A Matched-Cohort Study of Health Services Utilization and Financial Outcomes for a Heart Failure Disease-Management Program in Elderly Patients

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OBJECTIVES: To investigate the utilization and financial outcomes of a telephonic nursing disease-management program for elderly patients with heart failure.

DESIGN: A 1-year concurrent matched-cohort study employing propensity score matching.

SETTING: Medicare+Choice recipients residing in Ohio, Kentucky, and Indiana.

PARTICIPANTS: A total of 533 program participants aged 65 and older matched to nonparticipants.

INTERVENTION: Disease-management heart failure program employing a structured, evidence-based, telephonic nursing intervention designed to provide patient education, counseling, and monitoring services.

MEASUREMENTS: Medical service utilization, including hospitalizations, emergency department visits, medical doctor visits, skilled nursing facility (SNF) days, selected clinical indicators, and financial effect.

RESULTS: The intervention group had considerably and significantly lower rates of acute service utilization than the control group, including 23% fewer hospitalizations, 26% fewer inpatient bed days, 22% fewer emergency department visits, 44% fewer heart failure hospitalizations, 70% fewer 30-day readmissions, and 45% fewer SNF bed days. Claims costs were $1,792 per person lower in the intervention group than in the control group (inclusive of intervention costs), and the return on investment was calculated to be 2.31.

CONCLUSION: The study demonstrates that a commercially delivered heart failure disease-management program significantly reduced hospitalizations, emergency department visits, and SNF days. The intervention group had 17% lower costs than the control group; when intervention costs were included, the intervention group had 10% lower costs.
J Am Geriatr Soc 52:1655–1661, 2004.

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Funded and conducted by McKesson Corporation.

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Key words: matched pair analysis; disease management; congestive heart failure; elderly

Due to an aging U.S. population and increasing survival rates after diagnosis, the prevalence of heart failure (HF) is expected to increase over the next decade,[1–3] and it remains one of the chronic diseases with the greatest morbidity and mortality rates.[4]

Currently, HF directly and indirectly contributes to about 285,000 deaths per year.[1,5–8] It is the number one cause of hospitalization in the elderly in the United States.[9] Despite effective management strategies for HF, hospitalization and readmissions after discharge remain common, contributing to a poor quality of life. As such, the immense morbidity and mortality associated with HF push medical costs in excess of $20 billion per year.[5,10]

The recently updated American College of Cardiology/American Heart Association guideline promotes self-monitoring of weight, influenza vaccination, physical activity, and use of medications such as angiotensin-converting enzyme (ACE) inhibitors and beta-blockers, all of which are currently underused in the treatment of heart failure.[11]

HEART FAILURE DISEASE MANAGEMENT

Disease management is an integrated, systematic approach to healthcare delivery that focuses on a population of patients with specific chronic diseases. The Disease Management Association of America defines disease management as containing the following program elements:

- population identification processes
- evidence-based practice guidelines
- collaborative practice models to include physician and support-service providers
- patient self-management education (may include primary
- prevention, behavior modification programs, and compliance/surveillance)
- process and outcomes measurement, evaluation, and management

0002-8614/04/$15.00

routine reporting/feedback loop (may include communication with patient, physician, health plan and ancillary providers, and practice profiling)[12]

The pharmacological and nonpharmacological interventions and understanding of the pathophysiology of HF disease have allowed an increasing number of patients to be managed in an ambulatory setting.[13–18] Several investigators have shown that a multidisciplinary approach using disease-management nurses, frequent office visits, and telephone contact systems have had a positive effect and improved the quality of life and reduced hospitalizations and the overall cost of medical services for patients with HF,[19–22] but these evaluations have been pre/post evaluations with patients serving as their own controls or academic health center evaluations of largely clinic-based interventions. Clinic-based efforts also study selected patients who do not reflect the community of HF patients, and these models are geographically linked to the clinic setting. Furthermore, in these studies, intervention costs are not clearly delineated, nor is it evident whether the estimated cost savings include intervention costs. Analyses of commercial HF disease-management programs delivered to the elderly have not been published. This study is designed to address whether a telephonic disease-management program results in lower use of acute services, improvements in use of recommended interventions, and net cost reductions than no intervention.

METHODS

Study Population

A retrospective, concurrent matched cohort study design was employed. The eligible population for participation in the intervention or control group included members, aged 65 and older, of a Medicare+Choice health plan residing in Ohio, Indiana, or Kentucky who had a hospitalization or emergency department visit at which HF was one of the diagnoses as determined by medical claims review in the previous year, were not engaged in a local formal HF program, and were enrolled in the plan 12 months before the start date of the study and at least 3 months after the start date in the study. Patients residing (for >30 days) in a long-term skilled nursing facility (SNF) or participating in a hospice program or who were identified as having end-stage renal disease, dialysis, transplants, acquired immune deficiency syndrome, claims costs greater than $100,000 or malignant cancer were excluded. Long-term SNF stay (>30 days) was used as a criterion for exclusion because patients staying longer than 30 days were assumed to be nursing home residents, and the intervention was designed for community-dwelling residents, because they do not have the same access to around-the-clock nursing care that nursing home residents do and so would not benefit as much from a telephonic intervention. In addition, nursing home residents often do not have ready access to a telephone, making such in intervention impractical.

The quality management department at the health plan providing the service approved the intervention. The health plan did not wish to evaluate the effect with a randomized, controlled trial design and opted to employ a matched control analysis to evaluate program effects.

The control group was generated by matching each disease-management participant with a matched nonparticipant determined using a propensity score.[23,24] The control group was drawn from the population eligible for the intervention that could not be reached for telephonic enrollment. The health plan provided the telephone numbers and addresses. In general, 50% of a health plan's patient contact data are incomplete or inaccurate. Those who could not be reached by telephone formed the basis for the control group. Patients who refused to participate in the intervention were excluded from consideration in the control group.

Matching on a propensity score is a way of matching on many variables indirectly, instead of matching directly on many variables, which becomes increasingly difficult with more variables.[25–28] Matching on a propensity score reduces a multivariate matching problem into a simpler univariate matching. Variables from Table 1, baseline matching variables, were used in the propensity score estimation; these matching variables included demographics, comorbidities, use of medical services, medications, diagnostic tests, immunization history, and medical and pharmacy costs. Comorbidities were matched according to their presence, not severity, which is difficult to ascertain in an administrative database.

Propensity scores were calculated on participants and nonparticipants. The control group was formed by selecting nonparticipants with the closest propensity score to each participant using the method of replacement, whereby it is possible for a comparison group member to be selected more than once, which is beneficial in terms of bias reduction.[29] Once a comparison cohort was defined, variables were compared at baseline year to ensure the similarity of the two groups. The Kruskal-Wallis test was used for comparison of variables between the treatment and comparison cohorts.

Study Design

The number of patients initially eligible for the program was 2,454; 837 were recruited for participation in the study. The treatment cohort patients were 533 congestive heart failure patients. The numbers dropped from 837 to 533 due to the exclusion criteria. Major reasons for exclusion were 174 patients who did not have 12 months of baseline period plan eligibility, 173 patients with malignant cancers, 116 patients with less than 3 months of health plan eligibility during the intervention period, and 26 in hospice.

Table 1 reveals baseline characteristics of the two groups. The two groups were well matched on demographic and comorbidity variables, showing no significant differences. Also, the two groups were closely matched with respect to use of medical services, including hospitalization rates, emergency department visits, pharmacy prescriptions, short-term nursing home stay days, and office visits. Baseline use of drugs was also similar between the groups, as were diagnostic testing rates. Average age of the study participants was 76.2. As expected, the comorbidity burden in this group of elderly HF patients was high. More than 60% of the intervention and control groups had coronary artery disease, and more than 55% had hypertension. Chronic obstructive pulmonary disease (COPD) was

Table 1. Baseline Matching Results

Variable	Treatment Cohort (n = 533)	Matched Cohort (n = 533) *	*P*-value
Demographic and comorbidity			
Months pre, mean	12.0	12.0	1.000
Months post, mean	10.9	10.7	.741
Male, %	33.8	32.5	.649
Aged ≥65, %	100.0	100.0	1.000
Age, mean	76.2	76.6	.844
Coronary artery disease, %	63.0	62.9	.949
Chronic obstructive pulmonary disease, %	21.2	20.8	.881
Hypertension, %	56.3	59.8	.238
Diabetes mellitus, %	38.5	40.2	.573
Arthritis, %	15.9	17.3	.565
Dementia, %	0.9	0.6	.478
Depression, %	3.2	3.9	.509
Medical service utilization (annualized rate per 1,000)			
Inpatient admissions	962.7	1,075.5	.684
Inpatient bed days	4,385.6	4,534.6	.976
ED visits	636.3	750.5	.732
Doctors' visits	21,740.2	23,127.9	.232
Pharmacy prescriptions	57,170.4	58,513.7	.899
CHF inpatient admits	243.8	314.5	.906
CHF inpatient bed days	1,088.7	1,404.6	.895
CHF ED visits	45.4	75.5	.881
30 day readmissions	192.1	232.7	.273
Skilled nursing facility days	382.2	371.1	.779
Prescription drug use (annual days supply per person)			
ACE inhibitor	97.6	98.8	.994
Beta-blocker	45.1	47.6	.376
Antihypertensive	178.8	175.8	.602
Diuretics	163.1	161.4	.358
CG or antiarrhythmic	81.3	76.3	.271
Antianginal	99.0	104.8	.830
Prescription drug use baseline (% who had prescription)			
ACE inhibitor	41.7	42.0	.901
Beta-blocker	22.5	19.5	.229
Antihypertensive	63.0	61.5	.613
Diuretics	67.4	64.4	.302
CG or antiarrhythmic	32.8	29.3	.209
Antianginal	43.0	43.0	1.000
Intervention performed, %			
Hemoglobin A1c	24.4	27.8	.209
Electrocardiography	77.1	78.0	.714
Echocardiography	46.0	46.3	.902
Cardiac catheterization	18.4	16.7	.469
Myocardial imaging/perfusion	23.1	21.8	.607
Influenza immunization	53.8	56.1	.460
Pneumococcal immunization	5.6	7.5	.216
Annual cost, $			
Medical	12,014	12,198	.512
Pharmacy	1,760	1,757	.302
Total	13,774	13,955	.587

* 236 unique controls: 109 controls were used once; 59 controls were used twice; 34 controls were used three times; 11 controls were used four times; seven controls were used five times; and the remainder of unique controls were used more than five times, with one control used for a maximum of 11 intervention group participants.
ED = emergency department; CHF = congestive heart failure; ACE = angiotensin-converting enzyme; CG = cardiac glycosides.

present in more than 20% of each group, and diabetes mellitus was identified in approximately 40% in both groups. Both groups were high users of acute medical services, with rates of hospitalization of 963 per 1,000 in the intervention group and 1,076 per 1,000 in the control group. Emergency department visits were also high, with

more than 60% of the both groups seeking emergency department services during the baseline year. The groups are well matched and can be described as moderately to severely ill HF patients.

Intervention

In November 2000, registered nurses began calling identified participants for program enrollment. For those who agreed to enroll, McKesson Health Solutions customized a self-management intervention plan that included risk stratification; formal scheduled nurse education sessions; 24-hour access to a nurse counseling and symptom advice telephone line; printed action plans, workbooks, and individualized assessment letters; medication compliance reminders and vaccination reminders; and physician alerts about symptoms and signs of decompensation, as well as notification to physicians of gaps between patient-reported practice and guideline recommendations. Risk stratification was determined from direct patient assessment of utilization, Goldman Specific Activity Scale (SAS), self-management practices, medical history, medical management, and psychosocial factors. The tool employed Boolean logic and sorted patients into three categories, which determined the frequency of scheduled calls over the course of the year (low risk—2 calls; medium risk—7 calls, and high risk—16 calls). Patients with Goldman SAS scores of 3 or 4, which approximate New York Heart Association (NYHA) III and IV, were considered high risk, as were those with two congestive HF (CHF)-related hospitalizations in the previous year or one hospitalization in the previous 6 months; in addition active angina pectoris, oxygen-dependent COPD, or living alone and being aged 75 and older placed a patient in the high-risk category. A Goldman SAS score of 2 (NYHA II), one CHF-related hospitalization in the previous year, history of myocardial infarction, active arrhythmia, chronic stable angina pectoris, hypertension, living alone and being younger than 75, or tobacco use would place a patient in the medium-risk category. Presence of any high-risk indicator would place the patient into the high-risk category. Absence of any risk factor would place the patient in the low-risk category.

Physician communications took place through letters, facsimiles, and telephone calls. Two-way communication was encouraged from the physicians back to the disease-management nurse on recommendations for further counseling topics or clarification of patient-reported information. In addition, the disease-management nurse communicated to the health plans' case managers for provision and coordination of plan benefit issues such as durable medical equipment procurement, mental health visit coordination, transportation difficulties, or financial barriers to adhering to physician recommendations. Communications to physicians and case managers occurred regularly, usually after each scheduled patient call. The interventions took place telephonically, primarily in the participants' residence, although some participants did not have a telephone at home, and a convenient community-based alternative was employed. The two guidelines that formed the basis of the intervention were the Agency for Health Care Policy and Research Clinical Practice Guideline *Heart Failure Evaluation and Care of Patients with Left Ventricular Systolic Dysfunction*, published in 1994,[30] and the American College of Cardiology/American Hospital Association's *Guidelines for the Evaluation and Management of Heart Failure*, published in 1995.[31] Once patients were enrolled in the program, nurses conducted a telephonic assessment at intake and at 6 and 12 months to assess each participant's knowledge, behavior, and health status related to their HF condition. The improvement in patients' knowledge, behavior, and health status was expected to lead to changes in their medical service utilization. After a program period of 12 months, a matched-cohort study was conducted to evaluate group differences on selected clinical and healthcare utilization outcomes. Initial assessments were conducted between May 2000 and March 2002. Baseline period for participants is the year before the initial assessment date for the participant, and the baseline period for nonparticipants is linked to the initial assessment of the matching intervention participant. The control group received usual care from their providers. All members in the control and intervention groups were enrolled in a managed care plan that provided medical management services (case management, provider networks).

Clinical Assessment

Medical service utilization, prescription drug use, and procedures performed were determined from administrative medical claims. Medical service utilization included inpatient admissions, inpatient bed days, emergency department visits, physician evaluation and management visits, and the proportion of people with a readmission within 30 days of a previous admission. Prescription drug use included ACE inhibitor, beta-blocker, antihypertensive, diuretic, cardiac glycoside, or antiarrhythmic and antianginal use. These drug classifications come from the Food and Drug Administration (FDA) and can be obtained at the FDA's Website.[32] Procedures analyzed included influenza vaccines, pneumococcal vaccines, electrocardiography, echocardiography, and cardiac catheterization.

RESULTS

The intensity of the HF care support program for the 553 participants is shown by an average of 7.9 monitoring calls, 14.0 education topics, and 11.3 alerts to physicians per person. Thirteen percent of people received all of their scheduled monitoring calls, and 62% received at least 50% of their scheduled calls. Of the 533 intervention group participants, two were risk stratified into the lowest-risk level, 160 into the medium-risk category, and 371 into the highest-risk category. Intervention costs varied by the risk-stratification level and the number of months of participation. The monthly costs of the intervention by risk level were \$7.83 for the lowest-risk level, \$66.98 for the medium-risk level, and \$126.08 for the highest-risk level. The intervention costs were determined by multiplying the number of participants by their number of months of program participation and by the appropriate monthly risk costs. The costs by intervention were \$188 for the low-risk group, \$116,043 for the medium-risk group, and \$503,671 for the high-risk group, corresponding to an average of 12 months of participation for the low-risk group and 10.8 months for the medium- and high-risk groups. The total cost of the inter-

Table 2. Program Period Results

Variable	Treatment Cohort	Matched Cohort	*P*-value	Percentage Change
Medical service utilization (annualized rate per 1,000)				
Inpatient admits	735.4	974.8	.010*	−23.4
Inpatient bed days	3,860.9	5,289.3	.007*	−25.9
ED visits	580.5	752.6	.010*	−21.7
Doctors' visits	19,860.4	19,278.8	.184	4.5
Pharmacy prescriptions	52,125.7	53,616.4	.586	−1.3
CHF inpatient admissions	154.9	283.0	.001*	−44.4
CHF inpatient bed days	878.0	1,343.8	.002*	−33.7
CHF ED visits	37.2	60.8	.472	−37.9
30-day readmissions	16.5	56.6	.080‡	−70.4
Skilled nursing facility days	514.4	951.8	.032†	−45.2
Prescription drug use (annual days supply per person)				
ACE inhibitor	77.9	83.5	.185	−5.3
Beta-blocker	49.3	44.4	.971	12.6
Antihypertensive	170.3	193.7	.403	−10.7
Diuretics	145.3	146.4	.568	0.7
CG or antiarrhythmic	67.6	71.1	.687	−3.4
Antianginal	92.2	88.8	.773	5.4
Prescription drug use program period				
ACE inhibitor	34.0	38.8	.098‡	−13
Beta-blocker	23.5	24.0	.829	−2
Antihypertensive	59.5	59.5	1.000	0
Diuretics	60.6	58.7	.533	3
CG or antiarrhythmic	28.3	29.5	.685	−4
Antianginal	38.6	40.2	.616	−4
Intervention performed, %				
Hemoglobin A1c	28.9	28.3	.839	2.0
Electrocardiography	70.4	68.1	.426	3.3
Echocardiography	37.1	33.2	.178	11.9
Cardiac catheterization	7.1	8.8	.309	−19.2
Myocardial imaging/perfusion	16.3	15.9	.868	2.4
Influenza immunization	48.8	37.7	.000*	29.4
Pneumococcal immunization	8.1	5.1	.048†	59.3
Costs				
Annual medical costs	12,527	15,405	.201	−18.7
Annual pharmacy costs	1,845	1,922	.569	−4.0
Annual total costs	14,372	17,327	.151	−17.1

Note: Percentages reflective of full size of each group.
Significant at * 1%; † 5%; ‡ 10%.
ED = emergency department; CHF = congestive heart failure; ACE = angiotensin-converting enzyme; CG = cardiac glycosides.

vention was $619,902, and average cost was $1,163 per intervention-group participant.

Table 2 provides a comparison of measured outcomes of the participants and nonparticipants in the program period. The HF program appears to have had a marked favorable effect on participants' utilization of acute medical services. There was a pronounced, significant difference between the groups in overall inpatient admissions (23% fewer for the intervention group), inpatient bed days (26% fewer), inpatient admissions in which HF was identified as the primary diagnosis (44% fewer), HF inpatient bed days (34% fewer), and the proportion of people with a readmission to the hospital within 30 days of an admission (70% fewer); the intervention group had 4.5% more physician office visits, which was nonsignificant. There were no significant differences between the two groups for most recommended drug classes. Influenza and pneumococcal vaccination rates increased significantly (29% and 59%, respectively).

Total cost in the intervention group, inclusive of program fees, is $15,535, compared with $17,327 in the control group. The intervention group had 17% fewer claims than the control group, and with the cost of the program included, the intervention group had 10% lower claims costs than the control group. Another metric to evaluate financial effect is a return on investment calculation. Total intervention cost of $619,902 generated savings of $1,430,281, resulting in a return on investment of 2.31:1. Because the savings per person and the charges per person occurred in the same time period, starting in November 2000, no inflation adjustment was necessary.

DISCUSSION

Drugs and devices manufactured by private organizations subject their products to clinical research to demonstrate safety and efficacy to regulators and physicians. Healthcare services are rarely subject to similar levels of clinical research, particularly healthcare services sold by private organizations. HF disease-management programs have heavily penetrated managed care plans, with 75% of managed care plans (in a recent survey) responding that they offer comprehensive HF disease-management programs with at least six of eight program elements as defined by the Disease Management Association of America.[33] Growth in this industry is likely the result of many factors: healthcare payers frustration with the pace of adoption of guidelines through physician-directed interventions, guaranteed financial savings by disease-management companies, high patient satisfaction with personalized nurse services, and payers seeking innovative solutions to improve quality and lower costs. Nevertheless, assertions of improvements in quality and costs by disease-management companies are largely based on pre/post analyses. This study provides a concurrent analysis of a disease-management intervention in the elderly to determine effects on key markers of quality and costs. Significant reductions in hospitalizations, emergency department visits, and short-term SNF stays were found, with no significant changes in office visits. Total claims costs in the intervention group were 10% less than costs in the control group, with intervention costs included. There was a 2.31 return on investment through reduced claims.

Reductions in hospitalizations rather than shorter lengths of stay accounted almost entirely for inpatient bed-day reduction. The marked reductions in HF-specific admissions denote the specificity of the effect. Twenty percent of the intervention groups' hospitalizations and 30% of the control group's were HF specific. The reduction in hospitalization did not lead to increase in SNF days; rather, there was a 45% reduction in short-term SNF days. If the length of stay had accounted for the reduction in hospital bed days with an increase in SNF days, one could suspect strong discharge planning on cost shifting. Rather these results support a reduction in the demand for acute healthcare services.

Although matching on a propensity score tends to balance observed variables, it does not balance unobserved variables such as motivation for deciding to participate in an intervention. It is unknown which variables may be important in influencing a person's decision to participate in a disease-management program. As such, important unobserved variables may lead to selection bias. Evidence suggests that propensity score adjustment for selection bias is possible, as in a study of women who self-selected into epidural treatment or who did not self-select into epidural treatment[34] and in another study of people who self-selected into taking aspirin or not.[35] Further evidence suggests that selection bias is controlled, as in a study of people who used intravenous heparin, which was left to the discretion of the treating physician,[36] or who had a right heart catheterization.[37] The accuracy of controlling for selection bias is predicated on the assumption that the variables associated with selection are observable and used in the matching process.[38] If the variables associated with selection are unobserved, then the only study design capable of controlling for selection bias is the random trial.

Despite the marked reductions in costly, acute medical services, there was not a marked improvement in recommended classes of drugs. Immunizations were one of the few areas in which significant improvements were noted. The intervention emphasized ACE-inhibitor therapy, influenza vaccination, and pneumococcal vaccination. Beta-blocker therapy did not emerge as an American College of Cardiology recommendation until after the intervention was complete. Because the intervention was primarily focused at patients rather than physicians, the improvements were likely the result of greater patient awareness and response to early symptoms and signs of decompensation. The results obtained were derived strictly from administrative claims data. In the intervention group, patients reported improvements in symptom control, functional status, and self-management practices such as weight-log maintenance, vaccinations, and adherence to medical regimens over baseline, but no such information was gathered for the control group, which would have allowed for a richer understanding of the clinical effect.

One possibility for differential results between the two groups is that patients in the intervention group died at a higher rate and therefore generated fewer claims. Indeed, death is surprisingly difficult to ascertain from administrative databases. The control and intervention groups had nearly identical months of follow-up, defined as being listed as eligible to receive services by the health plan. Also, because the last weeks of life are typically extremely expensive, one could speculate that lower costs could occur if patients were dying at home rather than in inpatient settings. Furthermore, one would suspect that lower rates of other services such as prescriptions, diagnostic testing, and office visits would accompany lower rates of utilization because of death, which did not occur. Thus, although higher death rates cannot be excluded, several measures of outcomes do not support them.

It can be speculated that the population was healthy and amenable to self-management recommendations; the patients included in the study cannot be described as healthy or absent of significant disease. The patients' average age was 76, with a standard deviation of 7 years in the intervention group and 8 years in the control group; they had hospitalization rates greater than 900 per 1,000, and had significant comorbidities, with more than half with coronary artery disease or hypertension. Twenty percent had COPD, and nearly 40% had diabetes mellitus.

No attempt was made to match geography between controls and the intervention group, which may have resulted in different rates of exposure to particular local markets. Practice patterns may differ by market and thus account for the significant differences found during the intervention period. Analysis of the region assigned to the patient reveals a similar distribution of geographic distribution of patients, with three regions accounting for most of the patients: Youngstown—164 intervention group and 153 control group; Dayton—114 intervention group and 118 control group; Cincinnati—101 intervention group and 128 control group. Thus, although geography was not a matched variable, the groups were similarly distributed across regions.

In summary, this community-based, concurrent trial of a commercial HF disease-management intervention in the elderly demonstrated significant reductions in medical services, resulting in 10% lower cost of care. The control group was extremely well matched on a wide set of variables, and although the study design is subject to selection bias, the approach addresses temporal bias and provides a methodology for researchers to evaluate private healthcare service innovations without a randomized trial design.

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