Effects of Home-Based Intervention on Unplanned Readmissions and Out-of-Hospital Deaths

Simon Stewart, BA, BN,[*] Sue Pearson, BA (Psych Hons),[*] Colin G. Luke, MBBS, MPH,[†] and John D. Horowitz, MBBS, PhD[*]

OBJECTIVE: To determine the effect of a home-based intervention (HBI) on the frequency of unplanned readmission and out-of-hospital death among patients discharged home from acute hospital care.

DESIGN: A randomized controlled trial comparing HBI with usual care (UC).

SETTING: A tertiary referral hospital servicing the northwestern region of Adelaide, South Australia.

PARTICIPANTS: Medical and surgical patients (n = 762) discharged home after hospitalization.

INTERVENTION: Home-based intervention (n = 381) consisted of counseling of all patients before discharge followed by a single home visit (by a nurse and pharmacist) to those patients considered to be at high risk of readmission (n = 314) in order to optimize compliance with and knowledge of the treatment regimen, identify early clinical deterioration, and intensify follow-up of such patients where appropriate.

MEASUREMENTS: The primary endpoint was the number of unplanned readmissions *plus* out-of-hospital deaths over a 6-month follow-up period.

RESULTS: During the study follow-up, the major endpoint occurred most commonly in the UC group (217 vs 155 episodes: $P < .001$). Overall, the HBI group demonstrated fewer unplanned readmissions (154 vs 197: $P = .022$), out-of-hospital deaths (1 vs. 20: $P < .001$), total deaths (12 vs. 29: $P = .006$), emergency department attendances (236 vs 314: $P < .001$), and total days of hospitalization (1452 vs 1766: $P < .001$). There was a disproportionate reduction in multiple events among HBI patients ($P = .035$). Hospital-based costs of health care during study follow-up tended to be lower in the HBI group ($A2190 vs $A2680 per patient: $P = .102$). Mean cost of HBI was $A190 per patient visited, whereas other community-based health care costs were similar for both groups.

CONCLUSIONS: Among high-risk patients discharged from acute hospital care, HBI is beneficial in limiting unplanned readmissions and reducing risk of out-of-hospital death. It may be particularly cost-effective if applied selectively to patients with a history of frequent unplanned hospital admission. **J Am Geriatr Soc 46:174–180, 1998.**

From the Departments of [*]Cardiology and [†]Clinical Epidemiology of The Queen Elizabeth Hospital/University of Adelaide, Woodville, South Australia.

Supported by a grant from the Commonwealth Department of Health and Family Services of Australia (Pharmaceutical Education Program Grant 95/34956).

This study was presented at the 1997 World Congress of Gerontology, Adelaide, Australia.

Simon Stewart is a recipient of a National Heart Foundation of Australia Post graduate Medical Research Scholarship.

Address correspondence and reprint requests to J. D. Horowitz, MBBS, PhD, Department of Cardiology, The Queen Elizabeth Hospital, 28 Woodville Road, Woodville, South Australia, 5011.

Costs associated with hospital readmissions have been identified as a major component of healthcare expenditure in the United States:[1] the major factor accounting for cost variability among hospital inpatients was the occurrence of unplanned readmissions among high cost patients.[2,3] Possible strategies for reduction of readmissions might include increased utilization of outpatient or home-based services in an effort to improve compliance with prescribed medications and/or early detection of clinical deterioration. Despite the theoretical attractiveness of such treatment regimens, results of previously reported randomized controlled studies of this type have been conflicting, with favorable,[4–6] inconclusive,[7–12] and even unfavorable[13] effects reported on frequency and duration of rehospitalization. Importantly, these studies have varied considerably in regard to both the patient subgroups examined and the methods and intensity of patient follow-up.

The current study examined the effects of a home-based intervention (HBI) on a composite endpoint of total unplanned readmissions plus out-of-hospital deaths for a 6-month period. Patients studied were selected on the basis of an anticipated increased risk of unplanned readmission after home discharge from an acute hospital.

METHODS

The study was conducted at The Queen Elizabeth Hospital, a 440-bed hospital servicing the northwestern region of Adelaide, South Australia, an area with a disproportionate number of older and socially disadvantaged persons. The link between predominantly socially disadvantaged and older populations and poorer health outcomes in Australia[14] is reflected in the high levels of chronic illness and higher admission rates per capita for the region.[15]

Eligibility Criteria

Patients admitted to medical and surgical units at the hospital were eligible to participate if they were to be discharged home and were prescribed a medication regimen for a chronic condition. Exclusion criteria were presence of ter-

0002-8614/98/$3.50

minal malignancy requiring palliative care or home address outside the hospital catchment area.

Study Design

The study was approved by the hospital's Ethics of Human Research committee before patient recruitment took place. During a 12-month period, 4100 medical and surgical patients were screened, of whom 22% (n = 906) were considered eligible for the study. Of these initially identified patients, 762 (84%) agreed to participate. The baseline characteristics of participating patients were similar to those of the subset of eligible patients who refused to participate in the study. The predominant reasons for patient refusal included anticipated intrusiveness of a home visit and/or a belief that the intervention would be of little benefit.

Informed consent was obtained before hospital discharge, and participating patients were randomized to either usual care (UC) or HBI. Randomization was initiated via a telephone call to an investigator blinded to the patient's demographic and clinical profile but aware of their medical or surgical admission status. Using a computer-generated, stratified randomization program, patients were allocated to either HBI or UC, according to their medical or surgical admission status (to correct for potential imbalance between groups).

Immediately following randomization, an initial interview was conducted with all patients to document their baseline characteristics (including extent of comorbidity using the Charlson index).[16] During this initial assessment, the presence or absence of the following previously reported risk factors for unplanned hospitalization was identified: age 60 years or older, prescription of two or more medications, unplanned admission within preceding 6 months, and living alone and/or possessing limited English language skills.[17–22] Patients with multiple risk factors were designated prospectively as "high risk" for unplanned readmission during study follow-up; other patients were designated as "low risk."

Management

The intensity of study intervention in the HBI group was dependent upon initial assessment of risk. As such, all patients and caregivers in the HBI group (n = 381) were counseled before discharge by the study nurse and/or hospital pharmacist in relation to (1) compliance with prescribed medication and (2) early detection/reporting of clinical deterioration. Posthospitalization intervention, was, however, confined to those HBI patients with multiple risk factors and who were, therefore, designated as high risk (n = 314).

One-week postdischarge high-risk HBI patients were subject to a single home visit by the study nurse and pharmacist. The objectives of this home-visit were fourfold: (1) optimize home-medication management, (2) detect otherwise hidden problems, (3) increase patient/caregiver vigilance for impending crises, and (4) improve liaison with community-based services thereafter.

Before intervention, the study pharmacist performed an initially blinded assessment of the patient's medication compliance (via pill count) and knowledge (via questionnaire). Patients whose compliance deviated by 15% or more from prescribed dosage at discharge or whose medication knowledge was poor (less than 75% composite knowledge score of dosage, intended effect, potential side effects and special instructions) were then offered a combination of the following: (1) remedial counseling, (2) introduction of a compliance device and/or daily routine, (3) incremental monitoring by carers, (4) provision of a medication information/reminder card and (5) referral to a community pharmacist for regular review of potential problems thereafter (e.g., during each visit to the pharmacy to collect prescribed medication).

Following the pharmacist intervention, patients were assessed by the study nurse in order to detect any clinical deterioration since discharge. This involved both a physical assessment and a review of relevant symptoms since hospital discharge (e.g., degree of exercise intolerance among patients with congestive heart failure). Those requiring medical review were referred immediately to their community-based physician for a more detailed and definitive assessment. The study nurse also reviewed the patients' psychosocial status in order to determine the need (if any) for additional community-based support. In this respect, the patients' ability to maintain and monitor their health, especially in the absence of proximal caregivers, was of particular concern. Patients requiring additional support were referred to an appropriate community-based health professional/organization.

After the home visit, all of the patients' primary care physicians were contacted by the study nurse to inform them of the HBI and to discuss the need for further remedial action and/or more intensive follow-up. The extent of the HBI was not extended in any patients within the HBI group who required readmissions during the study.

Patients in the UC group (n = 381) were subject to the preexisting levels of discharge planning and posthospitalization care normally indicated. In this respect, all UC patients had appointments to be reviewed by their primary care physician and/or hospital physician (in the hospital's outpatient department) within 2 weeks of discharge. Furthermore, no restriction was imposed on the extent of home-based care (e.g., regular community nurse visits). In order to assess for potential confounding differences in the pattern of postdischarge medication management, and using the same methodology as for initial assessment of HBI patients, 84 high-risk UC patients received a home visit at 1 week to determine levels of compliance and medication knowledge.

Endpoints

The prospectively designated endpoint for this study was the number of unplanned readmissions within 6 months of index admission *plus* out-of-hospital deaths (weighted as the equivalent of one unplanned readmission). This combined mortality and rehospitalization endpoint was chosen, as in other previously reported studies,[6,23] to adjust partially for the potential reduction in readmissions if patients died outside of the hospital. Prospectively defined secondary endpoints were unplanned readmissions, total days of readmission (elective and unplanned), emergency service attendances, out-of-hospital mortality, overall mortality, and total cost of hospital-based health care.

Data Collection

All inpatient and outpatient activity was monitored through the hospital's computerized medical records system. Records of the time and location of all deaths occurring in South Australia (via the South Australian Birth, Deaths and Marriages Registry) were used to compile mortality data. Cost of hospital admissions and outpatient appointments were calculated using the hospital's inpatient and outpatient costing system. Costs associated with the study intervention

were calculated for the entire HBI group. Calculation of these costs included: (1) salary for the study nurse and pharmacist (as determined by diary entries), (2) use of other professional services (e.g., interpreting), (3) infrastructure requirements (e.g., personal communications and transport), and (4) additional consultation with community pharmacists. A detailed costing of community-based health care costs (other than study intervention) was performed in 150 randomly selected patients. Calculation of these costs included the following components: (1) consultation with primary care physicians (according to standard Medicare fees), (2) prescribed pharmacotherapy (according to standard pharmaceutical costs),[24] and (3) home-visits by healthcare professionals.

For comparative purposes, randomly selected HBI and UC patients were interviewed via telephone, by a blinded investigator, to determine quality of life of surviving patients at 1 and 3 months using the Australian version of the SF-36 health-related quality of life questionnaire.[25]

STATISTICAL ANALYSIS

Pilot data suggested that the rate of unplanned readmission plus out-of-hospital deaths would be approximately 0.5 events per patient during the 6 months follow-up.[17] We calculated, therefore, that a total of 380 patients would be required in each group to detect a 10% variation in this composite endpoint, with $\alpha = .05$ and $\beta = .2$.

Comparison of baseline and endpoint data involved utilization of: (1) chi-square analysis (with calculation of odds ratio (OR) and 95% confidence intervals (CI)) for discrete variables, (2) Student's t test for normally distributed continuous variables, (3) Mann-Whitney U test for non-normally distributed variables without a large proportion of tied observations, (4) z-test of two independent counts[26] for variables with a large proportion of tied observations and (5) log-rank test for analysis of the mortality data (Kaplan Meier Curve) and time to first unplanned readmission. All analyses were performed on an intention-to-treat basis and included data from the entire cohort (n = 782) for all major endpoints.

Comparison of the SF-36 quality of life scores was made with the Bonferonni t test for multiple comparisons.[27] Univariate analysis and step-wise multiple logistical regression were used to identify potential demographic and clinical correlates of unplanned readmission and out-of-hospital death.

RESULTS

Baseline Characteristics

Table 1 summarizes the clinical and demographic features of study patients according to treatment group. Analysis of baseline data, including extent of co-morbidity, suggested that the groups were well matched. The majority of the study cohort were older, of low socioeconomic status, and were being treated for a chronic condition with two or more prescribed medications. Despite initial informed consent, 56 (18%) high-risk HBI patients did not receive a home visit (usually as a result of withdrawal of consent).

Nature of Home-Based Intervention

During the initial assessment, 44% of the HBI patients (n = 258) visited at home were found to be malcompliant with their prescribed medications, and 96% demonstrated inadequate knowledge about their treatment status (these figures were 47% and 98%, respectively, in comparable UC patients). Consequently, all of these HBI patients received a combination of remedial counseling, introduction of a compliance device/reminder routine, and/or closer supervision by a caregiver (usually an immediate family member), and 37 patients (14%) were referred to their community pharmacist for more intensive follow-up thereafter. The majority of home visits were 90 to 120 minutes in duration.

Furthermore, all of the patients' primary care physicians were notified of this home assessment, and remedial action was recommended: 40 patients (16%) were subject to imme-

Table 1. Clinical and Demographical Profile of Study Cohort

	HBI n = 381	UC n = 381
Demographic profile		
Age in years (mean ± SD)	66.0 ± 15.7	65.3 ± 15.8
Male:Female	193:188	191:190
Socioeconomic status		
Employed (full or part-time)	42 (11%)	50 (13%)
Recipient of government pension	305 (80%)	306 (80%)
Married/Defacto	204 (54%)	207 (54%)
Live alone	132 (35%)	124 (33%)
Non-English speaking	43 (11%)	49 (13%)
Formal education ≤8 years in total	263 (69%)	263 (69%)
Clinical profile		
Pre-existing treatment for chronic condition	321 (84%)	323 (84%)
Charlston Index of comorbidity (mean ± SD)	1.3 ± 0.7	1.3 ± 0.6
Number of patients with an unplanned admission 6 months before follow-up	273 (72%)	283 (74%)
Number of patients with multiple unplanned admissions 6 months before follow-up	65 (17%)	67 (17%)
Days of unplanned hospitalization 6 months before follow-up (mean ± SD)	7.0 ± 8.1	7.1 ± 9.1
Type of index admission		
Unplanned for chronic illness	107 (28%)	120 (32%)
Unplanned for acute illness	162 (43%)	152 (40%)
Elective	112 (29%)	109 (28%)
Category of primary diagnosis		
Cardiac disease	99 (26%)	113 (30%)
Respiratory disease	52 (14%)	41 (11%)
Orthopedic condition	67 (18%)	65 (17%)
Vascular disease	57 (14%)	61 (16%)
Other	106 (28%)	101 (27%)
Discharge medications		
Number of prescribed medications (mean ± SD)	4.8 ± 2.8	4.7 ± 2.5
Assessed risk for an unplanned readmission within 6 months of follow-up		
High risk (≥2 risk factors)	314 (82%)	318 (84%)

diate referral in order to address evidence of clinical deterioration and/or adverse effects of prescribed medication.

Primary Endpoint

The primary (composite) endpoint occurred on 155 occasions in the HBI group and on 217 occasions in the UC group ($P < .001$) (Figure 1). This accounted for 154 versus 197 unplanned readmissions ($P = .022$) and 1 versus 20 out-of-hospital deaths ($P < .001$ (OR 0.04, 95% CI 0–0.4)). However, there was no significant difference in the number of patients in whom the primary endpoint occurred (104 HBI vs 117 UC; $P = .299$) or in time to first readmission. Hence, the effect of the intervention was mediated via reduced frequency of multiple unplanned readmissions and out-of-hospital deaths ($P = .035$) (Figure 2).

Post hoc analysis of the frequency and characteristics of readmissions suggested that the major disparity occurred among patients who would normally experience multiple hospital admissions. During study follow-up, 12 of 103 HBI patients, compared with 24 of 105 UC patients ($P = .035$ (OR 2.3, 95% CI 1.0–5.1)), were readmitted on three or more occasions. Within the UC group, patients with three or more readmissions were more likely to have a diagnoses of congestive heart failure ($P < .001$ (OR 5.8, 95% CI 2.2–15.2)) and/or chronic airways limitation ($P = .005$ (OR 3.8, 95% CI 1.4–9.7)), had experienced a previous unplanned admission within 6 months of the index admission ($P = .005$ (OR 3.2, 95% CI 1.3–8.00)), and were receiving a larger number of medications on discharge (mean 5.8 ± 2.6 vs 4.6 ± 2.4 medications per patient; $P = .018$). Furthermore, blinded review of the medical records pertaining to all unplanned readmissions during study follow-up revealed that a greater proportion of UC admissions were associated with documented malcompliance and/or adverse effects of prescribed medication (35/197 vs 13/154; $P = .012$ (OR 2.34, 95% CI 1.14–4.87)).

Secondary Endpoints

Total mortality was also significantly lower in the HBI group (12 vs 29; $P = .006$ (OR 0.4, 95% CI 0.2–0.8)) (Figure 3). However, numbers of in-hospital deaths were similar for both groups (11 HBI vs 9 UC).

Patient attendances at hospital emergency services were significantly lower in the HBI group (236 vs 314: $P < .001$) although the proportion of patients attending emergency service was similar (138 HBI vs 140 UC). Post hoc analysis of the frequency of emergency service attendance suggested that patients in the UC group were more likely to attend emergency service three or more times during study follow-up (42/140 vs 18/138: $P < .001$ (OR 2.86, 95% CI 1.5–5.5)).

Total days of hospitalization resulting from all readmissions during the study follow-up were significantly less in the HBI group (1452 vs 1766 days: $P < .001$). This comprised 1258 compared with 1497 days associated with unplanned readmissions ($P < .001$) and 194 compared with 269 days associated with elective admissions ($P < .001$).

Table 2 presents the results of univariate and subsequent multivariate analysis to determine significant correlates of unplanned readmission and out-of-hospital death. Adjusted odds ratios for relative probability of unplanned readmission within the entire study cohort were approximately 2.0 for patients with either prior dependence on home-based support or prior unplanned admission(s) and 2.2 for patients receiving five or more prescribed medications. Significant, independent correlates for out-of-hospital death were non-English speaking background and assignment to the UC group.

In order to determine whether there was significant interaction between treatment mode and correlates of unplanned readmission, multivariate analysis was also performed separately for each treatment group. In this respect, there were no significant differences between treatments as regards identified correlates. The odds ratio for unplanned readmission during the study period was 3.2 (95% CI 1.4–7.6) for patients in the HBI group who were considered prospectively to be at high risk for readmission (n = 314) versus those considered at lower risk (n = 67). Within the UC group, the corresponding odds ratio was 1.9 (95% CI 0.94–4.2).

Quality of Life

Quality of life scores (data not shown) indicated marked impairment of quality of life relative to age- and gender-matched norms for the local population for each of the eight

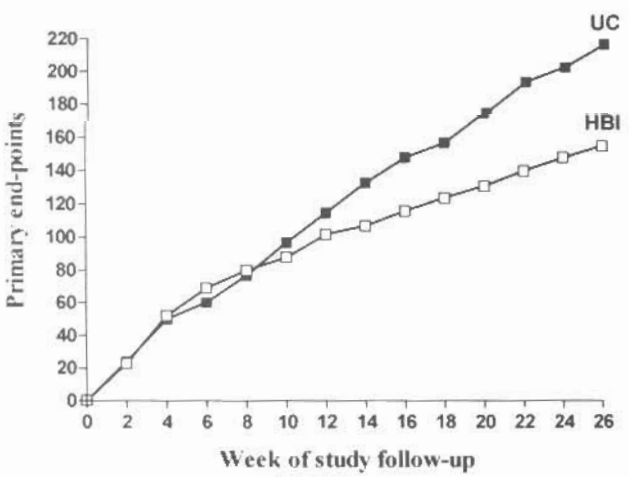

Figure 1. Progressive total of unplanned readmissions plus out-of-hospital deaths during 6-month follow-up. $P < .001$ for the comparison between the two groups at 6 months: z-test for two counts.

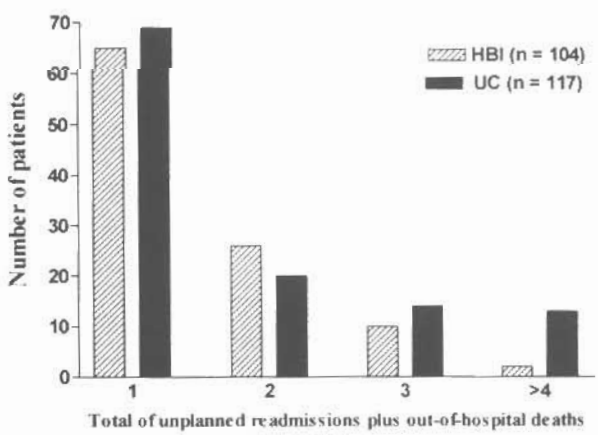

Figure 2. Frequency of unplanned readmissions plus out-of-hospital deaths among patients recording at least one event during study follow-up. $P = .035$ for the comparison between all HBI and UC patients: chi-square test.

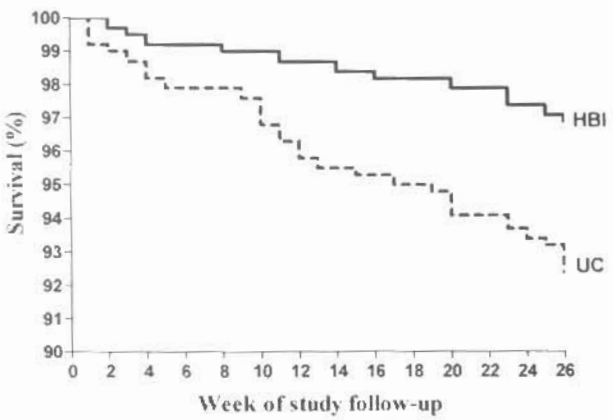

Figure 3. Survival data during study follow-up. $P = .006$ for the comparison between study groups at 6 months: log-rank test.

health dimensions measured (relating to physical, psychological, and social status/function),[28] but no significant differences between the two groups were seen at either 1 or at 3 months after study entry.

Costs of Health Care

Costs of the two treatment regimens were compared in regard to hospital-based health care in all patients, whereas community-based costs were estimated in a randomly chosen subset of 150 patients. Costs of hospital-based care tended to be lower among HBI patients, with a mean of $A2190 per patient (95% CI $A1740–2630) versus $A2680 per UC patient (95% CI $A2030–3320); this difference did not reach statistical significance ($P = .210$). On the other hand, the cost of implementing the study intervention among the 254 patients who received a home visit was $A190 per patient (total $A48,460). In regard to community-based costs, no difference could be detected between groups in respect to intensity of contact with primary care physicians (median of six consultations during study follow-up) or proportion of patients using home-based services (21% for both groups); mean cost of community-based care was $A610 per HBI patient (95% CI $A530–690) versus $A630 per UC patient (95% CI $A560–700); $P = .641$.

DISCUSSION

We examined the effect of a HBI on the frequency of unplanned readmissions and out-of-hospital deaths among a cohort of largely frail older patients requiring long-term medical care. *In the 6-month follow-up period*, patients in the HBI group demonstrated a significant reduction in the primary endpoint, a difference mediated almost exclusively by a reduction in multiple readmissions and out-of-hospital deaths. Although contact with primary care physicians and home-based services was similar for both groups, HBI patients had 18% fewer days of hospitalization. Examination of odds ratios for unplanned readmissions suggests that the 314 patients (82%) within the HBI group in whom the posthospitalization intervention was performed constituted a well delineated high-risk subset.

What are the potential explanations for these findings? Previous studies have suggested that between 9 and 54% of unplanned hospital readmissions are preventable.[29–33] Potentially avoidable causes of such readmissions include malcompliance with, and/or adverse effects of, prescribed medications,[34–39] inadequate follow-up,[10,11,29,40–42] suboptimal use of medical care,[31,40] and early clinical deterioration.[19,22,29,31,40]

We postulated that the early HBI program chosen might ameliorate all of the above factors, both directly and via increased vigilance of patients' physicians, community pharmacists, and caregivers. The high prevalence of malcompliance (44% is consistent with previous studies of chronically ill patients)[43–46] with, and/or suboptimal knowledge of, prescribed medication in patients visited at home confirmed the potential for improving subsequent health outcomes. Although we did not measure directly the potential changes in compliance behavior after the HBI (in order to retain the minimalist nature of study intervention), the apparent reduction in frequency of medication-related readmissions among HBI patients is consistent with the intended improvement in medication management.

Despite the reduction in total unplanned readmissions in the HBI group, the proportion of patients readmitted at 6 months was similar in both groups. The beneficial effect of the study intervention appeared to be confined largely to the subgroup of patients who would normally be at risk of multiple unplanned readmissions and out-of-hospital death. It was noted as a component of post hoc analysis that the frequency distribution of numbers of readmissions differed significantly between UC and HBI groups, with a disproportionately low number of multiple readmissions in the HBI group. Coupled with the analysis of predictors of three or more readmissions among UC patients, these data suggest that the predominant benefit of HBI may lie in patients at particular risk of multiple readmissions. Thus, while the current study was not designed specifically to identify mechanism(s) of putative benefit, potential malcompliance and concomitant cardiac and/or respiratory failure may be factors particularly identifying patients benefiting from HBI. Congestive heart failure in particular is associated with frequent and costly hospital use in the United States.[47–51]

While a number of previous investigations have sought to reduce frequency of readmissions to the hospital, via both community- and hospital-based strategies,[4,13,52–56] the current methodology differs from such studies with its utilization of a transient HBI to both identify and correct medication-related problems and to increase caregiver vigilance thereafter. Two previously reported studies of HBI involving nonmedical personnel have reported some success in reducing rates of readmissions after 18 months in a study of patients with a wide range of chronic illnesses[4] and, most notably, after 3 months in patients with chronic congestive heart failure.[6] The results of the current study and the two previous studies are, to some extent, consistent with the findings of a meta-analysis of randomized controlled studies examining the value of geriatric assessment programs. On the basis of this analysis, Stuck et al. concluded that such programs are associated with a 12% risk reduction in readmission during study follow-up.[57] However, the current study differs from those used in the meta-analysis in that it involves a more transient, and potentially more cost-effective, intervention and reports a significant reduction in mortality associated with a postdischarge intervention; previously reported reductions in mortality have been primarily associated with hospital-based interventions.[52,56,57]

The study has several limitations, including a lack of clear identification of the mechanism(s) of beneficial effect (as

Table 2. Potential Correlates of Unplanned Readmission and Out-of-Hospital Death Determined by Initial Univariate and Subsequent Multivariate Analysis

			P Value		
			Univariate Analysis	Multivariate Analysis	Adjusted Odds Ratio
Unplanned Readmission	**No n = 554**	**≥1 admission n = 208**			
Chronic illness at study entry	458 (83%)	186 (89%)	0.022	0.646	
Age (mean ± SD)	65 ± 16	69 ± 15	0.003	0.143	
Prior dependence on home support services	53 (9%)	44 (21%)	<0.001	0.004	2.1 (1.2–3.1)
Number of prescribed discharge drugs (mean ± SD)	4.4 ± 2.5	5.6 ± 2.8	<0.001	<0.001	2.2* (1.6–3.1)
Emergency admission 6 months before study entry	394 (71%)	178 (86%)	<0.001	<0.001	2.1 (1.4–3.1)
Out-of-hospital death	**No n = 741**	**Yes n = 21**			
Male	370 (50%)	14 (66%)	0.130	0.138	
Emergency admission 6 months before study entry	156 (21%)	8 (38%)	0.100	0.929	
Prescribed discharge medications (mean ± SD)	4.7 ± 2.6	5.5 ± 2.4	0.174	0.254	
Initial medical admission	445 (60%)	17 (81%)	0.128	0.081	
Primary language—non-English	84 (11%)	8 (38%)	0.002	<0.001	4.7 (1.8–12)
Usual care post-hospitalization (UC group)	361 (49%)	20 (95%)	<0.001	0.003	20.8 (2.7–156)

*Odds ratio for patients prescribed ≥5 discharge medications.

described above) and a limited duration of follow-up. In the current study 82% of patients randomized to HBI were categorized as high risk and, therefore, received in-hospital and home-based components of intervention. It therefore remains uncertain whether the in-hospital component of the intervention (counseling by a pharmacist and/or study nurse) contributed to the overall beneficial effect of HBI. Furthermore, the results of the study may be applicable only to patients of socioeconomic status similar to those currently investigated.

However, a number of conclusions are suggested by the available data. First, the algorithm for selection of high-risk patients was generally accurate; hence, there would be little purpose in considering the "low-risk" subset of patients (17% in this study) in future investigations. Second, as suggested by one previous similar investigation involving patients with congestive heart failure,[6] there was a considerable reduction in frequency of out-of-hospital deaths; hence, it is appropriate for this component of the overall beneficial effect to be taken into account in future treatment strategies. Finally, the available data indicate there was a disproportionate reduction in multiple readmissions among HBI patients. This does not necessarily imply the need to confine future implementation of such HBI to patient subsets at risk for multiple readmission.

We have demonstrated that an inexpensive and transient HBI reduces unplanned readmissions and mortality among a cohort of largely frail older patients discharged to home and requiring long-term medical care. Subject only to confirmation of the cost-effectiveness of this strategy in selected high-risk patients, it would appear that this type of intervention merits widespread adoption.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the invaluable contributions of Mimma De-Sanctis, BPharm, Jan Hooper, BN, Geoff March, BPharm, Margaret Davey, BPharm, Jane Harford, BBus, and Ron Wuttke, BSc.

REFERENCES

1. Schroeder SA, Showstack JA, Roberts HE. Frequency and clinical description of high cost patients in 17 acute care hospitals. N Eng J Med 1979;300:1306–1309.
2. Anderson GF, Steinberg EP. Hospital readmissions in the medicare population. N Engl J Med 1984;311:1349–1353.
3. Zook CJ, Moore FD. High cost users of medical care. N Eng J Med 1980;302:996–1002.
4. Townsend J, Piper M, Frank AO et al. Reduction in hospital readmission stay of elderly patients by a community based hospital discharge scheme: A randomised controlled trial. Br Med J 1988;297:20–27.
5. Melin AL, Bygren LO. Efficacy of the rehabilitation of elderly primary care patients after short stay hospital treatment. Med Care 1992;30:1004–1015.
6. Rich MW, Beckham V, Wittenberg C et al. A multidisciplinary intervention to prevent the readmission of elderly patients with congestive heart failure. N Engl J Med 1995;333:1190–1195.
7. Smith DM, Weinberger M, Katz BP, Moore PS. Postdischarge care and readmissions. Med Care 1988;26:699–708.
8. Hansen FR, Spedtsberg K, Schroll M. Geriatric follow-up by home visits after discharge from hospital: A randomised controlled trial. Age Ageing 1992;21:445–450.
9. Rubin CD, Sizemore MT, Loftis PA et al. The effect of geriatric evaluation and management on medicare reimbursement in a large public hospital: A randomized clinical trial. J Am Geriatr Soc 1992;40:989–995.

10. Fitzgerald JF, Smith DM, Martin DK et al. A case manager intervention to reduce readmissions. Arch Intern Med 1994;154:1721–1729.
11. Naylor M, Brouten D, Jones R et al. Comprehensive discharge planning for the hospitalized elderly: A randomized clinical trial. Ann Intern Med 1994;120:999–1006.
12. Siu AL, Kravitz RL, Keeler E et al. Postdischarge geriatric assessment of hospitalized frail elderly patients. Arch Intern Med 1996;156:76–81.
13. Weinberger M, Oddone EZ, Henderson WG. Does increased access to primary care reduce hospital readmissions? N Engl J Med 1996;334:1441–1447.
14. Mathers C. Health differentials among adult Australians aged 25–64 years. Australian Institute of Health and Welfare: Health Monitoring Series No.1. Canberra 1994: Australian Government Publishing Service.
15. Glover J, Shand M, Forster C, Woollacott T. A Social Health Atlas of South Australia. Adelaide: South Australian Health Commission, 1996.
16. Charlson ME, Pompei P, Ales KL, McKenzie RC. A new method of classifying prognostic comorbidity in longitudinal studies: Development and validation. J Chronic Dis 1987;40:373–383.
17. Stewart S, Davey M, De-Sanctis M et al. Home medication management: A study of patient post-hospitalisation. Aust Pharm 1995;14:472–476.
18. Anderson GF, Steinberg EP. Predicting hospital readmissions in the medicare population. Inquiry 1985;22:251–258.
19. Victor CR, Vetter NJ. The early readmission of the elderly to hospital. Age Ageing 1985;14:37–42.
20. Fethke CC, Smith IM, Johnson N. Risk factors affecting readmission of the elderly into the health care system. Med Care 1986;24:429–437.
21. Evans RL, Hendricks RD, Lawrence K, Bishop DS. Identifying factors associated with health care use: A hospital-based risk screening index. Soc Sci Med 1988;27:947–954.
22. Williams EI, Fitton F. Factors affecting early unplanned readmission of elderly patients to hospital. Br Med J 1988;297:784–787.
23. Packer M, O'Connor CM, Ghali JK et al. Effect of amlodipine on morbidity and mortality in severe chronic heart failure. N Engl J Med 1996;335:1107–1114.
24. Department of Human Services and Health. Schedule of Pharmaceutical Benefits. Canberra: Australian Government Publishing Service, 1995.
25. Ware JE, Sherbourne CD. The MOS 36-item short-form health survey (SF-36): Conceptual framework and item selection. Med Care 1992;30:473–483.
26. Daly LE, Bourke GJ, McGilvray J. Interpretation and Uses of Medical Statistics, 4th ed. Oxford: Blackwell Science, 1991, pp 98–99.
27. Cupples AL, Heeren T, Schatzkin A, Colton T. Multiple testing of hypotheses in comparing two groups. Ann Intern Med 1984;100:122–129.
28. Behavioural Epidemiology Unit. South Australian Population Norms for the SF-36 Health Status Questionnaire. Adelaide: South Australian Health Commission, 1995..
29. Graham H, Livesley B. Can readmissions to a geriatric medical unit be prevented? Lancet 1983;i:404–406.
30. Lakshmanan MC, Hershey CO, Breslau D. Hospital admissions caused by iatrogenic disease. Arch Intern Med 1986;146:1931–1934.
31. Bigby JA, Dunn J, Goldman L et al. Assessing the preventability of emergency hospital admissions. Am J Med 1987;83:1031–1036.
32. Clarke A. Are readmissions avoidable? Br Med J 1990;301:1136–1138.
33. Frankl SE, Breeling JL, Goldman L. Preventability of emergent hospital readmission. Am J Med 1991;90:667–674.
34. Col N, Fanale JE, Kronholm P. The role of medication noncompliance and adverse drug reactions in hospitalisation of the elderly. Arch Intern Med 1990;150:841–845.
35. Larmour I, Dolphin RG, Baxter H et al. A prospective study of hospital admissions due to drug reactions. Aust J Hosp Pharm 1991;21:90–95.
36. Einarson TR. Drug-related hospital admissions. Ann Pharmacother 1993;27:832–840.
37. Hewitt J. Drug-related unplanned readmissions to hospital. Aust J Hosp Pharm 1995;25:400–403.
38. Dartnell JG, Anderson RP, Chohan V et al. Hospitalisation for adverse events related to drug therapy: Incidence, avoidability and costs. MJA 1996;164:659–62.
39. Mason WB, Bedwell CL, Zwaag RV, Runyan JW. Why people are hospitalized. Med Care 1980;18:147–163.
40. Ashton CM, Wray NP, Dunn JK et al. Predicting readmission in veterans with chronic disease. Med Care 1986;25:1184–1189.
41. Evans RL, Hendricks RD. Evaluating hospital discharge planning: A randomized clinical trial. Med Care 1993;31:358–370.
42. Sackett DL, Haynes RB, Gibson ES et al. Randomised clinical trial of strategies for medication compliance in primary hypertension. Lancet 1975;1:1265–1268.
43. Eraker SA, Kirscht JP, Marshall HB. Understanding and improving patient compliance. Ann Intern Med 1984;100:258–268.
44. Spagnoli A, Ostino G, Borga AD et al. Drug compliance and unreported drugs in the elderly. J Am Geriatr Soc 1989;37:619–624.
45. Hawe P, Higgins G. Can medication education improve the drug compliance of the elderly? Evaluation of an in-hospital program. Patient Educ Couns 1990;16:151–160.
46. Rudd P, Ramesh J, Bryant-Kosling C, Guerrero D. Gaps in cardiovascular medication taking: The tip of the iceberg. J Gen Intern Med 1993;8:659–666.
47. Graves EJ. 1989 Summary. National Hospital Discharge Survey: Advance Data from Vital and Health Statistics, No. 199. Hyattsville, MD: Public Health Service, 1991.
48. Gooding J, Jette AM. Hospital readmissions among the elderly. J Am Geriatr Soc 1985;33:595–601.
49. Krumholz HM, Parent EM, Tu N et al. Readmission after hospitalization for congestive heart failure among medicare beneficiaries. Arch Intern Med 1997;57:99–104.
50. Rich MW, Freedland KE. Effect of DRG's on three-month readmission rate of geriatric patients with congestive heart failure. Am J Public Health 1988;78:680–684.
51. Vinson JM, Rich MW, Sperry JC et al. Early readmission of elderly patients with congestive heart failure. J Am Geriatr Soc 1990;38:1290–1295.
52. Rubenstein LZ, Josephson KR, Wieland DG et al. Effectiveness of a geriatric evaluation unit: A randomized clinical trial. N Engl J Med 1984;311:1164–1170.
53. Applegate WB, Miller ST, Graney MJ et al. A randomized, controlled trial of a geriatric assessment unit in a community rehabilitation hospital. N Engl J Med 1990;322:1572–1578.
54. Reuben DB, Wolde-Tsadik G, Pardamean B et al. The use of targeting criteria in hospitalized HMO patients: Results from the demonstration phase of the hospitalized older persons evaluation (HOPE) study. J Am Geriatr Soc 1992;40:482–488.
55. Winograd CH, Gerety MB, Lai NA. A negative trial of inpatient geriatric consultation. Arch Intern Med 1993;153:2017–2023.
56. Thomas DR, Brahan R, Haywood BP. Inpatient community-based geriatric assessment reduces subsequent mortality. J Am Geriatr Soc 1993;41:101–104.
57. Stuck AE, Siu AL, Wieland DG et al. Comprehensive geriatric assessment: A meta-analysis of controlled trials. Lancet 1993;342:1032–1036.