service was an intensive multifactorial intervention program that sought to modify suboptimal safety practices for each of these domains through both individual resident safety assessment and facility-wide interventions to improve staff safety practices.[25-28]

Individual Safety Assessment and Treatment Planning.—The cornerstone of the intervention program was a multidisciplinary, structured individual assessment that encompassed each of

From the Division of Pharmacoepidemiology, Department of Preventive Medicine, Vanderbilt University School of Medicine (Drs Ray, Thapa, and Griffin; Mss Taylor, Davis, and Gideon, and Mr Kajihara), and the Department of Occupational Therapy, Belmont University (Ms Brown), Nashville, Tenn; and the Department of Psychiatry, Veterans Affairs Medical Center, Duke University, Durham, NC (Dr Meador).

Reprints: Wayne A. Ray, PhD, Division of Pharmacoepidemiology, Department of Preventive Medicine, Vanderbilt University School of Medicine, Nashville, TN 37232.

the 4 safety domains. Following the assessments, the study team reviewed the data for each study resident, obtained further information when indicated from nursing home staff, and developed a structured, individual treatment plan. The team then reviewed the treatment plans with facility staff, and when appropriate with the resident, the resident's family, and facility administration. Each nursing home appointed a falls coordinator, who was responsible for coordinating implementation of these recommendations. We monitored progress by phoning the falls coordinator weekly for the first month and with on-site visits at 1, 3, and 6 months. We also held regular meetings for the falls coordinators and directors of nursing from intervention homes to reinforce motivation and encourage exchange of ideas.

Environmental and Personal Safety.—Potential hazards include the resident's bed, floor surfaces, clutter, lighting, accessibility of objects, bathroom equipment, poor foot care,[29] and unsafe footwear.[16] A team nurse assessed each study resident, the resident's room and bathroom, and adjoining or common areas to identify safety problems. Safety recommendations included obtaining functional wheel locks for beds, changing the lighting, modifying flooring, repositioning or repairing call lights, and purchasing bathroom equipment such as raised toilet seats.

Wheelchairs.—Because poorly maintained or poorly fitted wheelchairs may increase fall risk,[4,19] team occupational therapists conducted a structured, detailed assessment for every study resident who used a wheelchair. The assessment evaluated maintenance, safety features, foot and leg rests, the seat and back, forward motion protection, resident posture, and propelling/reaching. The team corrected wheelchair problems as soon as possible. We also instituted a wheelchair maintenance program in each facility.

Psychotropic Drugs.—Many psychotropic drugs increase the risk of falls and injuries.[6,14,15,20-23,30] The team reviewed the appropriateness of psychotropic drug use (antipsychotic, tricyclic antidepressant, or benzodiazepine) among regular users (≥4 of the previous 7 days) who were ambulatory because data suggest this group is at highest risk.[15] A team geropsychiatric nurse conducted a structured diagnostic assessment[31] that was reviewed by a team psychiatrist to identify treatment alternatives that posed less fall risk[21] and when appropriate to write letters to the attending physicians suggesting drug regimen changes. The psychiatrist also suggested appropriate psychosocial interventions and occasionally recommended that residents with severe problems receive further psychiatric evaluation.

Transferring and Ambulation.—Problems with transferring[4,16,24] and ambulation[6,29] are commonly associated with falls in nursing home residents. A team occupational therapist observed all study residents transferring from bed, chair (wheel/lounge), and toilet; safety was assessed in terms of equipment height and stability, transfer process, and quality of staff assistance. Ambulatory residents were observed rising from and lowering to bed, chair, and toilet and walking; each was assessed for symptoms of postural hypotension (self-reports and staff reports), safety of cane/walker use, and gait safety. The findings from this evaluation were used to instruct resident and staff in safer transferring techniques, to suggest routine staff assistance during transferring, to repair or modify the cane/walker, to obtain a physical therapist consultation, or to recommend a medical consultation. For residents with dementia-related unsafe transferring, an occupational therapist interviewed staff and if possible observed the unsafe behavior. Following this, the team instructed staff in techniques for communicating with and caring for cognitively impaired residents[32] and suggested specific interventions such as scheduled attention to needs or position alarms.

Facility Interventions.—The facility interventions were designed to improve safety practices throughout the home and to encourage implementation of safety recommendations from the individual assessments. Team physicians met with the attending physicians of study residents to obtain their support for the program and to facilitate acceptance of recommendations for medication changes. A team nurse provided three 45-minute in-services for all patient care staff and distributed a brochure that summarized the in-service content. The in-services provided a general discussion of the causes and consequences of falls as well as practical safety suggestions for each of the 4 study safety domains: the quick environment check, the quick wheelchair check, a checklist for adverse effects of psychotropic drugs, and the quick transfer check. The last in-service focused on review and further refinement of the resident treatment plans.

Compliance With Recommendations.— Each team safety recommendation was recorded on a special form. For those recommendations for which compliance could be verified by direct inspection (observable), the team ascertained compliance at the 3-month facility follow-up.

Study Nursing Homes

Study nursing homes were selected from the 186 licensed facilities in the 66-county middle Tennessee region. Of these, 79 were identified from available records as potentially eligible for the study because they had 80 to 250 beds, did not specialize in either psychiatric or short-stay skilled nursing care, were not in the lowest tertile of psychotropic drug use according to Medicaid data, and had no more than 1 level A violation on the most recent Health Care Financing Administration survey. Potentially eligible facilities were then contacted to determine ultimate eligibility. This required administrative stability (no current vacancy and no more than 3 turnovers during the past 18 months in the administrator, director of nursing, and assistant director of nursing positions), agreement to participate from the medical director and other physicians whose patients made up 25% or more of residents, agreement by the administrator and director of nursing to appoint a falls coordinator who would devote 2 to 4 hours each week to the study, and capacity to provide study data.

Homes were recruited in pairs and matched according to the number of beds. Each pair was constituted by ordering potentially eligible homes by geographic proximity, sequentially contacting facilities to identify 1 eligible home and then applying this procedure to identify a second eligible facility with a comparable number of beds. Between November 1993 and April 1995, 26 homes were contacted. Of these, 3 did not wish to participate, 7 were ineligible, and 2 could not provide baseline data. A total of 14 nursing homes (7 pairs) ultimately were randomized (Figure 1).

Baseline Data Collection

Baseline data were collected by a team of nurses not involved in the intervention program. Medical records provided information on demographics, height and weight, medications, use of physical restraints, and history of falls in the past 365 days. The nursing home staff member most familiar with the resident furnished functional status data that included mode of usual ambulation (defined by how resident gets to the dining room and bathroom), assistance with activities of daily living (Lawton scale[33]), cognitive status, ambulation problems, unsafe behaviors and other behavioral symptoms of dementia (measured using the Nursing Home Behavior Problem Scale[34]), and mobility (measured using the Nursing Home Life-Space Diameter[35]). The reference period for all measurements was the 7 days preceding the date of data collection.

Qualifying Residents

There were 1933 residents in participating facilities at the time of data collection (Figure 1). To maximize power, the

study was restricted to residents at high risk of falls[4,15] who had a potential problem in a study safety domain and who were likely to remain in the home. Thus, prior to randomization we excluded residents who were younger than 65 years (n=135), were not anticipated to remain in the home at least 6 months (n=95), were bedbound (n=554), had no fall in the past 365 days (n=608), or did not have a possible safety domain problem (n=42). Of the 499 randomized residents, there were 17 (6 control, 11 intervention) who died or were discharged from the home prior to program assessments. The program and analysis were thus restricted to the 482 (261 control, 221 intervention) evaluable patients.

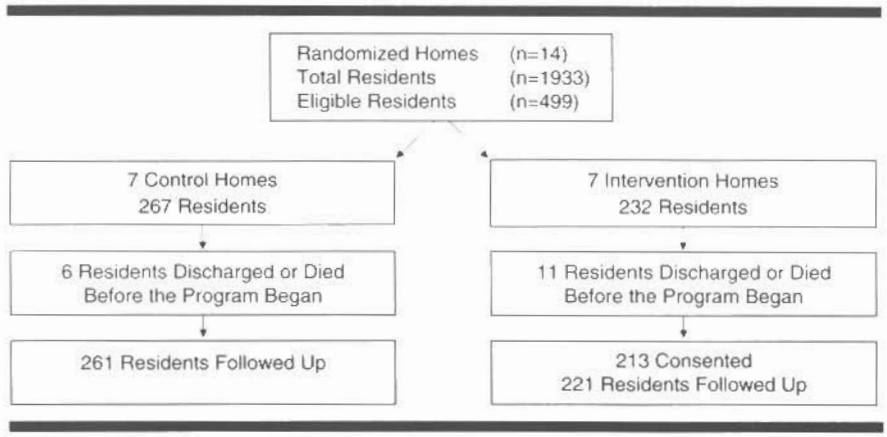


Figure 1.—Randomization scheme of nursing homes and residents into the study.

Randomization, Consent, and Subsequent Data Collection

After residents qualifying for the study had been identified from both members of a pair, 1 facility was randomized to the intervention. The statistician (W.A.R.) generated sealed-envelope random assignments for each pair from the SAS function RANUNI (using the clock for the seed).

There were no program activities in the matched control facility. For both members of the pair, the index date was defined as the first date that program assessments began in the intervention home.

Because the safety assessments could pose some risk to residents (thought to be minimal), we restricted these procedures to consenting residents. We did not approach residents whose family (informed in a special mailing) or physician (informed in writing) objected to the program. If the resident had a legal guardian or person with durable power of attorney, consent was sought from the guardian, with assent sought from the resident. Of the 221 study residents in intervention homes, 213 provided consent. The study was approved by the Vanderbilt University Committee for the Protection of Human Subjects.

One year after the index date, the data collection team of nurses (not informed of home assignment) repeated baseline data collection and abstracted falls that occurred in the 365 days following the index date. After final data collection, control homes were offered inservices on fall prevention.

Outcomes

Each study resident was followed up for the period from the index date through the 365 days following the index date, discharge or transfer from the facility, a hospital stay of 30 or more days, or death. Person-time outside the facility (hospitals, home leave) was excluded.

The primary study outcomes were the numbers of recurrent fallers (2 or more falls during follow-up, an indicator of high risk[7]) and injurious falls. A fall was defined as an unintentional change in position resulting in coming to rest on the ground or other lower level.[36] Injurious falls were those resulting in serious injuries that received medical treatment (hospitalization, emergency department visits, physician visit, or on-site radiological examination). Serious injuries were fractures, other head injuries with altered consciousness, joint dislocations or sprains, or sutured lacerations. This definition excluded minor injuries receiving only nursing first aid as well as falls with medical care only for diagnostic evaluation. Falls were ascertained from nursing home incident reports and medical records (primarily nursing notes but also hospitalization and emergency department visit summaries, radiology reports, and physician notes). Other outcomes assessed were changes from baseline in function and deaths from any cause during follow-up.

Analysis

The occurrence of each primary outcome was modeled with appropriate statistical techniques. For recurrent fallers, we estimated the proportion of residents with 2 or more falls in a 1-year period, adjusting for variable follow-up using the product-limit method.[37] For injurious falls, we estimated the incidence rate under the assumption that for each resident the number of such falls had a Poisson distribution.[38]

In the intention-to-treat analysis, the nursing home (the unit of randomization) was the unit of analysis. For each home, we calculated a single facility outcome occurrence estimate.

For recurrent fallers, this was the product-limit estimate of the proportion of recurrent fallers in 1 year among facility study residents. For injurious falls, this was the number of injurious falls divided by person-years of follow-up.

Statistical analysis preserved the facility pairing because each pair was matched for both number of beds and calendar time. For each facility pair, we subtracted the intervention facility occurrence from that of the control to conduct a paired t test[39] of the hypothesis that outcome occurrence was lower in intervention facilities. A similar paired analysis was conducted for the secondary outcomes of changes from baseline in function (restricted to residents in the facility at the end of follow-up) and deaths during follow-up.

We conducted a priori subgroup analyses for subgroups defined by compliance with study interventions (grouped into tertiles), baseline fall risk (as indicated by the number of falls in the past year), and study inclusion safety domain (wheelchair, psychotropic drug use, and transferring/ambulation problems). To increase power, subgroup analyses differed in 2 ways from the primary analysis. First, because we had not attempted to balance the subgroups across intervention and control arms, the individual patient was the unit of analysis. Second, the 30 days following the index date were excluded because no study interventions were implemented during this period. Testing for between-subgroup differences used the log-rank test for recurrent faller proportions[37] and Poisson modeling for injurious fall incidence rates.[38]

We conducted a multivariate analysis to determine if study findings could be explained by maldistribution of fall risk factors. Models were developed (backward elimination) in the control group because prognostic factors might be related to intervention efficacy and thus have a different association with outcomes in the intervention group. For recurrent fallers, the final proportional hazards model included number of past falls, sex, ambulatory status, difficulty maintaining bal-

Table 1.—Baseline Characteristics of Residents Qualifying for the Study*

Characteristics	Control Residents (n=261)	Intervention Residents (n=221)	P Value
Women	78.5	77.4	.76
Mean age, y	82.6	82.7	.87
Mean body mass index, kg/m^2	23.1	24.1	.03
Wheelchair to bathroom or dining room	45.6	45.7	.98
Always assisted walking to bathroom or does not walk	71.3	76.9	.16
Problems keeping balance while walking (if walks)	63.8	69.2	.25
Always assisted transferring to/from bed	16.9	14.0	.39
Always assisted transferring to/from toilet	26.1	34.1	.06
Always assisted moving around facility	9.6	10.4	.76
Mean No. of other ADLs† always assisted	1.3	1.3	.93
Mean Life-Space Diameter‡	25.7	22.0	<.001
Physical restraints within the past 7 d	34.2	29.4	.26
Cognitive impairment, moderate or marked	49.4	48.4	.83
Mean NHBPS score	14.3	15.9	.23
Regular benzodiazepine use	14.6	19.9	.12
Regular tricyclic antidepressant use	14.6	11.3	.29
Regular antipsychotic use	28.4	26.7	.68
Mean No. of falls within the past 365 d	3.2	2.9	.22

*All values are percentage except where otherwise indicated. ADL indicates activities of daily living; and NHBPS, Nursing Home Behavior Problem Scale.
†Other ADLs include eating, dressing, grooming, and bathing.
‡Not collected for the first pair of homes.

Table 2.—Implementation of Program Safety Recommendations Among Intervention Home Residents*

Safety Domains	Recommendations	Observable	Done at 3 mo (%)†
Environment	211/978	211/976	177/606 (76)
Wheelchairs	174/1162	169/708	131/454 (64)
Psychotropic drugs	68/149	68/149	43/67 (45)
Transferring and ambulation	207/968	109/180	93/136 (76)
All	213/**3257**	211/**2013**	187/**1263** (63)

*All values are number except where otherwise indicated. Values are expressed as residents/recommendations.
†Percentage refers to the proportion of observable recommendations completed.

ance while walking, and behavior problem score. For injurious falls, the final Poisson regression model included number of past falls, age, and ambulatory status. For both intervention and control residents, we calculated risk scores as the linear predictor ($z'\hat{\beta}$) from the regression analysis for each outcome. We assessed whether risk factor maldistribution distorted the intention-to-treat analysis by comparing mean risk scores for the intervention and control groups; these were essentially identical ($P=.53$ for recurrent fallers and $P=.91$ for injurious falls). For the subgroup analyses, we classified residents into risk quintiles and conducted an analysis stratified by quintiles to derive pooled estimators of intervention effect. These did not differ materially from the univariate estimators presented here and are available on request from the authors.

The study was designed to achieve a total sample size of 500 residents, which we estimated would provide power ($1-\beta=.80$) to detect a 20% reduction in recurrent fallers and a 35% reduction in injurious falls.[30] All P values were 2 sided. All statistical analyses were conducted with SAS statistical software, version 6.11 (SAS Institute Inc, Cary, NC).

RESULTS

Baseline characteristics of control and intervention residents were generally similar (Table 1). Multivariate modeling revealed that the 2 groups did not differ with regard to baseline likelihood of becoming recurrent fallers or sustaining injurious falls.

Compliance With Recommendations

Following the resident assessments, the study team made a total of 3257 safety recommendations for the 213 consenting intervention group residents, a mean of 15.3 per resident (Table 2). There were 211 residents with 2013 observable recommendations, of which 1263 (63%) had been implemented at 3 months.

The most common recommendations by safety domain were as follows: (1) environmental recommendations (978 total): label wheelchairs, other equipment, and furniture or other belongings with residents' names (181 recommendations), repair or replace furniture (71), use properly fitting shoes (63), and remove clutter and maintain cleared area around bed (56); (2) wheelchair recommendations (1162 total): adjust/repair brakes (219 recommendations), clean/lubricate moving parts (150), install antitip rods (150), and add brake extensions (142); (3) psychotropic drug recommendations (149 total): taper and discontinue benzodiazepine (22 recommendations), change benzodiazepine to as needed (9), reduce antipsychotic dose (9), and implement behavior management plan (9); (4) transferring and ambulation recommendations (968 total): increase observation of resident (74 recommendations), toilet/nourish at least every 2 hours (57), always assist resident during transfer (57), and remind resident of safe transferring techniques (57).

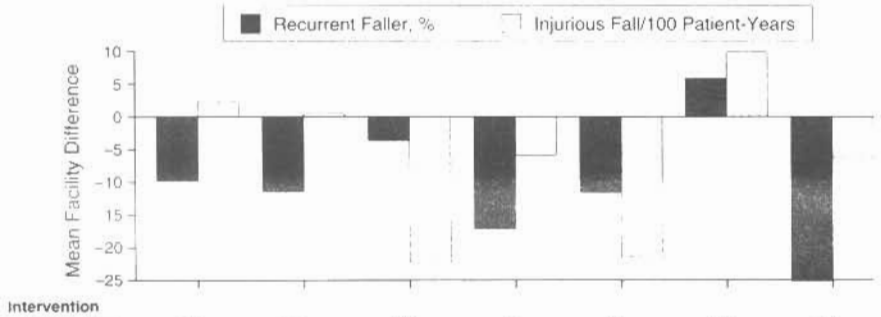
Intention-to-Treat Analysis

The 482 study residents had 416 (228 control, 189 intervention) person-years of follow-up during which 220 (129 control, 91 intervention) residents were recurrent fallers and there were 72 (44 control, 28 intervention) injurious falls. The injurious falls were made up of 34 fractures and 38 soft-tissue injuries that resulted in 24 hospitalizations, 45 emergency department visits, and 3 physician visits.

In 6 of the 7 pairs, the proportion of recurrent fallers was lower in the intervention home than in the control home (Figure 2). The mean recurrent faller proportion in intervention facilities (Table 2) was 43.8%, 19% (95% confidence interval [CI], 2%-36%) lower than that for control facilities (54.1%, $P=.03$). The mean rate of injurious falls (Figure 2) in intervention facilities (13.7 falls per 100 person-years) was 31.2% (95% CI, −24.6% to 86.4%) less than that in control facilities (19.9 per 100 person-years), although this difference was not statistically significant ($P=.22$). For the other study outcomes of change from baseline in resident function or all-cause deaths during follow-up, there were no significant differences between intervention and control facilities (Table 3), although the former had nonsignificant relative increases in the proportions of residents always assisted transferring from bed or with physical restraints in the past 7 days.

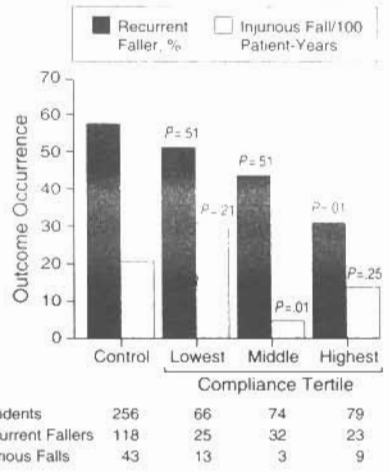
Subgroup Analyses

Compliance With Recommendations.—For the intervention group, we classified residents into tertiles according to the proportion of observable safety recommendations that had been implemented at 3 months. As compliance with the safety recommendations increased, the proportion of residents who were recurrent fallers and the rate of injurious falls decreased (Figure 3). For residents in the upper compliance tertile, the proportion of recurrent fallers was 31.2%, a re-



Intervention							
Study Residents	29	27	40	28	18	43	36
Recurrent Faller, %	53.4	34.4	54.2	29.1	49.2	57.1	28.7
Injurious Fall/100 Patient-Years	19.0	8.1	8.4	9.0	7.0	27.8	16.8
Control							
Study Residents	27	32	33	55	24	50	40
Recurrent Faller, %	63.0	45.7	57.7	46.4	60.9	51.4	53.9
Injurious Fall/100 Patient-Years	16.6	7.4	30.5	14.9	28.5	18.1	23.1

Figure 2.—Differences between paired intervention and control homes in mean facility proportions of recurrent fallers and rates of injurious falls.



Residents	256	66	74	79
Recurrent Fallers	118	25	32	23
Injurious Falls	43	13	3	9

Figure 3.—Proportions of recurrent fallers and rates of injurious falls by tertiles of compliance with observable study safety recommendations. Excludes first 30 days of follow-up, which was before safety recommendations had been made. *P* values reflect comparisons with entire control.

Table 3.—Differences Between Intervention and Control Homes, Other Outcomes*

	Control	Intervention	Difference	*P* Value
Functional status†				
Wheelchair to bathroom or dining room	4.00	−0.95	−4.95	.27
Always assisted walking to bathroom or does not walk	10.07	6.46	−3.61	.41
Problems keeping balance while walking (if walks)	6.97	1.75	−5.22	.62
Always assisted transferring to/from bed	13.77	27.34	13.57	.09
Always assisted transferring to/from toilet	12.12	16.54	4.42	.61
Always assisted moving around facility	16.69	25.61	8.92	.20
Mean No. of other ADLs‡ always assisted	0.48	0.65	0.17	.49
Mean Life-Space Diameter§	−4.13	−2.43	1.70	.72
Physical restraints past 7 d	−2.07	13.97	16.04	.14
Cognitive impairment, moderate or marked	16.27	13.95	−2.32	.81
Mean NHBPS score	0.63	2.32	1.69	.69
Deaths per 100 person-years	17.31	22.96	5.64	.28

*All values are percentage except where otherwise indicated. ADL indicates activities of daily living; and NHBPS, Nursing Home Behavior Problem Scale.
†Functional status based on the 362 residents (199 control, 163 intervention) in the facility at the end of follow-up. For each facility, we calculated the change from baseline in each of the mean measures of functional status.
‡Other ADLs include eating, dressing, grooming, and bathing.
§Not collected for the first pair of homes.

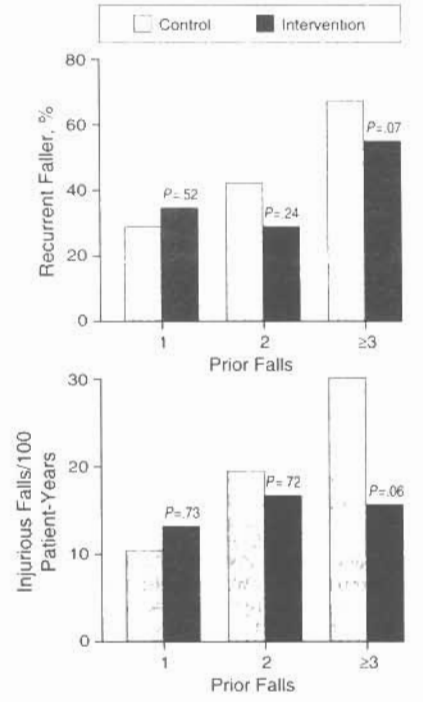


Figure 4.—Proportions of recurrent fallers (top) and rates of injurious falls (bottom), by number of falls in prior year. Excludes first 30 days of follow-up. *P* values reflect within-subgroup comparisons between intervention and control residents.

duction of 46% (95% CI, 12%-67%) relative to that of control residents (57.8%, $P=.01$).

Falls in Past Year.—In the year preceding the study, 35% of residents had 1 fall, 22% had 2 falls, and 43% had 3 or more falls. In the control homes, the proportions of recurrent fallers and rates of injurious falls increased with increasing numbers of prior falls. For residents with 3 or more prior falls, intervention residents had reductions of 19% (95% CI, 0%-36%) in the recurrent faller proportion ($P=.07$) and 49% (95% CI, −3% to 75%) in the injurious fall rate ($P=.06$). Residents with 1 or 2 prior falls had no significant improvement with the intervention.

Safety Domain.—There were no discernable differences in the effect of the intervention within subgroups defined by the safety domain that led to study inclusion.

COMMENT

In this randomized controlled trial, intervention facilities had 19% fewer recurrent fallers and 31% fewer injurious falls among study residents than did control facilities, although the latter was not statistically significant. The falls prevention program was most effective for intervention residents for whom the program's safety recommendations were followed and among residents who had had 3 or more falls in the prior year. In this latter high-risk group, intervention residents had 50% fewer injurious falls than controls, an attributable reduction of 15 serious fall-related injuries for every 100 person-years of follow-up. Intervention homes had a nonsignificant relative increase in physical restraint use, which probably reflects variation in restraint use practices during the study period. However, fall prevention interventions must be monitored closely to avoid inappropriate physical restraint use.

Our capacity to narrowly focus the intervention program on important fall risk factors was limited by the lack of controlled studies of nursing home residents for the study safety domains. There is a

considerable body of literature linking use of psychotropic drugs with increased risk of falls and related injuries.[23] However, although it is believed that the other factors addressed in our study, such as environmental hazards,[18] poorly maintained or improperly fitted wheelchairs,[19] transferring techniques,[16] and suboptimal care[16] can increase fall risk, this has not been confirmed by well controlled studies. Thus, it is unknown whether our study made optimal use of resources by targeting the most important risk factors.

Our intervention was also hindered by the lack of validated instruments to measure risk-factor abatement. Changes in psychotropic drug use could be readily assessed from nursing home medical records. However, we did not have validated scales to measure changes in other important safety practices, including the environment, wheelchairs and other equipment, transferring techniques, or care practices. Thus, we could not quantify the extent to which the intervention altered these factors nor could we show a link between risk-factor abatement and reduction of fall risk,[41] even though data from the intervention facilities suggest that compliance with our recommendations predicted better outcomes. Because we did not implement a sham intervention in the control facilities, it is possible that attention effects contributed to the reduction in falls, although the negative findings from other intensive nursing home interventions[12,13] suggest this is unlikely.

Another limitation of the program was that it largely followed the clinical consultation model[17] for delivery of the preventive measures. More than one third of the safety recommendations that we could verify by direct observation were not in place at 3 months. Wheelchairs for a study resident that were carefully repaired and fitted might be given to another resident. Carefully devised treatment plans to provide transferring assistance or more frequent care provision might not be implemented because of staff shortages. More than one half of the suggestions for changes in psychotropic drug regimens were not made. This component of the intervention was complicated by the practice in some nursing homes of subcontracting management of psychotropic drug regimens to third parties. A falls prevention program integrated more tightly with ongoing clinical management of nursing home residents could be more effective in risk-factor abatement.

The most likely effect of these limitations was to reduce the effectiveness of the intervention program through inability to target the most important risk factors, limited capacity to monitor progress in risk-factor abatement, and partial implementation of the safety recommendations. This suggests that future programs that address these limitations could be even more effective. Thus, the high rate of falls and related injuries in nursing homes should not be viewed as inevitable, but as outcomes that can be substantially improved through structured safety programs.

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