

Medication Adherence and Medicare Expenditure Among Beneficiaries With Heart Failure

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Objectives: To (1) measure utilization of and adherence to heart failure medications and (2) assess whether better adherence is associated with lower Medicare spending.

Study Design: Pooled cross-sectional design using six 3-year cohorts of Medicare beneficiaries with congestive heart failure (CHF) from 1997 through 2005 (N = 2204).

Methods: Adherence to treatment was measured using average daily pill counts. Bivariate and multivariate methods were used to examine the relationship between medication adherence and Medicare spending. Multivariate analyses included extensive variables to control for confounding, including healthy adherer bias.

Results: Approximately 58% of the cohort were taking an angiotensin-converting enzyme (ACE) inhibitor or angiotensin receptor blocker (ARB), 72% a diuretic, 37% a beta-blocker, and 34% a cardiac glycoside. Unadjusted results showed that a 10% increase in average daily pill count for ACE inhibitors or ARBs, beta-blockers, diuretics, or cardiac glycosides was associated with reductions in Medicare spending of \$508 (not significant [NS]), \$608 (NS), \$250 (NS), and \$1244 ($P < .05$), respectively. Estimated adjusted marginal effects of a 10% increase in daily pill counts for beta-blockers and cardiac glycosides were reductions in cumulative 3-year Medicare spending of \$510 to \$561 and \$750 to \$923, respectively ($P < .05$).

Conclusions: Higher levels of medication adherence among Medicare beneficiaries with CHF were associated with lower cumulative Medicare spending over 3 years, with savings generally exceeding the costs of the drugs in question.

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For author information and disclosures, see end of text.

Cardiovascular disease (CVD) remains the most costly cause of morbidity and mortality in the United States today,^{1,2} with expenditures estimated at \$448.5 billion in 2008—two-thirds attributable to direct patient care.³ Of the estimated 81 million adults with CVD, nearly 6 million have some degree of congestive heart failure (CHF), with an incidence approaching 10 per 1000 persons after age 65 years.² Recent estimates suggest it is the single most common reason for hospitalization in the elderly,⁴ costing Medicare in excess of \$10.0 billion in 2007,⁵ but it is thought that hospitalization could be substantially reduced with better outpatient care, including adequate drug therapy.⁶

There is also growing interest in the impact of medication adherence on health outcomes, and its consequent effects on healthcare utilization and expenditure. Despite its importance for clinical and coverage decision-making, the effect of medication adherence on healthcare expenditures has been studied in only a limited range of conditions, particularly diabetes,⁷⁻¹⁷ with very little focus on CHF despite the significant burden of disease and benefits of evidence-based treatment. Moreover, claims of cost offsets from improved adherence are often controversial, reflecting methodologic concerns about limited generalizability, short time frames, and particularly the impact of survivor bias and reverse causality. The latter implies that an inverse relationship between higher drug adherence and lower medical costs could reflect either the effect of the drug or that healthier people are more adherent to treatment, an effect known as “healthy adherer” bias.¹⁸

This study of the relationship between adherence to CHF medication and Medicare expenditure was designed to address a gap in the literature concerning cost offsets associated with CHF treatment, while also addressing methodologic limitations of prior studies. Our study cohort was selected from a nationally representative sample of the Medicare population. Users of each of 4 major drug groups for treatment of CHF were followed for up to 3 years, with explicit consideration of censoring by death or another cause. We applied an empirical specification of the relationship between medication adherence and spending on traditional Medicare services, including controls indicative of healthy lifestyle. The study protocol was approved by the University of Maryland Baltimore Institutional Review Board.

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METHODS

Data and Study Sample

We used the Medicare Current Beneficiary Survey (MCBS), a nationally representative rotating-panel survey of Medicare beneficiaries conducted by the Centers for Medicare & Medicaid Services. Approximately 4500 beneficiaries are selected for induction into the survey each year and are followed for up to 3 additional years using computer-assisted in-person interviews. The survey captures demographic and socioeconomic characteristics, health behaviors, and health and functional status. Self-reported information on health-care utilization and costs of all health services is collected for years 2 through 4. The MCBS survey responses are linked to Medicare administrative data and include all matching Part A and B claims as well as prescription drug utilization and spending. Respondents are asked to maintain records of prescriptions (eg, insurance slips, used medication containers) during the year. The MCBS interviewers record all prescription fills reported during each 4-month recall period, noting the drug name, unit dosage, and quantity dispensed, although the number of days of treatment supplied is not captured.

Drawing on the MCBS from 1997 to 2005, we identified beneficiaries with a CHF diagnosis in the induction year using a claims-based algorithm developed by the Centers for Medicare & Medicaid Services for the Chronic Condition Warehouse.¹⁹ Individuals were followed for up to 3 years until they completed their MCBS tenure or were lost to follow-up, admitted to a long-term care facility for a long-term stay, or died. Six 3-year, nonoverlapping cohorts were thus created. The sample was restricted to community-dwelling beneficiaries at the time of the initial survey, and also excluded individuals who were in capitated Medicare health plans at any time during their tenure in the MCBS because they lacked the Part A and B claims data necessary for computing Medicare costs. The final sample consisted of 2204 beneficiaries with a diagnosis of heart failure at baseline.

We then identified individuals who reported filling prescriptions during their first year in the MCBS following their fall induction survey in 4 broad pharmacologic groups that are among the recommended therapies for CHF:²⁰⁻²⁴ These groups were angiotensin-converting enzyme (ACE) inhibitors or angiotensin II receptor blockers (ARBs), beta-blockers with approved indications in heart failure, diuretics, and cardiac glycosides. The drug user cohorts were not mutually exclusive.

Take-Away Points

Hospitalization of the elderly with congestive heart failure (CHF) results in a significant cost burden. Prior research has shown that improved medication adherence can reduce medical expenditures among elderly patients.

- Modest increases in adherence to CHF medication regimens were associated with lower Medicare spending in 3 major drug classes, with savings exceeding the costs of the drugs.
- The evidence suggests there may also be a degree of undertreatment in the Medicare population with CHF.
- Policy makers should explore cost-effective methods for improving adherence to evidence-based treatment guidelines by prescribers and to prescribed medication regimens by patients.

Measures

Drugs within each class were identified through clinical review, using drug names reported on the MCBS. Drug adherence was based on the number of tablets dispensed. In cases where the counts of pills were missing, we imputed them by averaging intact pill counts over all years the individual was observed to use the specific drug(s) in question.

We measured adherence using average daily pill counts over the 36-month period of observation. This measure was generated by dividing the total pill count within each drug class by the number of days over which the individual was observed. This metric was independent of the number of pills dispensed at one time, which may have been 60 or even 90 days' supply for some medications. In addition, using the number of days observed as the denominator allowed us to consider disruptions in drug regimens (eg, hospitalization, admission to a long-term care facility, death) that also affect expenditures. The dependent variable was total Medicare Part A and B spending measured over the same period. All dollar values were converted to constant 2006 dollars using the Consumer Price Index for urban consumers.²⁵

Our multivariate models included an extensive set of covariates to control for confounding due to health status, preference for prescription drug use, access to care, and healthy adherer bias. Health status measures were captured from 3 sources: (1) self-reported measures (a standard 5-item scale of health status from excellent to poor, body mass index computed from self-reported height and weight, and limitations in activities of daily living); (2) Medicare administrative data (current and former recipients of Social Security Disability Insurance); and (3) select claims-based comorbidities common in the elderly, including hypertension, ischemic heart disease, diabetes, chronic obstructive pulmonary disease, chronic renal disease, hyperlipidemia, and osteoarthritis, plus an index of coexisting conditions. Demographic factors potentially influencing both prescription use and outcomes included age, sex, race, marital status, and education. Access to care was captured by data on income and the possession of supplemental medical or drug coverage. Dummy

■ **Table 1.** Baseline Characteristics of Heart Failure Medication User Groups

Characteristics	Total CHF Cohort (n = 2204)	ACE Inhibitor or ARB Users (n = 1116)	Beta-Blocker Users (n = 662)	Diuretic Users (n = 1440)	Cardiac Glycoside Users (n = 673)
Age, y, %					
<65	8.9	9.0	8.0	7.6	4.9
65-69	12.0	13.5	14.7	11.7	8.9
70-74	13.2	13.5	15.3	13.1	12.6
75-79	19.1	20.6	21.0	19.6	19.9
≥80	46.8	43.4	41.1	48.1	53.6
SSDI ≥65	18.3	18.3	17.7	17.6	13.8
Female, %					
55.4	55.8	53.9	58.6	55.0	
Race, %					
Non-Hispanic white	80.1	79.3	82.0	80.7	84.1
Non-Hispanic black	11.2	11.0	9.7	11.4	8.5
Hispanic	5.1	5.7	4.4	4.5	4.9
Other	3.6	3.9	3.9	3.4	2.5
Marital status, %					
Married	43.0	43.4	46.8	42.4	43.4
Widowed	43.5	41.9	39.3	45.4	45.9
Single	13.6	14.7	13.9	12.2	10.7
Education, %					
No high school	25.8	24.3	23.1	25.3	26.3
Some high school	18.8	19.0	18.7	20.3	16.8
High school graduate	27.6	28.3	29.2	27.9	27.3
Some higher education	27.3	28.0	28.5	26.1	28.7
Income as percentage of FPL, %					
≥100	21.1	20.0	17.5	20.8	19.0
101-199	35.8	35.8	38.2	36.4	34.2
200-299	20.6	21.0	22.2	20.8	22.0
≥300	22.1	22.8	21.1	21.5	24.5
Region, %					
East	22.7	22.8	24.5	20.1	23.8
Midwest	23.5	25.0	25.1	24.8	21.7
South	40.6	39.6	38.5	42.6	40.7
West	13.2	12.5	11.9	12.5	13.8
Supplemental medical coverage, %					
94.3	95.0	95.5	94.4	95.2	
Drug coverage, %					
Medicaid	19.0	19.1	16.6	18.1	15.5
Employer plan	32.9	32.6	35.0	32.8	36.3
Self-purchased	15.3	15.9	18.9	16.9	17.4
Other public	8.5	9.6	10.7	9.2	9.2
Other private	1.6	1.5	1.5	1.3	1.8
None	29.0	26.9	23.1	28.3	27.2

(Continued)

variables were used to capture censoring (loss to follow-up, admission to a long-term care facility, death), as well as year of induction into the MCBS (a proxy for temporal trends in treatment).

We controlled for healthy adherer bias by including additional measures of prescription drug utilization for each of the

4 drug classes in each drug-specific equation. This approach enabled us to estimate the effect of an incremental increase in adherence with each medication conditional upon utilization of other medications in the regimen. Except for the drug utilization and censoring variables, all covariates were measured during the baseline year.

■ **Table 1.** Baseline Characteristics of Heart Failure Medication User Groups (*Continued*)

Characteristics	Total CHF Cohort (n = 2204)	ACE Inhibitor or ARB Users (n = 1116)	Beta-Blocker Users (n = 662)	Diuretic Users (n = 1440)	Cardiac Glycoside Users (n = 673)
Health status, %					
Excellent/very good	24.0	22.8	22.5	23.0	24.4
Good	29.3	29.7	29.0	29.9	30.6
Fair	29.0	29.5	31.9	29.4	28.8
Poor	17.4	17.6	16.5	17.4	16.0
Body mass index, %					
<18.5 (underweight)	4.5	3.9	2.9	3.5	5.8
18.5-24.9 (normal)	38.2	35.8	37.9	35.4	45.0
25.0-29.9 (overweight)	30.7	30.5	32.0	29.8	31.5
30.0-34.9 (obese 1)	14.7	17.3	17.8	17.5	11.7
35.0-39.9 (obese 2)	4.9	5.6	4.2	6.2	3.0
≥40.0 (obese 3)	3.6	3.7	2.1	4.3	1.2
Comorbidities, %					
Diabetes	36.4	41.8	38.2	38.8	37.7
Chronic kidney disease	8.1	6.5	9.1	7.3	6.2
Hypertension	73.3	82.3	82.3	76.3	70.3
Ischemic heart disease	63.3	67.7	74.3	64.7	68.8
Hyperlipidemia	33.1	38.8	43.8	34.3	30.6
COPD	30.2	27.7	25.7	30.3	30.6
Osteoarthritis	21.3	21.2	21.6	22.3	19.6
HCCs, mean (SE)	12.3 (5.7)	12.4 (5.5)	12.4 (5.3)	12.4 (5.3)	12.6 (5.5)
ADLs, mean (SE)	1.3 (1.7)	1.2 (1.6)	1.9 (1.5)	1.3 (1.6)	1.3 (1.7)
MCBS induction year, %					
1997	16.1	12.5	10.3	13.7	17.7
1998	17.0	15.4	12.4	17.6	19.3
1999	16.8	16.7	15.9	18.0	17.8
2000	16.5	19.4	19.0	17.7	17.4
2001	15.5	16.8	18.3	14.7	13.7
2002	18.1	19.3	24.2	18.3	14.1
Any imputation of pill count, %	62.3	76.7	76.1	74.7	76.2
LTC facility admission, %	8.1	8.2	8.2	8.5	8.3
Lost to follow-up, %	9.7	10.5	11.2	10.4	10.3
Died, %	33.6	26.7	23.9	30.4	33.0
Number of months observed, mean (SE)	26.7 (11.9)	29.0 (10.3)	29.1 (10.2)	28.2 (10.6)	27.9 (10.6)

ACE indicates angiotensin-converting enzyme; ADL, activity of daily living; ARB, angiotensin receptor blocker; COPD, chronic obstructive pulmonary disease; FPL, federal poverty level; HCC, Hierarchical Condition Categories; LTC, long-term care; MCBS, Medicare Current Beneficiary Survey; SSDI, Social Security Disability Insurance.

Statistical Analysis

Regressions for each of the drug groups were used to estimate the relationship between medication adherence and 3-year Medicare spending. Models were estimated using a generalized linear model with a gamma distribution and log link to approximate the right skewed distribution of Medicare costs.

Three sets of 4 models were estimated. The models within sets were estimated by restriction to users of the 4 distinct drug groups. The first set modeled the bivariate relationship between Medicare spending and average daily pill counts within the specified drug group without control variables.

The other 2 sets of models included an extensive set of covariates (Table 1) as well as additional drug measures to address confounding due to unobserved healthy adherer effects. The drug measures in the second set included daily pill counts for the specified drug group in addition to dichotomous variables indicating use of the other 3 groups of drugs. The third set of models included measures of daily pill counts for all 4 drug groups as well as indicators of use of each.

We contend that by including measures of utilization for several drugs in the same equation, any shared variance due to a healthy adherer effect is removed. However, this does give rise

■ **Table 2.** Unadjusted Measures of Medication Use, Adherence, and Medicare Expenditures by Drug User Groups

Medication Use	Total CHF Cohort (n = 2204)	ACE Inhibitor or ARB Users (n = 1116)	Beta-Blocker Users (n = 662)	Diuretic Users (n = 1440)	Cardiac Glycoside Users (n = 673)
Overall, %	83.2	57.6	37.1	71.8	33.6
ACE inhibitors or ARBs					
Any use, %	57.6	100.0	69.5	67.1	68.2
Median number of pills per day	0.68	0.75	0.70	0.71	0.74
Mean 3-year Medicare spending, 2006 \$	56,082	55,668	59,348	54,083	51,322
Beta-blockers					
Any use, %	37.1	44.5	100.0	41.2	39.8
Median number of pills per day	0.63	0.67	0.72	0.63	0.64
Mean 3-year Medicare spending, 2006 \$	58,959	60,576	57,822	56,798	58,381
Diuretics					
Any use, %	71.8	83.8	80.1	100.0	87.1
Median number of pills per day	0.75	0.80	0.80	0.81	0.82
Mean 3-year Medicare spending, 2006 \$	53,365	53,297	55,059	53,281	50,473
Cardiac glycosides					
Any use, %	33.6	41.2	35.8	41.5	100.0
Median number of pills per day	0.68	0.70	0.81	0.69	0.73
Mean 3-year Medicare spending, 2006 \$	53,623	51,849	59,944	52,1434	52,532
No (other) drug use					
No drug use, %	16.8	11.4	11.2	19.2	7.6
Median number of pills per day	NA	0.67	0.69	0.74	0.75
Mean 3-year Medicare spending, 2006 \$	56,471	61,192	NA	53,276	52,570

ACE indicates angiotensin-converting enzyme; ARB, angiotensin receptor blocker; CHF, congestive heart failure; NA, not available.

to larger standard errors and introduces the possibility of underestimating the true impact of drugs with similar effects on health outcomes due to multicollinearity between the drug measures.

To facilitate interpretation, all model coefficients were converted to marginal effects, holding all covariates at their sample means. All models were estimated using Stata 11 (Statacorp, College Station, Texas).

RESULTS

Descriptive Findings

The characteristics of the study sample and medication user groups are presented in Table 1. Despite a CHF diagnosis confirmed by claims data, almost 17% received no drug therapy, with more than half the cohort taking an ACE inhibitor or ARB (57.6%), 71.8% taking a diuretic of any class, 37.1% taking a beta-blocker, and a third (33.6%) on cardiac glycoside therapy (Table 2). As anticipated, higher proportions of each drug user group were generally concentrated in the later years, possibly reflecting worsening disease as well as evolution in recommended treatment regimens and the diffusion of new products in some drug classes over the study period. While beta-blocker and cardiac glycoside groups had slightly lower percentages of minorities than ACE inhibitor/ARB and diuretics users, generally the groups were demographically simi-

lar. Despite their heart failure diagnoses, more than half the subjects in each group described their health as “good” or “excellent.” Table 2 also presents data on medication adherence and Medicare expenditure. Cumulative mean 3-year spending on Medicare Part A and Part B services exceeded \$50,000 for each user group, measured in constant 2006 dollars. The median pill count ranged from 0.63 to 0.82 per day over the 36-month follow-up period for all drug groups examined.

Table 3 presents the bivariate regression results under model set 1 and the multivariate regression results under model set 2. The models quantify the estimated impact of changes in prescription drug adherence, as measured in daily pill counts, on Medicare expenditures, with a negative association reflecting an overall cost saving to the program. For each drug group, the first row shows the unadjusted impact on Medicare expenditure of a 10% increase in daily pill counts estimated in the simple regressions of model set 1. The results show that increased utilization of ACE inhibitors or ARBs, beta-blockers, and cardiac glycosides was generally associated with lower Medicare spending, with only the effect of cardiac glycosides reaching statistical significance ($P < .05$). Results from model set 2 show that a 10% increase in daily pill counts of ACE inhibitor/ARB, beta-blockers, diuretics, and cardiac glycosides resulted in savings to Medicare of \$390 ($P = .06$), \$510 ($P = .04$), \$13 ($P = 0.92$), and \$923 ($P = .01$), respectively.

■ **Table 3.** Model Set 1 and 2 Results: Marginal Effects on Cumulative Medicare Expenditure^a

Additional Pills per Day Among Users	Marginal Effect (SE), \$			
	ACE Inhibitor or ARB Users (n = 1116)	Beta-Blocker Users (n = 662)	Diuretic Users (n = 1440)	Cardiac Glycoside Users (n = 673)
Model set 1: unadjusted results	-507.8 (328.4)	-607.9 (435.0)	250.3 (165.8)	-1244.0 ^b (575.4)
Model set 2: adjusted results, indicators for other drug use	-389.6 ^c (204.5)	-510.2 ^b (256.7)	-12.9 (122.2)	-923.1 ^d (357.9)

ACE indicates angiotensin-converting enzyme; ARB, angiotensin receptor blocker.

^aRegression model set 2 controlled for characteristics listed in Table 1. Marginal effects are presented to reflect a 10% change in daily pill counts.

^b $P < .05$.

^c $P < .10$.

^d $P < .01$.

■ **Table 4.** Model Set 3 Results: Marginal Effects on Cumulative Medicare Expenditure^a

Additional Pills per Day	Marginal Effect (SE), \$			
	ACE Inhibitor or ARB Users (n = 1116)	Beta-Blocker Users (n = 662)	Diuretic Users (n = 1440)	Cardiac Glycoside Users (n = 673)
ACE inhibitors/ARBs	<i>-259.7 (212.5)</i>	441.5 (301.3)	-395.4 (258.8)	-499.0 (318.6)
Beta-blockers	-196.0 (285.5)	<i>-561.2^b (258.1)</i>	<i>-637.1^b (281.3)</i>	-993.6 ^c (382.6)
Diuretics	-99.2 (164.2)	105.0 (176.8)	<i>97.1 (119.2)</i>	180.0 (180.9)
Cardiac glycosides	<i>-1110.6^b (467.9)</i>	<i>-1793.2^c (678.4)</i>	<i>-1069.2^c (377.9)</i>	<i>-749.6^b (359.7)</i>

ACE indicates angiotensin-converting enzyme; ARB, angiotensin receptor blocker.

^aRegression model set 3 also controlled for characteristics listed in Table 1. Marginal effects are presented to reflect a 10% change in daily pill counts. The marginal effects of a 10% increase in daily pill count of each drug group are presented in italics for each of the 4 drug user group models.

^b $P < .05$.

^c $P < .01$.

Table 4 presents results from the fully controlled models of the third set. A 10% increase in daily beta-blocker and cardiac glycoside pill counts resulted in savings to Medicare of \$561 ($P < .05$) and \$750 ($P < .05$), respectively. As expected, the effect size and statistical significance generally decreased in the multivariate models. We attribute this decrease to the shared variance associated with the healthy adherer effect. The direction of effect was consistent across all 3 sets of models. Among the other covariates, the strongest positive associations with Medicare costs were the chronic comorbidities, particularly counts of coexisting conditions, as well as diabetes, chronic renal disease, hypertension, ischemic heart disease, and chronic obstructive pulmonary disease. Admission into a long-term care facility and death were also strong positive cost predictors. The complete result for model sets 2 and 3 are shown in **eAppendix A** and **eAppendix B**, available at www.ajmc.com.

Finally, **Table 5** presents estimates of the average cost of each 30-day prescription fill during this time period, which ranged in price from \$10.85 for cardiac glycosides to \$41.19 for ACE inhibitors/ARBs in 2006 dollars. The mean cost per fill for each class of medication was lower than the estimated cost savings that a 10% increase in average daily pill count would generate for the Medicare program.

DISCUSSION

In this study we explored the relationship between adher-

ence to medications commonly used in the treatment of heart failure and Medicare expenditures for beneficiaries between 1997 and 2005.

We focused our analyses on 4 key drug groups. Despite significant concordance among clinical guidelines on the role of ACE inhibitors and beta-blockers in the management of congestive cardiac failure, less than 60% of the study population were receiving either an ACE-inhibitor or ARB and less than 40% a beta-blocker. This prompts several questions as to whether this reflects inadequate access to care, suboptimal management, or inability to afford prescription medicines. The apparent underprescribing in these and other drug groups studied here highlights the potential impact of medication adherence on Medicare spending.

We found the median number of daily pill counts for ACE inhibitors/ARBs was 0.75 over 36 months, which would generally be considered reasonable adherence for a chronic medication regimen.²⁶ Similar levels of adherence were seen with the other drug classes studied. Poor adherence can reflect either intermittent or inconsistent use, gaps in therapy, or discontinuation of a drug. Nevertheless, our results show that a modest increase in adherence was associated with lower spending on Medicare Part A and Part B services, ranging from \$510 to \$561 for beta-blockers and \$750 to \$1244 for cardiac glycoside. Our results also suggest that potential savings may be attributable to use of ACE inhibitor/ARBs and diuretics, although a larger sample size would be required to estimate significant effects.

■ **Table 5.** Mean Prescription Fill Costs^a

Prescription for 30 Pills	ACE Inhibitor or ARB Users (n = 1116)	Beta-Blocker Users (n = 662)	Diuretic Users (n = 1440)	Cardiac Glycoside Users (n = 673)
Cost, mean (SD), \$	41.19 (28.54)	33.13 (56.25)	17.19 (36.14)	10.85 (15.61)

ACE indicates angiotensin-converting enzyme; ARB, angiotensin receptor blocker.
^aPrices are expressed in 2006 dollars.

Although the estimated savings are modest relative to average annual expenditures in each class, they substantially exceeded the additional costs of the medications and should be considered as conservative estimates of savings given the method we used to control for healthy adherer bias. During our study time frame the cost of a 30-pill prescription fill ranged from an average of \$41.19 for ACE inhibitors/ARBs to as low as \$10.85 for a cardiac glycoside. Thus, improved adherence in all drug groups would appear to be associated with potential net savings to the Medicare program.

For these findings to influence policy, consideration must be given to implementation costs other than the costs of the drugs themselves. Clearly, savings to Medicare may be difficult to achieve unless cost-effective methods can be applied to improving medication adherence. Although cost is clearly not the only potential barrier, there is substantial evidence that both magnitude and uncertainty in cost sharing can adversely affect medication adherence.²⁷⁻³¹ Although some authors have proposed value-based benefit designs in which lowered (or even zero) cost sharing is postulated to increase adherence, to date the evidence on the effectiveness of incentives of this type remains sparse.^{11,32-35} Moreover, within the current structure of Medicare Part D, in which stand-alone prescription drug plans predominate, incentives of this type would be difficult to implement. For prescription drug plans at least (unlike Medicare Advantage plans), there is little commercial incentive to encourage drug utilization that could increase costs to the insurer even as it potentially reduces spending elsewhere in the Medicare system. Other nonmonetary barriers to adherence may be even more challenging to address.³⁶

The study has a number of key strengths. Our use of the MCBS enabled a direct linkage to service utilization over periods of up to 3 years. Many previous medication adherence studies tracked patterns of utilization for periods as short as 12 months and did not link adherence to claims data in this way. Our study included observations for persons who died or were otherwise lost to follow-up, allowing the study findings to be generalizable to the general Medicare population and not restricted solely to a cohort of survivors. Lastly, the study design utilized multiple controls for potential confounding due to indication bias, concurrent drug use, and healthy adherer bias.

Nevertheless, several limitations that we identified in previous analyses are also relevant to this study. The lack of fill dates and number of days of supply in the MCBS prescription drug

event files mean that our use of daily pill counts as the measure of adherence may be less informative than measures based on claims data. Second, although we were able to track adherence for 3 years, heart failure is a chronic, progressive condition, and our metric does not take into account changes in treatment attributable to disease progression. Studies with longer time frames may be needed to corroborate our findings and to clarify whether the benefits of increased adherence are linear, or whether there is a ceiling effect. Such studies would help us understand whether differential efforts to improve compliance should be targeted to different patient subpopulations (eg, stratified by baseline disease severity or prior level of adherence). Third, as in all observational studies, we cannot rule out residual bias arising from unobserved confounders.

CONCLUSION

Congestive heart failure is chronic and progressive. Our analyses showed that relatively modest increases in medication adherence among Medicare beneficiaries with CHF were associated with lower cumulative Medicare spending over 3 years. The savings generally exceeded the costs of the drugs in question.

Improving adherence to medication use is clearly only 1 element in optimizing pharmacotherapy in CHF. The finding that despite a CHF diagnosis at baseline, only 83% of the cohort were taking medications in any of the 4 classes studied is cause for concern. What we cannot discern is whether this finding reflects undertreatment—patients not being prescribed appropriate medications—or failure of the patients to fill their prescriptions. Further research is needed to clarify the extent to which underutilization reflects patient attitudes, access to care, affordability, or lack of adherence to evidence-based treatment guidelines, and to find robust ways to address these issues.

Given the aging population, increasing prevalence of obesity and diabetes, and suboptimal control of risk factors, the individual and societal burden of CHF and other forms of cardiovascular disease can only be expected to increase. Addressing these residual questions about access to and utilization of appropriate pharmacotherapies is critical if the potential benefits of advances in treatment over recent decades are to be realized.

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