A Matched-Cohort Study of Health Services Utilization Outcomes for a Heart Failure Disease Management Program

GREGORY D. BERG, Ph.D.,1 EDWARD FLEEGLER, M.D., FACP, EMF,2 CATHERINE J. VANVONNO, Ph.D.,3 and EILEEN THOMAS, R.N., C.C.M.4

ABSTRACT

Chronic disease is the leading cause of illness, disability, and death in the United States, affecting nearly 100 million Americans. Heart failure alone affects nearly 4.9 million Americans, with another 550,000 newly diagnosed cases each year. The aim of this study was to investigate the program effects of a heart failure care support program. A two-group cohort study matching on propensity scores was used to investigate 277 heart failure care support program participants and corresponding matched non-participants. Measures used were rates of hospitalizations, emergency department visits, physician office visits, and heart failure-related prescription drug use and procedures. Relative to the matched control group, program participants experienced 26.3% ($p = 0.023$) fewer inpatient admissions, 37.9% ($p = 0.018$) inpatient bed days, 33.3% ($p = 0.059$) more beta blocker use, 76.7% ($p = 0.048$) more alpha blocker use, 22.2% ($p = 0.006$) more lipid panels, 13.4% ($p = 0.019$) more electrocardiographies, 50.0% ($p = 0.008$) fewer cardiac catheterizations, and 94.6% ($p = 0.014$) more pneumonia vaccinations. The current study employs a propensity score matching methodology to select a subset of comparison patients most comparable to treatment patients, and documents the beneficial health services outcomes of participation in a heart failure care support program. (Disease Management 2005;8:35–41)

INTRODUCTION

Due to an aging United States population increasing survival rates after diagnosis, the prevalence of heart failure (HF) is expected to increase two- to threefold,1,2 and remains one of the chronic diseases with the greatest morbidity and mortality rates.3 Currently, HF directly and indirectly contributes to about 285,000 deaths per year.4–8 It is the number one cause of hospitalization in the United States.9 Despite the availability of effective treatment for HF, hospitalization and readmissions after discharge remain all too 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...
(ACC/AHA) guidelines promote 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 HF.11

Heart failure disease management

Disease management is an integrated, systematic approach to health care delivery that focuses on populations of patients with specific chronic diseases. These programs are intended to promote effective chronic condition management in several ways. These interventions may include, among others, patient and provider education and (where appropriate) monitoring, print and web-based educational materials, and toll-free telephonic access for subscribers. Information on a person’s condition, associated comorbid conditions, potential complications, and overall compliance with recommended interventions is used by physicians, nurses, and other health care professionals to more effectively support program participants.

Goals of the study

This report details 1-year post-enrollment health services utilization outcomes for the Blue Cross Blue Shield Association Government-wide Service Benefit Program (BCBSA FEP). This study is designed to address whether a telephonic disease management program results in lower utilization of acute services and improvements in the use of recommended interventions compared to a group not receiving the intervention.

MATERIALS AND METHODS

Study population

Treatment cohort patients were 277 HF patients who were continuously enrolled 12 months prior to disease management program participation and 12 months subsequent to program participation in the BCBSA FEP, and who resided in Maryland. Initial assessments for program participants occurred during calendar year 1999. Patients with a skilled nursing facility, hospice claim, or who were identified as having end-stage renal disease, dialysis, transplants, acquired immunodeficiency syndrome, or cancer were excluded from the analysis of the program. The comparison cohort was chosen with the additional condition of having been identified with a HF claim. For every treatment cohort patient, a matched comparison subject with a history of HF who also was a member of the BCBSA FEP was selected from the neighboring state of Virginia. All treatment cohort patients agreed to participate and participated for at least 3 months.

Study design

The control group was generated by matching each disease management participant with a matched non-participant determined by a propensity score.12–16 Matching by 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. A propensity score is a single variable comprised of the many variables for which a match is developed that tends to balance observed variables.

Statistical analysis

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. Finally, variables were compared during the program year to estimate the treatment effects of the disease management program.

In this study, a propensity score is estimated using a logistic regression with the dichotomous dependent variable indicating whether or not the person participated in the disease management program. Explanatory variables include the health service utilization variables in Table 1 that occurred during the year prior to program participation.

As proven by Rosenbaum and Rubin,12 matching on a propensity score balances the many variables included in the propensity score model, in effect matching on all of those variables. Matching on a propensity score reduces a multivariate matching problem (matching separately on all variables in Table
1) into a simpler univariate matching problem (matching only on the propensity score).

**Health utilization assessment**

Medical service utilization, prescription drug use, and procedures performed were determined from administrative medical and pharmacy claims. Medical service utilization included inpatient admissions, the number of readmissions within 30 days of a previous admission, inpatient bed days, emergency department visits, and physician evaluation and management visits. Prescription drug use included ACE inhibitors, beta-blockers, antihypertensives, diuretics, other antihypertensives, cardiac glycosides, antiarrhythmics, antianginals, and alpha-blockers (FDA drug classes). Procedures analyzed included Hemoglobin A1c tests, lipid panels, electrocardiography, echocardiography, cardiac catheterization, myocardial imaging/perfusion, influenza vaccines, and pneumococcal vaccines.

**Intervention**

In February 1999, registered nurses began calling identified people with HF 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-h access to a nurse counseling and symptom advice telephone line; printed action plans, workbooks, and individualized assessment letters; medication compliance reminders; vaccination reminders; and physician alerts about signs and symptoms 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, two calls; medium risk, seven calls; and high risk, 16 calls).

Goldman SAS scores of 3 or 4, which approximate NYHA III and IV, made a patient high risk, as did two CHF-related hospitalizations in the past year or one hospitalization in the past 6 months. In addition, active angina, oxygen-dependent chronic obstructive pulmonary disease, or living alone and being over 75 would place a patient in the high-risk category. Goldman SAS score of 2 (NYHA II), one CHF-related hospitalization in the past year, history of a myocardial infarction, active arrhythmia, chronic stable angina, hypertension, living alone and less than 75, or tobacco use would make a patient in the medium risk category. Presence of any one 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, faxes, and phone 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 with 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. This was usually after each scheduled patient call. The interventions took place telephonically primarily in the participants’ residences, though 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 AHCPR Clinical Practice Guideline, Heart Failure Evaluation and Care of Patients with Left Ventricular Systolic Dysfunction, published in 1994, and the ACC/AHA’s Guidelines for the Evaluation and Management of Heart Failure, published in 1995, a summary of which was mailed to physicians.

Once patients were enrolled in the program, nurses conducted a telephonic assessment at intake, and 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.

Following a program period of 12 months, a matched-cohort study was conducted to evaluate group differences on selected health services utilization outcomes. Initial assessments ranged from February through June 1999. Baseline period for participants is the year before the initial assessment date for the participant, and the baseline period for the non-participant is tied to the initial assessment of the matching intervention participant. The control group received usual care from their providers. It is relevant to note that all members in the control and intervention group were enrolled in a managed care plan that provided medical management services (case management, provider networks).

RESULTS

Characteristics of study patients and matched cohort at baseline

The characteristics of the study patients at baseline are shown in Table 1. No significant differences were seen between the treatment cohort and matched comparison cohort for any demographic and comorbidity variables including the percentage of males, percentage of
participants aged 65 and over, coronary artery disease, chronic obstructive pulmonary disease, hypertension, and diabetes. No significant differences were seen between each cohort for any medical service utilization variables including inpatient admissions or bed days, emergency department visits, physician evaluation and management visits, HF-related inpatient admissions and emergency department visits, or 30-day readmissions. Also, no significant difference was seen for prescription drug use including ACE inhibitor use, beta-blocker use, antihypertensives, cardiac glycosides or antiarrhythmics, antianginals, or alpha-blocker use. Lastly, no significant difference between the treatment and comparison cohorts were seen for any procedures performed including Hemoglobin A1c tests, lipid panels, electrocardiography, echocardiology, cardiac catheterization, perfusion imaging, influenza vaccines, or pneumococcal vaccines.

Characteristics of study patients and matched cohort during study period

The characteristics of the study patients and the matched comparison cohort during the program year are shown in Table 2. Significant differences for medical service utilization were seen for inpatient admissions, inpatient bed days, non-acute visits, and pharmacy prescriptions. The treatment cohort had 26.3% fewer inpatient admissions \((p = 0.023)\) along with 37.9% fewer bed days \((p = 0.018)\). There was no statistical difference in office visits.

<table>
<thead>
<tr>
<th>Table 2. Analysis Period Results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Treatment cohort</strong></td>
</tr>
<tr>
<td>Medical service utilization</td>
</tr>
<tr>
<td>Inpatient admissions</td>
</tr>
<tr>
<td>Inpatient bed days</td>
</tr>
<tr>
<td>Emergency department visits</td>
</tr>
<tr>
<td>Physician office visits</td>
</tr>
<tr>
<td>Non-acute visits</td>
</tr>
<tr>
<td>Procedure visits</td>
</tr>
<tr>
<td>Pharmacy scripts</td>
</tr>
<tr>
<td>HF inpatient admissions</td>
</tr>
<tr>
<td>HF inpatient bed days</td>
</tr>
<tr>
<td>HF emergency department visits</td>
</tr>
<tr>
<td>30-day readmissions</td>
</tr>
<tr>
<td>Prescription drug use</td>
</tr>
<tr>
<td>ACE inhibitor use, %</td>
</tr>
<tr>
<td>Beta blocker use, %</td>
</tr>
<tr>
<td>Antihypertensives use, %</td>
</tr>
<tr>
<td>Diuretics use, %</td>
</tr>
<tr>
<td>Cardiac glycoside or antiarrhytmic use, %</td>
</tr>
<tr>
<td>Antianginals use, %</td>
</tr>
<tr>
<td>Alpha agonist/alpha blocker use, %</td>
</tr>
<tr>
<td>Procedures performed</td>
</tr>
<tr>
<td>Hemoglobin A1c test, %</td>
</tr>
<tr>
<td>Lipid panels, %</td>
</tr>
<tr>
<td>Electrocardiography, %</td>
</tr>
<tr>
<td>Echocardiology, %</td>
</tr>
<tr>
<td>Cardiac catheterization, %</td>
</tr>
<tr>
<td>Myocardial imaging/perfusion, %</td>
</tr>
<tr>
<td>Influenza immunization, %</td>
</tr>
<tr>
<td>Pneumococcal immunization, %</td>
</tr>
</tbody>
</table>

*Significant at 10%.
**Significant at 5%.
***Significant at 1%.
Significant differences for prescription drug use were seen for alpha- and beta-blocker use. The treatment cohort had 76.7% more alpha-blocker use ($p = 0.048$) along with 33.3% more beta-blocker use ($p = 0.059$).

Significant differences for procedures performed were seen for lipid panels, electrocardiography, cardiac catheterization, and pneumococcal vaccines. The treatment cohort had 22.2% more people who had a lipid panel ($p = 0.006$), 13.4% more electrocardiographies ($p = 0.019$), 50.0% fewer cardiac catheterizations ($p = 0.008$), and 94.6% more pneumococcal vaccines ($p = 0.014$).

**DISCUSSION**

Drugs and devices manufactured by private organizations are subject to clinical research in order to demonstrate safety and efficacy to regulators as well as 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 DMAA. Growth in this industry is likely the result of many factors: health care 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. However, 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 to determine impacts on key markers of quality. We report significant reductions in hospitalizations and inpatient bed days with significant increases in beta-blocker use and alpha-blocker use. There was no significant change in office visits.

Although matching on a propensity score tends to balance observed variables, it does not balance unobserved variables like 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. The results obtained were derived strictly from administrative claims data.

Evidence suggests that propensity score adjustment for selection bias is possible, as in a study of women who either self-selected into epidural treatment or who did not self-select into epidural treatment, and in another study of people who self-selected into taking aspirin or not. Further evidence suggests that selection bias is controlled for, as in a study of people who used intravenous heparin which was left to the discretion of the treating physician, or who had a right heart catheterization. The accuracy of controlling for selection bias is predicated on the assumption that the variables associated with selection are both observable and used in the matching process. If the variables associated with selection are unobserved, then the only study design capable of controlling for selection bias is the random trial.

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 did have nearly identical months of follow-up as defined as being listed as eligible to receive services by the health plan. One could suspect that lower rates of inpatient healthcare utilization due to death would be accompanied with lower rates of other services such as prescriptions, diagnostic testing, and office visits which did not occur.

In summary, this community-based, retrospective cohort study of a commercial HF disease management intervention demonstrated significant reductions in inpatient admissions. The control group was extremely well matched on a wide set of variables, and though the study design is still subject to selection bias, the approach does address temporal bias and provides a methodology for researchers to evalu-
ate private health care service innovations without a randomized trial design.\textsuperscript{26}

**ACKNOWLEDGMENTS**

We thank Cheryl L. Neel, R.N., of the Blue Cross Blue Shield Association, and Steve Silverstein, M.D., of McKesson Corporation, for helpful comments. This work was supported by McKesson Corporation and the Blue Cross and Blue Shield Association Government-wide Services Benefit Program.

**REFERENCES**


Address reprint requests to:

**Gregory D. Berg, Ph.D.**

McKesson Corporation

335 Interlocken Parkway

Broomfield, CO 80021

**E-mail:** greg.berg@mckesson.com