SPECIAL ARTICLES

A TRIAL OF ANNUAL IN-HOME COMPREHENSIVE GERIATRIC ASSESSMENTS FOR ELDERLY PEOPLE LIVING IN THE COMMUNITY

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Abstract *Background and Methods.* The prevention of disability in elderly people poses a challenge for health care and social services. We conducted a three-year, randomized, controlled trial of the effect of annual in-home comprehensive geriatric assessments and follow-up for people living in the community who were 75 years of age or older. The 215 people in the intervention group were seen at home by gerontologic nurse practitioners who, in collaboration with geriatricians, evaluated problems and risk factors for disability, gave specific recommendations, and provided health education. The 199 people in the control group received their regular medical care. The main outcome measures were the prevention of disability, defined as the need for assistance in performing the basic activities of daily living (bathing, dressing, feeding, grooming, transferring from bed to chair, and moving around inside the house) or the instrumental activities of daily living (e.g., cooking, handling finances and medication, housekeeping, and shopping), and the prevention of nursing home admissions.

Results. At three years, 20 people in the intervention group (12 percent of 170 surviving participants) and 32 in the control group (22 percent of 147 surviving participants) required assistance in performing the basic activities of daily living (adjusted odds ratio, 0.4; 95 percent confidence interval, 0.2 to 0.8; $P = 0.02$). The number of persons who were dependent on assistance in performing the instrumental activities of daily living but not the basic activities did not differ significantly between the two groups. Nine people in the intervention group (4 percent) and 20 in the control group (10 percent) were permanently admitted to nursing homes ($P = 0.02$). Acute care hospital admissions and short-term nursing home admissions did not differ significantly between the two groups. In the second and third years of the study, there were significantly more visits to physicians among the participants in the intervention group than among those in the control group (mean number of visits per month, 1.41 in year 2 and 1.27 in year 3 in the intervention group, as compared with 1.11 and 0.92 visits, respectively, in the control group; $P = 0.007$ and $P = 0.001$, respectively). The cost of the intervention for each year of disability-free life gained was about $6,000.

Conclusions. A program of in-home comprehensive geriatric assessments can delay the development of disability and reduce permanent nursing home stays among elderly people living at home. (N Engl J Med 1995;333: 1184-9.)

THE projected increase in the number of disabled older persons poses a challenge for health care and social services.[1] Comprehensive geriatric assessment has been used primarily for the evaluation and rehabilitation of chronically ill patients.[2,3] More effective preventive care for older persons might be achieved through a geriatric assessment in the home that was designed to detect and modify biologic, psychological, social, and environmental risk factors for disability.[4,5]

Comprehensive geriatric assessment directed toward rehabilitation has been shown to improve patients' outcomes, but this approach seems to be effective only in settings where the recommendations that arise from the assessment can be implemented.[3,6] Preventive home visits have been carried out in Denmark and the United Kingdom, with variable results.[7-12] We conducted a randomized, controlled trial to test the effect of combining these two methods on the rate of disability in older persons living in the community.

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METHODS

Study Participants

We used a voter-registration list to identify people in Santa Monica, California, who were 75 years of age or older and living at home.[13] Among the 966 persons contacted by telephone, 353 (37 percent) agreed to participate in the program. In addition, 86 persons were recruited by mail and 46 others asked to participate. Among these 485 subjects, 71 were excluded on the basis of the following a priori criteria: severe cognitive impairment (24 patients), language problems (18), plans to move to a nursing home (9), plans to move away (9), self-reported terminal disease (6), participation in another randomized trial (3), and severe functional impairment (2).

From December 1988 to June 1990, 215 of the participants were randomly assigned to the intervention group, and 199 to the usual-care (control) group. All participants gave written informed consent before being assigned to a group. Randomization was performed with sealed envelopes containing random numbers, with stratification according to age and sex. The study was approved by the institutional review committee at the University of California, Los Angeles.

Intervention

During the three-year study period, the people in the intervention group underwent annual comprehensive geriatric assessments per-

formed in their homes by gerontologic nurse practitioners. The assessment included a medical history taking, a physical examination, hematocrit and glucose measurements in blood samples obtained by finger stick, a dipstick urinalysis, and a mail-in fecal occult-blood test. The subjects were also evaluated for functional status,[14] oral health,[15] mental status (presence or absence of depression[16] and cognitive status[17]), gait and balance,[18] medications,[19] percentage of ideal body weight,[20] vision,[21] hearing,[21] extensiveness of social network,[13] quality of social support,[13] and safety in the home and ease of access to the external environment. The nurse practitioners discussed each case with the study geriatricians, developed rank-ordered recommendations, and conducted in-home follow-up visits every three months to monitor the implementation of the recommendations, make additional recommendations if new problems were detected, and facilitate compliance. If additional contact was considered necessary, the nurse practitioner telephoned the participant or was available by telephone. All the participants were encouraged to take an active role in their care and to improve their ability to discuss problems with their physicians. Only in complex situations did the nurse practitioners or study physicians contact the patients' physicians directly.[22]

Of the 215 people in the intervention group, 13 were never seen by nurse practitioners: 3 died and 10 declined to be visited. The remaining 202 people received a mean (±SD) of 10.9±3.2 visits during the three-year study period. Forty-nine people did not complete the program because they died (20 participants), moved out of the area (13), moved to a nursing home (9), or refused to continue (7).

Each year, participants were given an average of 5.9 recommendations about self-care (e.g., physical exercise, sleep, management of urinary incontinence, nutrition, use of over-the-counter medications, compliance with regimens involving prescription medications, use of aids and devices, and safety in the home; accounting for 51 percent of all recommendations), 3.3 recommendations to discuss new problems or potentially suboptimal therapy with their personal physicians (29 percent), and 2.3 recommendations involving the use of community services (20 percent). On average, the participants adhered to 47 percent of all recommendations, did not adhere to 39 percent, and partly adhered to 14 percent (usually those involving changes in long-term behavior, such as nutrition or exercise). In addition, the nurse practitioners reinforced primary and secondary prevention by monitoring the frequency of regular dental care, vaccinations, eye examinations, breast self-examination, Pap smears, and mammographic screening.[23] Telephone interviews of a subgroup of 102 participants in the intervention group revealed that 99 percent of them were satisfied with the program and that 84 percent would have liked to continue the preventive home visits after the completion of the study.

Outcome Measures

Before randomization and annually thereafter for three years, patients were seen at home by trained interviewers not involved in the intervention who used a structured interview format. Information was collected on the basic activities of daily living (bathing, dressing, feeding, grooming, transferring from bed to chair, and moving around inside the house),[14] instrumental activities of daily living (e.g., cooking, handling finances and medication, housekeeping, and shopping),[14] and combined basic and instrumental activities,[24] and a hierarchical score was calculated.[25] Analysis of disability-free survival was based on date-of-death information and on functional status (basic activities of daily living) at base line and at three years. Information on hospital admissions was based on a systematic review of the participants' names and Social Security and Medicare numbers at all local hospitals.

In telephone interviews conducted every four months by the independent interviewers, the participants or, in cases of a severe decline in health, predesignated proxies provided information about nursing home admissions and use of community services. The nursing home information was systematically verified by reviewing hospital-discharge data and contacting local nursing homes.

Information on visits to physicians was obtained from Medicare claims files and local health maintenance organizations. Nursing home stays were classified as either permanent or short-term. Stays were deemed permanent if the participants remained for 100 days or more or if they were admitted for terminal care. Short-term stays were defined as lasting fewer than 100 days and ending with a discharge to the participant's home.[26]

Statistical Analysis

All analyses were based on a priori hypotheses, with functional status and nursing home admissions as the primary outcomes.[27,28] Base-line characteristics of the participants were added to the intention-to-treat models of the effects of the intervention. Proportional-hazards models were used for survival data. For functional status at three years, we used repeated-measures regression analyses, adding functional status at one and two years to the models after ascertaining that there was no interaction between time and treatment effect. In addition, standard and polychotomous logistic-regression techniques were used. The effects of the intervention on the number of hospital admissions for acute care, short-term nursing home admissions, and visits to physicians were based on multivariate Poisson regression models corrected for overdispersion.[29]

We estimated the required sample size needed for an alpha level of 0.05 (two-tailed) on the basis of data from similar trials.[2,7,8] According to this estimate, a sample of 200 persons in each group was sufficient (with a statistical power of 0.8) to detect a 40 percent reduction in the number of persons with disability and a 25 percent change in the number of acute hospital admissions, with a marginal ability (statistical power of 0.5) to detect a 50 percent reduction in nursing home admissions.

Sensitivity analyses were conducted by repeating the analyses with the base-line characteristics of the participants excluded, as well as outliers, if appropriate. In addition, analyses of functional status were repeated, with imputed (estimated) values used for missing data. The imputed estimates were derived from the known base-line and outcome data, with the use of maximum-likelihood techniques and simulations.[30]

To determine whether certain subgroups benefited more from the intervention than others, age, sex, functional status, self-perceived health, and education were added as covariate by treatment interaction terms to the covariate models. All statistical tests were two-sided, with a P value of 0.05 considered to indicate statistical significance.

Results

The base-line characteristics of the people in the intervention and control groups were similar (Table 1). Survival at three years was also similar in the two groups, with 24 deaths (11 percent) in the intervention group and 26 (13 percent) in the control group (odds ratio, 0.8; 95 percent confidence interval, 0.5 to 1.5; P=0.8). Vital status and location of residence were known for all participants at three years.

Functional Status

At three years, the people in the intervention group had a higher mean functional status than those in the control group (Table 2). The detailed results of a hierarchical analysis are shown in Table 3. With independence as the reference state, the odds of being dependent on assistance in the basic activities of daily living at three years were significantly lower in the intervention group than in the control group (adjusted odds ratio, 0.4; 95 percent confidence interval, 0.2 to 0.8; P=0.02; P=0.03 for the unadjusted odds ratio). The odds of being dependent on assistance only for the instrumental

activities of daily living were similar in the two groups (odds ratio, 1.1; 95 percent confidence interval, 0.6 to 2.0; P = 0.8).

Analyses in which values were imputed for missing functional-status measures yielded somewhat larger estimates of the treatment effect for all measures than did the primary analysis. The primary analysis may therefore understate the true effect of treatment on functional status.

Table 2. Mean Functional-Status Score among the Surviving Participants at Three Years, According to Intention-to-Treat Analysis.*

Functional-Status Score	Intervention Group (N = 170)	Control Group (N = 147)	Difference in Scores (Intervention Group vs. Control Group)	P Value
		mean (95% CI)		
Basic ADL†	96.8 (94.8–98.8)	95.4 (93.4–97.4)	+1.4 (−0.3 to +3.1)	0.1
Instrumental ADL‡	72.3 (69.0–75.6)	69.3 (66.0–72.6)	+3.0 (+0.6 to +5.4)	0.02
Basic and instrumental ADL	75.6 (73.2–77.9)	72.7 (70.2–75.2)	+2.9 (+0.4 to +5.4)	0.03

*Data are based on reports by 287 study participants and 30 proxies (in most cases, a spouse or close relative) during the home interview at three years. Data were not available for 45 persons in the intervention group (24 died, 14 refused, and 7 moved away) and 52 in the control group (26 died, 21 refused, and 5 moved away). Results have been adjusted for age, sex, whether the subject lived alone, base-line self-perceived health, and base-line functional status. ADL denotes activities of daily living, and CI confidence interval. All scores are on a scale of 0 to 100, with 100 representing the highest functional status.

†As defined in Table 1.

‡Instrumental ADL include cooking, handling finances, handling medication, engaging in "handyman" work, housekeeping, doing laundry, shopping, using the telephone, and using public or private transportation.

Permanent Nursing Home Admissions

During the three-year period, 9 persons in the intervention group and 20 in the control group were permanently admitted to nursing homes (odds ratio for the intervention group as compared with the control group, 0.4; 95 percent confidence interval, 0.2 to 0.9; P = 0.02) (Table 4). There were approximately one sixth as many nursing home days in the intervention group as in the control group. Six people in the intervention group and seven in the control group were living in nursing homes at the three-year follow-up. Information on functional status at three years was available for four surviving people in each group; all eight were dependent on assistance in performing the basic activities of daily living.

Table 1. Base-Line Characteristics of the Study Participants, According to the Original Group Assignment.*

Characteristic before Random Assignment	Intervention Group (N = 215)	Control Group (N = 199)
Age — yr	81.0±3.9	81.4±4.2
Women — no. (%)	149 (69)	141 (71)
Living alone — no. (%)	140 (65)	125 (63)
Completed high school — no. (%)	173 (80)	151 (76)
Annual income <$11,000 — no. (%)†	82 (38)	74 (37)
Mean score for self-perceived health‡	3.2±1.2	3.1±1.2
Independence in basic ADL — no. (%)	196 (91)	183 (92)
Depression score§	2.8±2.7	3.1±2.9
Regular exercise — no. (%)	142 (66)	116 (58)
Current nonsmoker — no. (%)	198 (92)	184 (92)
No. of medications	4.9±2.8	4.6±3.1
No. of visits to physicians in previous month	1.3±1.4	1.1±1.6
Characteristic at Initial Geriatric Assessment¶		
Arterial hypertension — no. (%)	67 (33)	—
Poor vision — no. (%)	34 (17)	—
Poor hearing — no. (%)	61 (30)	—
Impaired gait and balance — no. (%)	20 (10)	—
Underweight — no. (%)	14 (7)	—
Overweight — no. (%)	54 (27)	—
In-home hazard — no. (%)	61 (30)	—

*Plus–minus values are means ±SD. Basic ADL denotes basic activities of daily living (bathing, dressing, feeding, grooming, transferring from bed to chair, and moving around inside the house).

†An annual income of $11,000 is considered the poverty line.

‡The rating scale for self-perceived health ranges from 5 (excellent) to 1 (poor).

§The Geriatric Depression Scale, short form, ranges from 0 to 15, with a score above 5 indicating probable depression.[16]

¶Data are missing for 13 persons who dropped out of the study before the assessment could be performed. Assessments were not performed in the control group. Arterial hypertension was defined as >160 mm Hg systolic or >90 mm Hg diastolic. Poor vision was defined as <20/50 in the better eye. Poor hearing was defined as 1000 or 2000 Hz not heard at 40 dB in the better ear. Impairment in gait and balance was defined as a score <23 on a scale of 0 to 28, with 28 representing the best result.[18] Underweight was defined as 20 percent below average body weight, and overweight as 20 percent above average body weight.[20]

Acute Care Hospital Admissions

The intervention did not have a significant effect on the number of admissions to acute care hospitals or the number of short-term nursing home stays (Table 4). Eighteen percent of the study participants in the intervention group and 21 percent of those in the control group were admitted at least once to an acute care hospital in the first year; 21 and 20 percent, respectively, were admitted at least once in the second year; and 24 and 25 percent, respectively, were admitted at least once in the third year. The mean length of stay per acute care admission was 6.3 days in the intervention group and 5.1 days in the control group (P = 0.7, by the polychotomous logistic-regression analysis). With self-reported hospital admissions outside the study area added to the data in Table 4, the estimated number of hospital days per 100 subjects per year was 203 for the intervention group and 180 for the control group.

Although there was no overall effect of the intervention on hospital admissions, we performed an exploratory analysis to determine whether the intervention was associated with an increased or decreased number of admissions among certain subgroups of study participants. A polychotomous logistic-regression analysis showed that the intervention was associated with a decreased number of short stays (i.e., those lasting one to seven days) among persons with fair or poor self-perceived health (odds ratio, 0.4; 95 percent confidence interval, 0.2 to 1.0; P = 0.05) and among those with less than a high-school education (odds ratio, 0.3; 95 percent confidence interval, 0.1 to 1.0; P = 0.04). None of

Table 3. Functional Status (Dependence or Independence) of the Surviving Participants at Three Years, According to Intention-to-Treat Analysis.

Functional Status	Intervention Group (N = 170)	Control Group (N = 147)	Odds Ratio (95% CI)*	P Value
	no. of persons (%)			
Dependent on assistance in basic ADL†	20 (12)	32 (22)	0.4 (0.2–0.8)	0.02
Dependent on assistance in instrumental but not basic ADL‡	39 (23)	28 (19)	1.1 (0.6–2.0)	0.8
Independent§	111 (65)	87 (59)	—	—

*Odds ratios are based on a polychotomous logistic-regression analysis adjusted for age, sex, whether the subject lived alone, base-line self-perceived health, and base-line functional status, with independent persons as the reference group. The odds ratios are for the intervention group, as compared with the control group. CI denotes confidence interval.

†Dependence was defined as requiring assistance in at least one of the basic activities of daily living (ADL; defined in Table 1).

‡Dependence was defined as independence in basic ADL but a need for assistance in at least one of the instrumental ADL (defined in Table 2).

§Independence was defined as a need for no assistance in either basic or instrumental ADL.

the subgroups of the intervention group had significant increases in admissions to acute care hospitals.

Use of Community Services

The intervention was not associated with changes in the use of in-home and supportive services. Study participants in the intervention group were more likely than those in the control group to use services promoting socialization, such as college courses for older persons or a friendly-visitor program (Table 5).

Visits to Physicians

In the second and third years, the people in the intervention group had significantly more outpatient visits than those in the control group (Table 6). Exploratory subgroup analyses showed that this effect was more pronounced among the study participants with symptoms of depression (P = 0.03). The intervention was also associated with a reduction in the proportion of persons who did not visit a physician in a 12-month period. Nine percent of the study participants in the intervention group, as compared with 16 percent of those in the control group, did not visit a physician during the third year of follow-up (P = 0.04).

Cost Estimates

The approximate yearly cost of the intervention can be derived from the costs of the program itself, including the costs for personnel (1.0 full-time-equivalent nurse practitioner and 0.1 full-time-equivalent geriatrician per 136 persons), supplies, travel, and overhead (estimated at $48,000 per 100 persons); the marginal costs for the increased number of visits to physicians (estimated at $18,000 per 100 persons); and the marginal savings from the decreased number of permanent-stay nursing home days (estimated at $42,000 per 100 persons), resulting in a net cost of $24,000 per 100 persons. Acute care hospital admissions and short-term nursing home stays are not included in this calculation, because they did not differ significantly between the two groups.

The effect of the intervention on health-related outcomes can be summarized in two ways: by estimating the number of disability-free years gained by the intervention (4.1 years per 100 persons per year during the 3-year follow-up), or by calculating the number of permanent-stay nursing home days avoided (692 days [820 − 128] per year) (Table 4). On the basis of these estimates, the cost for each disability-free year of life gained was approximately $6,000. The cost of preventing one day of a permanent stay in a nursing home was $35.

Discussion

We found that a three-year program of comprehensive in-home geriatric assessments resulted in a significant reduction in the number of persons who required assistance in performing the basic activities of daily living and a significant reduction in the number of permanent nursing home admissions. Although it is not possible to determine whether the reduction in disability was responsible for the reduction in nursing home admissions, such a relation is likely. The intervention emphasized reducing the risk factors for disability. There was no measurable increase in the use of supportive home care services. All participants living in nursing homes at three years were dependent on assistance in performing the basic activities of daily living. These findings suggest that the prevention of declines in functional status at least partially explains the reduction in nursing home admissions.

Table 4. Hospital and Nursing Home Admissions during the Three-Year Follow-up Period, According to Intention-to-Treat Analysis.*

Type of Admission	Intervention Group (N = 215)	Control Group (N = 199)	Adjusted Odds Ratio or Relative Risk (95% CI)†	P Value
Permanent nursing home				
No. of persons admitted (%)	9 (4)	20 (10)	OR = 0.4 (0.2–0.9)	0.02
No. of days/100 persons/yr	128	820		
Acute care hospital				
No. of persons admitted at least once (%)	99 (46)	93 (47)	RR = 1.0 (0.8–1.4)	0.8
No. of days/100 persons/yr	197	160		
Short-term nursing home				
No. of persons admitted at least once (%)	27 (13)	31 (16)	RR = 0.9 (0.6–1.4)	0.6
No. of days/100 persons/yr	89	111		

*Nursing home data are based on information reported by the study participants, with verification from secondary sources. Permanent and short-term admissions are defined in the text. Hospital data are based on systematic reviews of admissions to local hospitals.

†Results have been adjusted for age, sex, base-line self-perceived health, and base-line functional status. The odds ratio (OR) is based on a multivariate logistic-regression analysis, and the relative risks (RR) are based on multivariate Poisson analyses corrected for overdispersion. The odds ratio and relative risks are for the intervention group, as compared with the control group. CI denotes confidence interval.

It is unlikely that these results have been affected by missing information. Sensitivity analyses indicated that the 12 percent rate of missing data on functional status at three years did not result in an overestimation of treatment effects and may actually have caused an underestimation of these effects (data not shown).

The intervention was not a substitute for usual care (medical and social services) but instead was integrated with such care. It was therefore not unexpected that, as a result of the recommendations by the nurse practitioners, the people in the intervention group consulted their physicians more frequently than the people in the control group. To calculate the overall cost of the intervention, we included the cost of these additional visits to physicians.

Two European trials have found that preventive home visits can reduce the number of admissions to acute care hospitals.[8,11] Our intervention did not appear to have this effect. We hypothesize that this may reflect a balance between two opposite effects of the intervention. It is likely that among study participants with previously unrecognized or suboptimally managed problems, hospital admissions increased, whereas among other participants, unnecessary admissions were prevented.

As compared with the U.S. population of persons 75 years old or older living at home, our study group had a higher educational level, a lower mortality rate, and a lower rate of acute care hospital admissions, with a higher proportion of persons living alone.[31,32] Caution should therefore be used in generalizing our results to different groups, such as older persons in rural communities or those with a lower level of education.

The results of our study support the view that a program of comprehensive in-home geriatric assessments may help prevent disability, but it cannot be determined from our results which components of the program are most important. Other controlled studies have shown that preventive home visits without an annual comprehensive geriatric assessment,[7-12] a one-time in-home geriatric assessment with follow-up,[33] regular telephone follow-up,[34] or health promotion[35-37] may improve outcomes in the elderly. It is unlikely that the social contacts provided by our intervention resulted in the observed effects, since social contacts alone have been shown to be ineffective.[38] The reasons for the benefits of this approach are being explored so that even more effective strategies can be developed.[39]

Table 5. Use of Community Services during the Three-Year Follow-up Period, According to Intention-to-Treat Analysis.*

Type of Service	Intervention Group (N = 215)	Control Group (N = 199)	P Value
	no. of persons (%)		
In-home and supportive services			
Care management†	43 (20)	33 (17)	0.4
Home health care	27 (13)	17 (9)	0.2
Homemaker	24 (11)	28 (14)	0.4
Meals on wheels	23 (11)	18 (9)	0.6
Personal care	20 (9)	24 (12)	0.4
Services promoting socialization			
College courses for senior citizens	45 (21)	23 (12)	0.01
Friendly visitors‡	23 (11)	7 (4)	0.01
Community transportation	57 (27)	36 (18)	0.04

*Data are based on reports provided by the study participants at one or more of the interviews conducted every four months during the three-year follow-up period.

†Formerly known as case management.

‡Denotes a home-based program that schedules social visits by volunteers with elderly persons.

Table 6. Mean Number of Visits to Physicians per Month, According to Intention-to-Treat Analysis.*

Year	Intervention Group		Control Group		Adjusted Relative Risk (95% CI)†	P Value
	no. of persons	mean no. of visits	no. of persons	mean no. of visits		
1	207	1.27	185	1.03	1.1 (1.0–1.3)	0.1
2	199	1.41	180	1.11	1.2 (1.1–1.4)	0.007
3	191	1.27	162	0.92	1.4 (1.1–1.6)	0.001

*Data are based on Medicare claims data and on records of health maintenance organizations. Persons who had died, moved permanently to nursing homes, or moved out of the area were excluded from the analysis. In addition, 22 persons (8 in the intervention group and 14 in the control group) were excluded because reliable data on the number of visits to physicians were not available.

†Relative risks (based on a multivariate Poisson analysis corrected for overdispersion) have been adjusted for age, sex, membership in a health maintenance organization, base-line self-perceived health, and base-line functional status. Relative risks are for the intervention group, as compared with the control group. CI denotes confidence interval.

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