A Randomized, Controlled Trial of Comprehensive Geriatric Assessment and Multidisciplinary Intervention After Discharge of Elderly from the Emergency Department—The DEED II Study

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OBJECTIVES: To study the effects of comprehensive geriatric assessment (CGA) and multidisciplinary intervention on elderly patients sent home from the emergency department (ED).

DESIGN: Prospective, randomized, controlled trial with 18 months of follow-up.

SETTING: Large medical school–affiliated public hospital in an urban setting in Sydney, Australia.

PARTICIPANTS: A total of 739 patients aged 75 and older discharged home from the ED were randomized into two groups.

INTERVENTION: Patients randomized to the treatment group underwent initial CGA and were followed at home for up to 28 days by a hospital-based multidisciplinary outreach team. The team implemented or coordinated recommendations. The control group received usual care.

MEASUREMENTS: The primary outcome measure was all admissions, to the hospital within 30 days of the initial ED visit. Secondary outcome measures were elective and emergency admissions, and nursing home admissions and mortality. Additional outcomes included physical function (Barthel Index (total possible score = 20) and instrumental activities of daily living (/12) and cognitive function (mental status questionnaire (/10)).

RESULTS: Intervention patients had a lower rate of all admissions to the hospital during the first 30 days after the initial ED visit (16.5% vs 22.2%; $P = .048$), a lower rate of emergency admissions during the 18-month follow-up (44.4% vs 54.3%; $P = .007$), and longer time to first emergency admission (382 vs 348 days; $P = .011$). There was no difference in admission to nursing homes or mortality. Patients randomized to the intervention group maintained a greater degree of physical and mental function (Barthel Index change from baseline at 6 months: -0.25 vs -0.75; $P < .001$; mental status questionnaire change from baseline at 12 months: -0.21 vs -0.64; $P < .001$).

CONCLUSION: CGA and multidisciplinary intervention can improve health outcomes of older people at risk of deteriorating health and admission to hospital. Patients aged 75 and older should be referred for CGA after an ED visit.
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Key words: emergency service; hospital; geriatric assessment; activities of daily living; cognition; patient readmission

Older patients more frequently present to the emergency department (ED) than younger patients and are more frequently admitted to hospital.[1,2] At presentation, there is often a history of short-term decline in health.[3] This raises the theoretical possibility that, if there could be some intervention after older patients start to decline but before they reach the stage at which they require admission, it might be possible to improve their health enough to avoid admission to hospital. But how could older patients at proximate risk of admission be identified?

One way is through patients discharged from the ED. We have been studying the discharge of elderly from the ED (DEED) because patients aged 75 and older who are discharged from the ED have a greater risk of being admitted to the hospital over the following 2 weeks or month and are at increased risk of death.[3,4] They have a wide variety of medical problems, and at the greatest risk for subsequent admission are those who have lower scores on indices of activities of daily living (ADLs) and mental status and those receiving support at home.[3] These observations suggest a role for comprehensive geriatric assessment (CGA) to

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improve outcomes after DEED, but assessment of function of older patients is unusual in junior doctors in the ED, who see most of the older patients there.[5]

Elderly patients also have a high re-admission rate after discharge from the hospital.[6] Some schemes that provide extra support after discharge have demonstrated a decrease in readmission rates,[7,8] although not all have shown such an outcome.[9] CGA during admission to the hospital has resulted in decreased mortality, improved function, and decreased placement in nursing homes.[10] One report of a nonrandomized, controlled trial of CGA in an ED found no statistically significant differences in health outcomes.[11] Two randomized studies found improved functional scores at 1 and 4 months, but the long-term effects were unclear, as was how this affected health service utilization.[12,13]

A randomized, controlled trial of comprehensive geriatric assessment and up to 4 weeks intervention was therefore conducted on patients aged 75 and older sent home from a single ED with 18 months of follow-up to assess whether it would decrease hospital admissions and improve health and functional outcomes. Subjects randomized to the control arm received usual care.

METHODS

Setting

The setting for this trial was the ED of Prince of Wales Hospital in Sydney, Australia. This ED is an area trauma center staffed by staff specialists and registrars in emergency medicine and by residents and interns on rotation.

Participants

Patients aged 75 and older who were discharged from the ED and consented were eligible for enrollment. Patients were only enrolled once the doctor in the ED had determined their fitness for discharge, so as not to influence the decision to admit or discharge the patient. Patients who lived in a nursing home, had previously already been enrolled in this study, or lived out of the local area of the hospital were excluded.

Enrollment Procedures

A study coordinator was present in the ED 7 days a week from 8 a.m. until 8 p.m. Patients who presented and were discharged between 8 p.m. and 8 a.m. were offered enrollment by telephone the next day. All patients gave informed consent to enter the study and then answered a questionnaire including living arrangements; background of the presentation to the ED; the Barthel Index[14] of ADLs, such as washing, dressing, and mobilizing; a modified instrumental ADL (IADL) index,[15] which measures more complicated activities such as housework, managing medications, and finances; and the mental status questionnaire (MSQ),[16] which measures cognitive function. Patients enrolled in the ED provided information in the ED, whereas patients enrolled at home provided baseline information at home. If patients could not provide consent or complete information at any stage during the study, consent or information was obtained from their caregivers, generally the next of kin identified by the medical record. The initial assessment took between 30 and 60 minutes to complete.

Intervention

Between 8:00 a.m. and 8:00 p.m., the intervention patients were seen in the ED and then at home. For those discharged after hours (8:00 p.m. to 8:00 a.m.), a member of the team saw them at home within 24 hours of leaving the ED. Generally, that member was a nurse experienced in care of the elderly who conducted a semistructured assessment guided by clinical findings and, using the records obtained from the ED, assessed the results from the study questionnaire and conducted a discussion with the patient's general practitioner (GP). The nurse would formulate a care plan, initiate urgent interventions and referrals, and present the patient's history at a weekly interdisciplinary team meeting attended by a geriatrician or a geriatric registrar, nurses, physiotherapists, and occupational therapists, at which further interventions or referrals could be ordered. Interventions that the team could perform were done for up to 4 weeks, and referrals were made to the patients' GP, specialist physicians or surgeons, community-health nurses, or other community services as appropriate. Patients who required ongoing care after 4 weeks were referred to the appropriate services in a timely fashion to allow seamless transfer of care. If the other service could not take over within the 4-week period, the study service provided care until the other service could start.

Usual Care

Usual-care patients were allowed to go home after randomization with no alteration to the discharge plan formulated by the medical officer in ED.

Objectives

The objective was to test the efficacy of CGA after discharge of elderly from the ED. It was hypothesized that this would decrease admissions to the hospital within 30 days but would have no effect on mortality or nursing home admissions because of lack of power.

Outcomes

Primary outcome measures were all admissions to any hospital within 30 days of being discharged home from the ED, assessed by patient questionnaire and checking electronic hospital admission data. Secondary outcome measures were elective and emergency admissions to the hospital, nursing home admissions (whether direct from home or from hospital), and mortality. Additional outcome measures included physical function, measured using the Barthel and IADL indices, and cognitive function, measured using the MSQ.

Data Collection

All patients were followed-up at 3, 6, 12, and 18 months by telephone interview: almost half conducted by a research assistant, with the rest performed by different members of the multidisciplinary team. Whenever possible, the interviewers spoke to the subject, but when this was not possible because of cognitive impairment or other reasons, they spoke to the caregiver/next of kin. The follow-up interviews asked about the primary and secondary outcomes: admissions to hospital or nursing home, death, the Barthel Index, and IADL and MSQ indices. Hospital admissions were also

checked in the computerized records of hospitals in the local area by checking each patient's admission record at the end of the study.

Interrater reliability was compared on a subset of patients who were scored twice within 24 hours by two different raters and rating treatment patients who were discharged from the ED during working hours in the ED and then within 24 hours at home: interrater reliability was found to have a correlation coefficient greater than 0.80 on all measures.

The hospital ethics committee approved the study.

Sample Size

The study was powered to detect a relative 40% decrease in the 30-day hospital admission rate from 20% to 12% with $\alpha = 95\%$ and $\beta = 80\%$.

Randomization

After obtaining the baseline information, patients were randomized using computer-generated random numbers coded into opaque envelopes. The allocation was subsequently not concealed.

Statistical Methods

Statistical calculations were performed using SPSS for Windows, version 10 (SPSS, Inc. Chicago, IL). Continuous variables were compared using *t* tests, dichotomous variables using chi-square, and multiple comparisons using analysis of variance. All statistical tests were two-tailed. For the logistic regression analysis, variables were entered into the model in a variety of combinations and analyzed using automated model building to find the combination of variables with the best interpretability and parsimony as recommended by the software. Because the three functional indices moved together when the whole group was analyzed, overall function was assessed by calculating a composite function score by adding the three functional indices (ADL, IADL, and MSQ) to yield a single, continuous measure of function. This summary measure was used to control for baseline function in multivariate models and included improvement and decline.

RESULTS

Between February 12, 1996, and September 4, 1997, all patients aged 75 and older who were discharged from the ED (not admitted to hospital) were studied (Figure 1). All together, 1,425 patients aged 75 and older who lived in the local area, at home or in a hostel, presented to the ED during this time, and 750 were enrolled, although 11 were subsequently excluded because it was found that they had been previously enrolled. Of the 675 patients who were not enrolled, two were dead on arrival, five discharged themselves, seven died in the ED, 242 left the ED before they could be enrolled or declined to be enrolled, and 419 were admitted to a hospital.

At baseline, there were no significant differences between treatment and control groups in age, sex, living arrangements, self-perceived health, ADL, IADL, or mental status (Table 1, baseline characteristics).

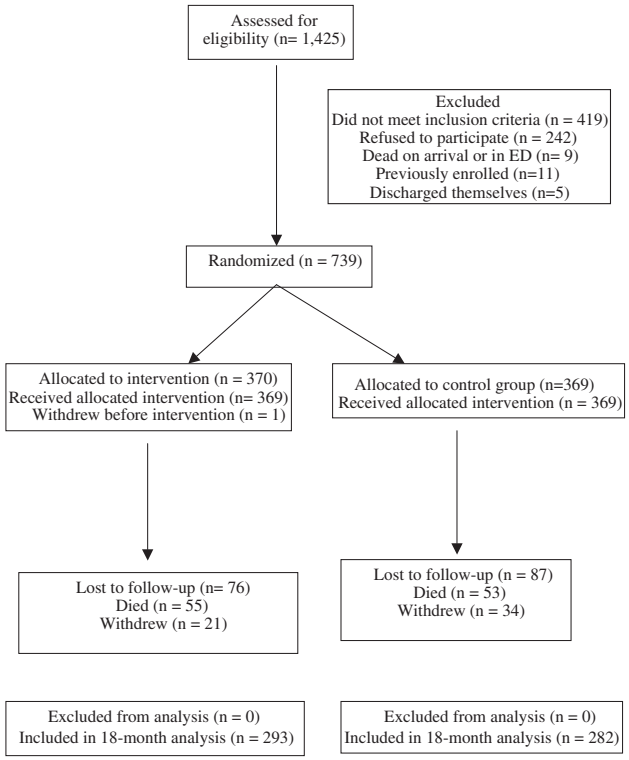

Figure 1. Flow diagram.

The CGA generated an action plan. Each action was referred to an appropriate clinician to implement, and 50% of the referrals made were to members of the multidisciplinary team (nurse, 31.1%; physiotherapist, 10.7%; and occupational therapist, 8.2%), with the other 50% referred as follows: specialist, 18.9%; GP, 18.5%; and other, 12.6%. Some of the specialist referrals were to the geriatrician on the team.

In assessing and treating the intervention group, on average, 1.65 new problems were identified, and patients received 2.29 home visits. The problems were diverse and not readily categorized into discrete groups. The largest group of new problems was medical problems, some of which the nurse addressed. Sometimes, as a result of the CGA, a patient returned to the ED, occasionally for an unavoidable admission but more often for treatment and then return home. However, if patients were sent back to the ED, detailed information about required investigation(s) or management preceded or accompanied them so that their visits were concise and targeted. There was a perceptible, but not statistically significant, increase in visits to the GP, ED, and outpatient clinics by the intervention group during the first month. All CGA recommendations that required nursing, physiotherapy, occupational therapy, or ED intervention were implemented by or under the supervision of the team. Recommendations that required GP or specialist review were at the discretion of the treating doctor. There was no data on the completion rate for these recommendations.

In the first 30 days after the initial ED visit, there were significantly fewer total admissions (elective and emergency) in the intervention group than in the control group (61 intervention (16.5%); 82 control (22.2%); $P = .048$), although there was no significant difference in the number of

Table 1. Baseline Characteristics

Characteristic	Intervention (n = 370)	Control (n = 369)	*P*-value
Age, mean ± SD	82.1 ± 6.6	82.4 ± 5.2	.402
Barthel score, mean ± SD*	18.4 ± 3.5	18.6 ± 3.4	.445
Instrumental activities of daily living, mean ± SD†	8.9 ± 3.7	9.0 ± 3.5	.598
Mental Status Questionnaire, mean ± SD‡	7.7 ± 2.7	7.8 ± 2.7	.522
Acuity in emergency department, mean ± SD§	3.4 ± 1.2	3.3 ± 1.3	.298
Self-rated health, mean ± SD‖	2.8 ± 1.1	2.9 ± 1.2	.920
Medical problems, n (%)			
Ischemic heart disease	152 (41.3)	139 (37.7)	.448
Diabetes mellitus	49 (13.3)	52 (14.1)	.771
Presentation due to a fall	95 (25.8)	94 (25.5)	1.000
Living arrangements, n (%)			.741
Home alone	142 (38.5)	146 (39.8)	
Home with others	194 (52.6)	185 (50.4)	
Hostel	26 (7.0)	31 (8.4)	
Other	3 (0.8)	3 (0.8)	
Community services, n (%)			
Community nurse	37 (10.0)	33 (9.0)	.632
Meals on Wheels	34 (9.2)	37 (10.1)	.690
Community options	1 (0.3)	6 (1.6)	.123
Other community services	14 (3.8)	13 (3.5)	.856
Female, n (%)	222 (60.0)	225 (61.0)	.786

* Range 0 (severe disability) to 20 (no disability).
† Range 0 (severe disability) to 12 (no disability).
‡ Range 0 (severe cognitive impairment) to 10 (no cognitive impairment).
§ Range 1 (immediate life threatening) to 5 (nonurgent).
‖ Range 1 (excellent) to 5 (poor).
SD = standard deviation.

emergency admissions (42 intervention (11.9%); 51 control (14.4%); $P = .31$). More intervention than control patients visited their GP (281 intervention (75.9%); 264 control (71.5%)), the ED (58 intervention (15.7%); 49 control (13.3%)), and outpatient clinics (99 intervention (26.8%); 89 control (24.1%)) during the first 30 days, although these differences were not significant.

There was also a significant decrease in the number of treatment patients admitted to the hospital as an emergency admission over the 18 months of follow-up (164 (44.4%) vs 201 (54.3%); $P = .0072$). The number needed to treat to prevent one hospital admission within 30 days is 18 and to prevent one emergency hospital admission within 18 months is 10.

There was no difference between the two groups in the number of patients admitted to nursing homes. At the termination of the study, there was no difference between the groups in death rates (14.9% vs 14.1%; $P = 0.765$) (Table 2).

Patients in the treatment group maintained their level of function over the first 6 months of the trial, as indicated by the fact that their mean Barthel score did not decline significantly from baseline until 12 months. At 6 months, their score had declined 0.25 points ($P = .260$, compared with baseline), but the control group experienced a decline of 0.75 points ($P < .001$) in their Barthel score at 6 months. By 18 months, there was no difference between the two groups; the treatment group's Barthel score declined 2.37 points, compared with controls, whose score declined 2.46 points (both $P < .001$, compared with baseline). There was a similar result for cognitive function; patients in the treatment group showed no decline in cognitive function until the 18-month follow-up, whereas the control group demonstrated significant declines in cognitive function at 6 and 12 months (Figure 2).

Multivariate analysis of change in Barthel Index score at the 6-month follow-up showed that the only significant factors in relation to the decline in Barthel score were being admitted to the hospital as an emergency patient and the initial score in the functional indices (Barthel, IADL, and MSQ). Similarly, analysis of change in functional scores showed that being admitted to the hospital as an emergency patient was associated with a sharp decline in scores on all three indices, separately and in combination (Figure 3).

DISCUSSION

An important goal in the care of older community-living people is to deliver targeted multidisciplinary care to achieve improved health outcomes. A randomized, controlled trial of CGA and intervention for up to 1 month was conducted in an at-risk group of older persons living in the community. Differences between the treatment and control group showed decrease in admissions to the hospital, with trends toward increased outpatient care and slower deterioration in measures of physical and cognitive function for the treatment group.

Some studies of outpatient CGA have shown no benefit.[9,17] The current study was similar to other studies that demonstrated benefits in that the intervention was

Table 2. Outcomes

Parameter	Intervention (n = 370) n (%)	Control (n = 399) n (%)	Difference % (95% Confidence Interval)	*P*-value
Died	55 (14.9)	53 (14.4)	0.5 (−4.6–5.5)	.765
Withdrew from study	37 (10.0)	48 (13.0)	−3.0 (−6.1–0.1)	.209
Admitted to a nursing home	32 (8.6)	28 (7.6)	1.0 (−2.9–4.9)	.598
Health service use within 30 days				
Emergency admissions to hospital	42 (11.9)	51 (14.4)	−2.5 (−7.4–2.4)	.312
Elective admissions to hospital	19 (5.4)	31 (8.8)	−3.4 (−7.1–0.3)	.075
Any admission	61 (16.5)	82 (22.2)	−5.7 (−11.4–0.0)	.048
Visited general practitioner	281 (75.9)	264 (71.5)	4.4 (−1.9–10.7)	.155
Visited emergency department without being admitted to hospital	58 (15.7)	49 (13.3)	2.4 (−2.7–7.5)	.349
Visited outpatient clinic	99 (26.8)	89 (24.1)	2.7 (−3.6–9.0)	.399
Health service use over 18 months				
Any emergency admission to hospital	164 (44.4)	201 (54.3)	−9.9 (−17.1 to −2.7)	.007
Emergency admissions to hospital, mean ± standard deviation	0.92 (1.3)	1.1 (1.5)		.061
Days to first emergency admission to hospital, mean ± standard error of the mean	382 (12)	348 (11)		.011

targeted toward at-risk older persons and the study had sufficient power because of larger size.[12,13,18] A group was selected that was high risk because of the patients' ages ($\geq$75) and their discharge to home from the ED. (Both are important predictors of hospitalization and functional decline.) Other recent similar studies of CGA and intervention after DEED used a cutoff of age 65 but then screened for risk status,[13,19] which might seem to result in a similar population, but patterns of ED use vary across different countries depending on access to primary care, and the studies have used somewhat different assessment instruments, making comparisons difficult. In the current study, the mean age of the participants was 5.5 years higher than in another study[13] and nearly 8 years older than in a different study,[19] and the average MSQ score was 0.3 points lower (suggesting slightly more cognitive impairment).[19] In our control group, the 1-month hospitalization rate was 22.2%, versus 14%.[19] One study also found a decrease in functional decline.[13] Both of the other studies found nonsignificant trends toward decreased hospital use. There was a 53% decrease in the total hospital days within the first 30 days (0.36 vs 0.76 days) but no difference in percentage hospitalized (14% in both).[19] There was a 32% decrease in acute hospitalizations over 4 months (0.30 vs 0.44) but only a 20% decrease in total hospital costs ($1,154 vs $1,439),[13] compared with the 25% statistically significant decrease (16.5% vs 22.2%; $P = .048$) in total hospitalizations during the first month found in the current study.

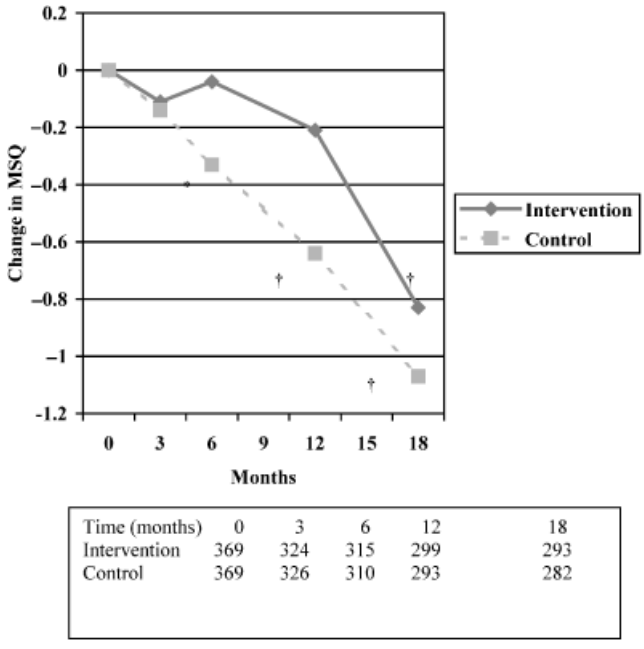

Figure 2. Change in Mental Status Questionnaire (MSQ) score from baseline. *$P < .05$; †$P < .001$ compared with baseline.

Older people at home develop problems that, for various reasons, are not addressed. An average of 1.65 unidentified problems were found in the current study, nearly as many as found in one study (1.87 in men and 2.03 in women) in Edinburgh in 1964.[20] The current study replicated the finding that elderly patients discharged from the ED benefit functionally from CGA[12,13] and additionally found that there was an associated decrease in hospital admissions. This study targeted people aged 75 and older sent home from the ED, a group known to be at acute risk of poor health outcomes. In this study, a higher rate of admissions (22.2%) was found during the first month for the control group; a previous study found a rate of 17.1%.[3]

A meta-analysis of comprehensive geriatric assessment found an overall decrease in mortality, which was strongest for inpatient geriatric evaluation and management units,

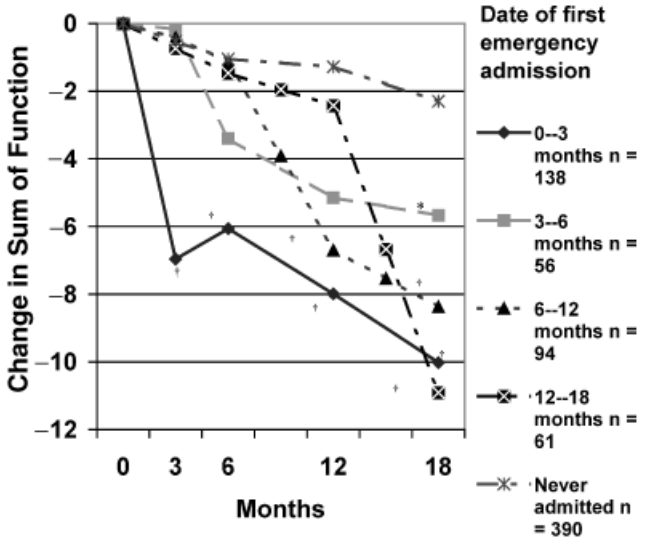

Figure 3. Change in total function according to date of first emergency admission. Lines represent change in sum of Barthel Index, instrumental activity of daily living index, and Mental Status Questionnaire. $^{*}P < .05$; $^{\dagger}P < .001$ compared with the never admitted group.

but home assessment services similar to this one did not produce a significant reduction in mortality.[10] A more recent review focusing on 15 trials of preventative home visits to elderly people living in the community found no clear evidence in favor of their effectiveness,[21] although most of the trials focused on the general population of people aged 65 and older. In previous studies of CGA, the intervention was generally of similar duration to that of the intervention in the current study. With the benefit of regular and longer follow-up after a short but intensive intervention, the trajectory of the functional benefits of CGA in the current study, and that the intervention group regresses to the control level after 6 to 12 months, can by clearly seen. This suggests that annual assessments of frail elderly would be useful.

This study demonstrates how CGA, along with a multidisciplinary team care plan leads to improved function and better health outcomes for elderly patients who are discharged from the ED. Why does that not happen now? Deficits in the ED have previously been identified with CGA. Less-experienced doctors, who see most patients, do infrequent functional and mental state assessments.[5] More-experienced doctors recognize patients with functional deficits without using an assessment instrument, but recent graduates working in the ED need to be taught the importance of routine assessment of older patients, or alternate mechanisms need to be devised for assessment. In practice, busy EDs admit that they do not have time to adequately assess older patients,[22] and older patients, to be adequately treated in the ED, seem to require a supplementary team, within the ED system.[23] In the same way that health services came to realize that hospitalized geriatric patients require a separate team and ward to be treated properly, perhaps geriatric patients need a parallel geriatric emergency service.

The effect that the intervention had on function was modest although statistically significant. A preplanned multivariate analysis was performed in the hope that it would demonstrate that the intervention had a significant effect on function after adjusting for other variables, but the effect of hospitalization was so strong that it displaced the effect of the intervention, statistically. The aim of this study was not to deny older people access to the hospital or other appropriate treatment when they needed it, but one aim was to reduce their unnecessary exposure to inpatient care. As part of the treatment plan, patients in the treatment group were occasionally referred back to the hospital for admission, but more often for ambulatory treatment and return home. Sometimes, patients came back urgently for an emergency admission, but often they could be delayed for a short period and then have an elective admission (booked >24 hours before admission). One possible explanation is that intervention at home could have an effect in the first month on less urgent medical problems but not emergency admissions and by improving functional status have an effect on emergency admission for periods up to 18 months. It also may be that there is less separation between elective and emergency admissions for frail older people than for healthy young people (i.e., more elective admissions are semiurgent or may become emergencies if problems are not managed rapidly or early).

It has been demonstrated that hospitals are dangerous places for older people,[24] and the rate of fatal adverse events associated with hospitalization is 10 times higher for people aged 65 and older than for those younger than 45.[25] Therefore, it should not be assumed that the chain of causality is that CGA leads to improved function and health and necessarily leads to less hospitalization. It may be that prevention of hospitalization, which avoids the deterioration in health associated with it, leads to improved function, although to some the distinction may be academic. Hospitalization is associated with deteriorating function in many older persons,[26] and treating people at home instead of in the hospital leads to lower rates of complications.[27,28] CGA prevents hospitalization through a number of mechanisms, which can be summarized as follows: addressing problems before they deteriorate to the stage where admission is unavoidable. At the time they are addressed, the problems may appear unimportant and often require persuasion and follow-up to ensure that recommendations are acted upon. However, this study demonstrates that CGA for at-risk elderly in the community, such as those who are DEED, improves functional status and health outcomes.

This study did have limitations. Although the initial assessment was performed blind to the patient's randomization status, because it was performed before randomization, subsequent assessments were not similarly blinded and may therefore have been subtly biased by awareness of the assessor. Self-reports provided by participants, or their caregivers where significant cognitive impairment existed, were used. This may have biased the study in favor of the treatment group because participants or their caregivers may have subtly sought to validate the input. Also, patients who may have had CGA performed in any other way by another service were not excluded, so there may have been some contamination of the control group, but it was felt that this better reflected reality. In addition, data were not available on how many recommendations the GPs and specialists who patients were referred to as a result of the CGA implemented.

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