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Does Medication Adherence Lower Medicare Spending Among Beneficiaries with Diabetes?

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Abstract

Objective—To measure three-year medication possession ratios (MPR) for renin-angiotensin-aldosterone system (RAAS) inhibitors and statins for Medicare beneficiaries with diabetes, and to assess whether better adherence is associated with lower spending on traditional Medicare services controlling for biases common to previous adherence studies.

Data Source—Medicare Current Beneficiary Survey data from 1997–2005

Study Design—Longitudinal study of RAAS-inhibitor and statin utilization over 3 years.

Data Collection—The relationship between MPR and Medicare costs was tested in multivariate models with extensive behavioral variables to control for indication bias and healthy adherer bias.

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Principal Findings—Over three years, median MPR values were .88 for RAAS-I users and .77 for statin users. Higher adherence was strongly associated with lower Medicare spending in the multivariate analysis. A 10 percentage point increase in statin MPR was associated with $832 lower Medicare spending (se=219; p<.01). A 10 percentage point increase in MPR for RAAS-Is was associated with $285 lower Medicare costs (se=114; p<.05).

Conclusions—Higher adherence with RAAS-Is and statins by Medicare beneficiaries with diabetes results in lower cumulative Medicare spending over three years. At the margin, Medicare savings exceed the cost of the drugs.

Keywords

diabetes; Medicare; medication adherence; cost offsets

Clinical trials have established that statins and renin-angiotensin-aldosterone system (RAAS) inhibitors including angiotensin-converting enzyme ACE-inhibitors and angiotensin II receptor blockers (ARBs) can provide benefits for many elderly diabetic patients by preventing or delaying certain secondary complications of the disease (Brown et al. 2003; Odegard and Capoccia 2007; American Diabetes Association 2008). Indeed, the evidence has convinced some clinicians that virtually all elderly diabetics should be treated with ACE-inhibitors (Rosen et al. 2005; Birkmeyer and Welch 2005) and statins (Kamari et al. 2009). A growing literature also suggests that improved adherence with these medications not only improves clinical outcomes but reduces medical costs as well (Golon et al. 1999; Balkrishnan et al. 2003; Brandle et al. 2003; Hepke et al. 2004; Gilmer et al. 2005; Rosen et al. 2005; Sokol et al. 2005; Stuart et al. 2009).

Claims of medical cost offsets from drug use are controversial. A well known review of the literature by the U.S. Congressional Budget Office (2002) prior to enactment of the Medicare Part D drug benefit concluded that the empirical evidence of cost offsets was insubstantial and rested on questionable methods. Some argue that there has been little progress since then. For example, a recent systematic review of studies of adherence with antidiabetic drugs concluded that, “the research assessing the association between medication adherence/nonadherence and health-care costs is limited and of poor quality” (Salas et al. 2009, p. 920). Shortcomings cited by Salas et al. (2009) and others include reliance on convenience samples with limited generalizability, short analytical timeframes (typically a year) that preclude analysis of drugs—such as statins—with longer time to benefit, survivor bias (virtually all adherence studies exclude decedents), and reverse causality. Of these analytic weaknesses, reverse causality represents perhaps the greatest threat to internal validity. A negative relationship between drug adherence and medical costs could be due to the impact of the drug, but it could also signal that healthier people are more adherent and would have better outcomes irrespective of drug effects. This “healthy adherer” phenomenon has been observed in clinical trials in which patients with good adherence to placebo have better prognosis than those with poor adherence to placebo (Coronary Drug Project Research Group 1980; Horwitz and Horwitz 1993; LaRosa 2000). Healthy adherer bias is an even greater potential threat in observational studies of drug adherence (Chewning 2006; Simpson et al. 2006; Granger et al. 2005).

We designed this study of cost offsets associated with adherence to RAAS-Is and statins to address each of the methodological concerns raised above. Our study sample of Medicare beneficiaries with diabetes was selected from the nationally representative Medicare Current Beneficiary Survey. Following an annual baseline assessment, users of each drug class were followed for up to an additional three years with explicit consideration of censoring by death or other cause. Most importantly, we developed an empirical specification of the

relationship between adherence and spending on traditional Medicare services that is robust to indication bias and healthy adherer bias.

METHODS

Data and Study Sample

We used data from the Medicare Current Beneficiary Survey (MCBS) from 1997 through 2005 for the study. The MCBS employs a rotating panel design in which approximately 4,000 beneficiaries are randomly selected for induction into the survey each fall. Members of each new panel are then interviewed every four months for up to three additional years using computer assisted in-person interviews. The survey collects information on demographic and socioeconomic characteristics, health and functional status, utilization and cost of all health services including prescription drugs, and various other factors relevant to understanding beneficiaries' health care utilization decisions and the consequences of care received (CMS 2009). Respondents maintain logs of prescriptions and are asked to keep pharmacy receipts, insurance claims, and used medication containers. The MCBS interviewers then record every prescription fill or refill reported during each four-month recall period as a separate event noting drug name, strength, and quantity of doses, but not the date the prescription was filled nor the number of days treatment supplied. On alternative years the survey asks a panel of questions about diabetes knowledge and self-care for beneficiaries with the disease. The MCBS survey responses are linked to Medicare administrative data including Part A and B claims.

We pooled 6 panels of beneficiaries inducted into the MCBS from 1997 through 2002 with a diagnosis of diabetes in the year of their baseline MCBS survey. Diabetes cases were identified from claims using an algorithm developed by the Centers for Medicare and Medicaid Services (CMS) for the Chronic Condition Warehouse (Buccaneer 2009).1 We also included beneficiaries who self-reported being given a diagnosis of diabetes by a physician. The availability of self-reported diabetes is a strength of this study as it is considered the gold standard for identifying individuals with diabetes in the absence of clinical indicators (Herbert et al., 1999; Saydah et al., 2004). Beneficiaries residing in long term care (LTC) facilities during their baseline surveys were excluded because of differences in the way the surveys are administered in these settings (however, beneficiaries with future LTC admissions were retained). We excluded individuals who enrolled in capitated Medicare health plans at any time during their tenure in the MCBS because these subjects lacked Part A and B claims data necessary for computing Medicare costs. The final sample comprised 3,765 beneficiaries with diabetes at baseline. We then created two overlapping cohorts of individuals who reported filling prescriptions for a RAAS-inhibitor and/or a statin during their first full year in the MCBS following their fall induction survey. Individuals in each drug user cohort were then followed until they completed their MCBS tenure or were lost to follow up, admitted to a LTC facility for a long-term stay2 or died.

Measures

Drugs within each class were identified through drug names, therapeutic class indicators, and a pharmacist's review. Because days supply for prescription fills was not available in

[1]The CCW criteria for diabetes include beneficiaries with an ICD-9 code for 250.xx (diabetes), 357.2 (polyneuropathy in diabetes), 362.01 (background diabetic retinopathy), 362.02 (proliferative diabetic retinopathy NOS), 366.41 (diabetic cataract)on one or more inpatient hospital, skilled nursing facility (SNF), or home health claims or two outpatient hospital or physician claims in any position (Buccaneer, 2009).

[2]The MCBS considers beneficiaries who are admitted to Medicare-covered post-acute SNF admissions to be "community" residents unless they are expected to remain facility residents after their SNF benefits expire. Residents in this latter category were censored on their date of admission to the LTC facility

the MCBS, we used pill counts to measure drug adherence over the period each subject was followed. In cases where pill counts were missing, we imputed values based on other information in each individual's medication regimen.3 Our adherence measure is a variant of the medication possession ratio (MPR) in which the number of pills aggregated into 30-pill fills is divided by the number of months observed for each study subject up to 36. For example, if a person reported a total of 800 statin pills over three complete observation years (i.e., the beneficiary survived and was not lost to follow up) then the MPR was 800/30 = 26.7 30-pill fills divided by 36 months = an MPR of 0.74. We excluded inpatient days from the denominator of the ratio because hospitals and other inpatient facilities provide drugs from their own pharmacies. This MPR measure accurately captures drug availability for medications dispensed in once-a-day dosing forms, which is the case for most RAAS-Is and virtually all statins.

Our dependent variable was Medicare expenditures for Part A and B services measured over the same timeframe as the MPR measures. To account for inflation, all dollar values were converted to constant 2006 dollars using the CPI-urban price index (U.S. Department of Labor 2009).

We included an extensive set of covariates in our regression models to control for confounding due to demographic factors, health status, access to care, and healthy adherer bias. Demographic characteristics hypothesized to influence both prescription use and Medicare spending were age, sex, race, marital status, education, and census region. Health status and disease severity are particularly important control variables in order to avoid indication bias associated with prescribing. We captured multiple health status measures from three sources: (1) self-reported measures (a standard five-item scale of health status from excellent to poor, body-mass index [BMI] computed from self-reported height and weight, limitations in activities of daily living [ADLs], and self-reported diabetes type); (2) Medicare administrative data (current and former recipient of Social Security Disability Insurance or SSDI); and (3) measures derived from diagnostic information in the Medicare claims (diabetes complications [ICD-9 codes 250.1x to 250.9x] and various comorbidities commonly associated with diabetes, including chronic renal failure, hypertension, ischemic heart disease, cardiac failure, hyperlipidemia, chronic obstructive pulmonary disease, and osteoarthritis, plus a count of hierarchical coexisting conditions or HCCs4). Access to care was captured by data on income and the possession of supplemental medical and drug benefits by source of coverage.

Control variables designed to mitigate the effects of healthy adherer bias included indicators for use of antidiabetic medications, knowledge of diabetes, and diabetes management behaviors. Antidiabetic medication use was coded as a series of dummy variables for any use of older oral hypoglycemic agents (metformin and sulfonylureas), newer oral hypoglycemic agents (thiazolidinediones, α-glucosidase inhibitors, meglitinides), and insulin. We also included interaction terms to capture users of both newer and older oral antidiabetic agents, and users of insulin plus oral agents. The behavioral variables included responses to the following questions: "Have you ever participated in a diabetes self-

[3]We found that 15.8% of medication fills for our drugs of interest had missing pill counts. All quantity information was missing for 12 individuals and they were dropped from the sample. We used a two-stage imputation procedure to fill in missing pill counts for the rest of the sample. In the first stage, we identified all instances in which an individual with one or more prescriptions with missing pill counts in a given year had prescriptions for the same drug(s) with non-missing pill counts in that same year. Such cases represented 81.5% of missing fills. For these, we computed the mean pill counts per prescription for the intact fills drug-by-drug and year-by-year and replaced missing values with these computed counts. For the remaining 18.5% of missing pill counts, we averaged intact pill counts over all years the individual was observed to use the specific drug(s) in question, and used these estimates to replace missing values.

[4]Hierarchical coexisting conditions (HCCs) are used by the Centers for Medicare and Medicaid Services to risk-adjust capitation payments to Medicare Advantage plans, and as a co-morbidity index in studies of the Medicare population.

management course or class, or received special training on how you can manage your diabetes?" "Do you test your blood for sugar or glucose?" "Do you check for sores or irritations on your feet?" "Do you use diet control (planning meals, what to eat, what not to eat)?" "Do you exercise regularly or get regular physical activity?" "Do you take aspirin regularly for your diabetes?" (CMS 2009). We reasoned that persons who control their diabetes though some combination of antidiabetic drugs, diet, exercise, and other healthy behaviors would be more likely to exhibit good adherence to RAAS-Is and statins.

Finally, we included dummy variables to capture censoring (loss to follow up, LTC admission, death), as well as year of induction into the MCBS (a proxy for temporal trends in diabetes and availability of treatment options).

Statistical Analysis

We estimated the relationship between the MPR for each drug class and cumulative Medicare spending in unadjusted bivariate and multivariate regression equations covering the entire period observed for each subject (36 months for survivors and time till censoring for beneficiaries who died, were lost to follow-up or were admitted to a long-term care facility). For ease of interpretation, we scaled MPR from 0 to 10 so that the coefficients of interest can be read as a 10 percentage point change in MPR (a one-unit change on the original scale of 0.0 to 1.0 would be read as a change from zero to perfect adherence, which is an unrealistic scenario). Except for the drug utilization and censoring variables, all covariates were measured during the baseline year.[5] All models were estimated in Stata 9 using a generalized linear model with a gamma distribution and log link to approximate the right skewed distribution of Medicare costs. Because virtually all subjects had some Medicare spending over the three-year observation period, we estimated one-part models, replacing the small number of zero observations with a value of $1. Model coefficients were converted to marginal effects for ease of interpretation.

In addition to these models, we conducted two sensitivity tests. The first assessed the linearity of the relationship between adherence and Medicare spending by replicating the basic models for subsets of individuals with MPRs above and below the median values for each drug class. The second test used propensity score matching to assess the relationship of MPR and spending on samples of beneficiaries with below and above average adherence rates who had otherwise similar characteristics.[6] Because both sensitivity tests relied on relatively small samples, we consider the findings to be suggestive and only report key findings.

The study protocol was approved by the University of Maryland Baltimore Institutional Review Board.

[5]Because the diabetes management questions are only asked on alternative years, we included values for these measures either at baseline or the year closest to baseline, depending on the year of induction into the MCBS. Individuals with a diagnosis of diabetes and no self-report have missing values for these variables. In order not to lose these subjects, we added a dummy variable in the multivariate equations identifying persons with no self report of diabetes.

[6]For the propensity score analysis. we divided each study cohort into two groups, one with below and the other with above median MPRs. We then estimated a logistic regression with group assignment as the dependent variable using the same explanatory variables as in the original models. From these regressions we output predicted probabilities (propensity scores) of being an above average adherer. Next, we matched individuals with above and below average MPRs to 3 digits on their propensity scores. The matched samples represented 642 RAASI users and 384 statin users. Finally, we re-estimated the original regressions restricted to the matched samples.

RESULTS

Descriptive Findings

Baseline characteristics of the RAAS-I and statin user cohorts are presented in Table 1. The two groups are quite similar, due in large part to the fact that they overlap—50 percent of RAAS-I users also used statins and 71 percent of statin users took RAAS-Is. Cumulative mean 3-year spending on Medicare Part A and Part B services exceeded $40,000 for each user group measured in constant 2006 dollars. The RAAS-I group had slightly higher percentages of minorities, was less likely to be married, and had lower educational levels and income. The illness profiles of the two groups were broadly similar except for hyperlipidemia which was much higher among statin users (suggesting perhaps that their cholesterol levels were not well controlled or alternatively that patients diagnosed with hypercholesterolemia continue to carry that diagnosis even if their cholesterol levels are controlled). Three-year mortality rates were 40 percent higher in the RAAS-I group (14.3 versus 10.2 percent for statin users). It is also interesting to note that higher proportions of each drug user group are concentrated in the later years of the study period. These trends reflect the increasing diffusion of new products in each drug class over the study period.

Table 2 presents data on medication adherence, diabetes knowledge, and self-management practices for the two groups. Median three-year adherence rates were .88 for RAAS-Is and . 77 for statins. High proportions of both groups reported use of antidiabetic drugs over the three-year observation windows. Forty-one percent reported using older oral antidiabetic agents alone (metformin and/or sulfonylureas) with smaller proportions using new oral agents (thiazolidinediones, meglitinides, and α-glucosidase inhibitors) either alone or in combination with the older agents. Between 11 and 12 percent used insulin either alone or in combination with an oral agent. About 60 percent of beneficiaries reported having a good understanding of their disease, and high proportions reported routinely checking their blood sugar levels, regularly checking their feet, and using diet to control their diabetes. Smaller percentages reported exercising or taking a daily low-dose aspirin, and fewer than a third of each group reported attendance at a diabetes management class.

Table 3 shows how MPR varied for individuals who reported practicing these behaviors compared to those who did not. There was general support for the hypothesis that MPR and other diabetes-related health behaviors are positively correlated—14 of the 22 contrasts were in the hypothesized direction, 6 showed no relationship, and in only 2 cases were the signs in the opposite direction (statin use among those taking RAAS-Is and daily aspirin use among statin users). Most of the differences were small in the range of 2 to 4 percentage points. The strongest relationship was for diet control. The MPR for RAAS-I users who also practiced diet control was 0.90 compared to just 0.81 for those who did not. Among statin users, MPRs were 5 percent higher for those using diet control versus not. Being at least somewhat knowledgeable about their diabetes was also associated with higher MPRs for RAAS-I users, but not for statin users.

Regression Results

Regression results are presented in Table 4. The unadjusted bivariate results (at the top of the table) indicate that adherence with RAAS-Is and statins was negatively associated with Medicare spending, but the marginal effects were small and insignificant for RAAS-Is, and only marginally significant ($p<.1$) for statins. In the multivariate models, the MPRs for both classes of drugs were strongly associated with lower Medicare spending. For RAAS-Is, a 10 percentage point increase in MPR was associated with $285 lower spending ($p=.05$), whereas a 10 percentage point increase in MPR for statins was associated with $832 lower spending ($p<.01$).

Relatively few of the variables designed to control for healthy adherer bias were independently significant predictors of Medicare costs due to high collinearity among behaviors. In the RAAS-I equation, exercise ($p<.05$) and "checks feet for sores" ($p<.1$) predicted lower Medicare costs, while aspirin use was associated with higher costs ($p<.1$). In the statins equation, being a user of newer antidiabetic drugs (and no older oral antidiabetic agents) was associated with much lower Medicare costs (−$9,571; $p<.01$), while using both older and newer oral agents was associated with much higher costs ($16,114; $p<.01$). Reporting use of diet to control diabetes was associated with higher Medicare costs in both equations, but the effect was statistically significant only for statin users.

Sensitivity Test Results

The test designed to determine if changes in MPR had a linear impact on Medicare costs provided evidence that the effect is greater among relatively nonadherent beneficiaries. For RAAS-I users in the lower half of the MPR distribution (median MPR = .62; range .05 to .87), a 10 percentage point increase in MPR was associated with $1,051 lower Medicare spending over 3 years ($p=0.022$). For statin users in the lower half of the MPR distribution (median MPR = .57; range .05 to .78), a 10 percentage point increase in MPR was associated with $1,221 in Medicare savings ($p=0.036$). Median MPRs for the upper halves of the distributions were close to 1.0 for both statin and RAAS-I users, and there were no statistically significant associations with Medicare costs in either case.

The propensity score analysis yielded estimates similar to the original regressions, but with higher standard errors. For the RAAS-I user sample (n=642), a 10 percentage point increase in MPR generated a Medicare savings of $354 ($p=0.013$). For the statin sample (n=384), the estimated savings were $427 ($p=0.081$).

DISCUSION

This study analyzed the relationship between adherence to RAAS-Is and statins and spending on traditional Medicare services for disabled and aged Medicare beneficiaries with diabetes between 1997 and 2005. The study is unique in several important respects. First, unlike medication adherence studies that rely solely on prescription claims, the MCBS permitted us to draw an exceptionally rich picture of the personal characteristics, health service utilization and spending, and diabetes knowledge and self-management practices of a nationally representative sample of community-dwelling diabetics treated in fee-for-service settings. Second, the MCBS samples can be tracked longitudinally to capture medication adherence patterns and potential outcomes over durations of up to three years. Typical medication adherence studies track utilization patterns over a single year. A third strength of the study is the inclusion of observations for persons who died and were otherwise lost to follow-up. This means that the study findings can be generalized beyond the survivor cohorts typical of traditional adherence studies. A fourth strength of the study design is the multiple controls for potential confounding due to indication bias and healthy adherer bias.

We found that median MPR adherence rates were .88 for RAAS-Is and .77 for statins. An MPR of .80 is often cited as reasonably good adherence behavior for chronic medications (Vink et al. 2009). By that standard slightly more than half of RAAS-I users were adherent with therapy over three years whereas slightly fewer than half of statin users were adherent. Nonadherence can take the form either of intermittent use with gaps in therapy or discontinuance of the drug. Lack of dispensing dates in the MCBS dataset precluded analysis of therapy gaps, but we were able to determine discontinuance rates from one year to the next. For individuals surviving all three years, 15 percent of both the RAAS-I and statin user groups discontinued therapy by the start of the second year, and an additional 15

percent discontinued therapy by the third year (results not shown). This would suggest that therapy gaps and drug discontinuance contributed roughly equal shares of observed nonadherence for the two groups. Gaps in therapy are usually ascribed to lapses in patient behavior. Discontinuance could be due either to patient behavior or physician response to treatment failure or adverse drug reactions.

Whatever the cause of nonadherence, we found that beneficiaries with better MPRs had lower spending on traditional Medicare Part A and Part B services. For statin users, a 10 percentage point increase in MPR was associated with $832 lower Medicare expenditures in the multivariate model ($p<.01$). A 10 percentage point increase in MPR for RAAS-Is was associated with $285 lower Medicare costs ($p<,.05$). To put these estimates in context, during our study timeframe a 30-pill statin fill averaged $80.95 and a 30-pill RAAS-I fill averaged $30.68 in 2006 dollars.7 For non-censored survivors in our sample, a 10 percentage point change in MPR would be equivalent to 3.6 months of use which would cost $291.44 and $110.45 for statin and RAAS-I users, respectively. In other words, at the margin, utilization of both drugs was associated with net saving to the Medicare program. Results from our sensitivity tests suggest that the savings potential from increased adherence is concentrated among relatively poor adherers, but additional analysis using larger samples is necessary to confirm that finding.

As noted in the introduction, other studies have reported cost savings from improved adherence with these drugs. Although differences in study design and sample populations make direct comparisons difficult, it is possible to examine variation in overall effect sizes across studies. For example, Sokol et al. (2005) computed the relationship between annual adherence and medical costs for nonelderly patients with diabetes, hypertension, hypercholesterolemia, and heart failure. In models controlling for comorbidity but no additional drug use or patient behavior variables, medical costs among the poorest adherers (MPR = 0.1 to 0.19) were reported to be two to three times higher than for the highest adherers (MPR = 0.80 to 1.00) for all cohorts except heart failure. It is difficult to imagine that drug adherence was the only or even the primary cause of cost differences of this magnitude. Even studies with longer timeframes report implausibly high expenditure cost offsets from drug adherence. A study of aged diabetics enrolled in a Medicare HMO for up to five years reported that a 10 percent increase in MPR for antidiabetic medications was associated with lower total medical cost of between 8.6 percent and 28.9 percent (Balkrishnan et al. 2003). By contrast, our estimated adherence impacts are modest. We estimate that a 10 percent increase in MPR would reduce Medicare outlays by approximately 0.7 percent for RAAS-I users and by about 2.1 percent for statin users over three years. Short of replicating our research design on these other data sources, it is impossible to determine the true source of such discrepant findings. However, we believe that our sample frame and expansive confounder domains address limitations in other work in this area.

That said, our results should be interpreted in the light of several important limitations. The lack of service dates and days supply in the MCBS prescription drug event files mean that our MPR measures are less accurate than measures based on actual claims data. We believe that the standardized 30-pill measure used to compute MPR is accurate for statins and most RAAS-I prescriptions. However, some patients receive prescriptions for ACE-inhibitors that require two or even three pills per day. For this reason, our estimated MPR for RAAS-Is may be slightly overestimated, and to this extent, our estimates of RAAS-I adherence effects may be understated. Second, because our samples are relatively small, the estimated

[7]These price statistics are based on self-reported and imputed prices from the MCBS surveys. They have been inflated to 2006 dollars using the CPI index.

standard errors are large compared to those using large claims datasets. Small sample sizes limited our ability to conduct detailed analyses of Medicare savings associated with different levels of MPR. Third, while we were able to track adherence in medication use for three years, diabetes is a chronic and progressive condition, and studies with longer timeframes are needed to corroborate our findings. Fourth, because the MCBS does not gather data on prescribing, we were unable to identify beneficiaries who were prescribed RAAS-Is or statins and failed to fill them (non-fulfillment). Fifth, the lack of Medicare claims data for Medicare Advantage enrollees means that our results cannot be generalized to this segment of the Medicare population.

Finally, our estimates of potential Medicare savings do not include any costs associated with improving adherence other than the added cost of the drugs themselves. It goes without saying that additional savings will be difficult to obtain unless cost-effective methods are available to increase drug adherence among Medicare beneficiaries with diabetes. Value-based insurance designs (VBID) with lowered copayments—or even free drugs—have been suggested as one approach to increasing medication utilization rates among diabetics (Rosen et al. 2005; Nicholson 2006; Fitch et al. 2008; Spaulding et al. 2009). At this point, the evidence base on VBID effectiveness is meager and such programs would be difficult to implement under current Medicare payment rules because drug copay policies are made by private Part D prescription drug plans. Moreover, nonfinancial barriers to adherence may be even more difficult to surmount (Gellad et al. 2009). One potential way to spur better adherence is through focused diabetes self-management courses. Our analysis showed that beneficiaries who attended these courses had lower Medicare spending. Although these results were not statistically significant, the fact that only a third of the respondents had taken such a class provides ample room for improvement.

CONCLUSIONS

Higher levels of adherence with RAAS-inhibitors and statins by Medicare beneficiaries with diabetes results in lower cumulative Medicare spending over three years with savings exceeding the cost of the drugs.

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Table 1

Characteristics of Medication User Cohorts[†]

Beneficiary Characteristics	Cohort of RAAS Inhibitor Users (N=1,766)	Cohort of Statins Users (N=1,139)
Use of RAAS-inhibitors (%)	100	71.4
Use of statins (%)	49.9	100
Cumulative 3-year Medicare Spending (2006 constant dollars)	$41,540	$40,525
Diabetes ascertainment (%)		
Claims and self-report	74.9	73.1
Claims/no self-report	17.7	19.1
Self-report/no claims	7.5	7.8
Age (%)		
Age < 65 (SSDI)	14.8	15.6
65 – 69	22.2	26.7
70 – 74	19.9	20.5
75 – 79	18.7	18.4
80+	24.4	18.8
Former SSDI ≥ age 65	24.5	26.3
Female (%)	55.6	53.2
Race (%)		
Non-Hispanic white	71.1	76.1
Non-Hispanic black	15.1	12.6
Hispanic	9.0	6.9
Other	4.8	4.4
Marital status (%)		
Married	49.7	56.7
Widowed	34.1	27.7
Single	16.1	15.6
Education (%)		
No high school	22.6	19.1
Some high school	19.2	18.2
High school grad	29.1	29.9
Some higher education	28.2	32.5
Annual income (%)		
≤ 100% FPL	22.2	19.1
101% to 199% FPL	34.3	32.9
200% to 299% FPL	20.8	21.1
≥300% FPL	22.4	26.6
Census region (%)		
East	22.3	20.6
Midwest	24.6	25.5
South	39.3	40.7
West	13.9	13.3

Beneficiary Characteristics	Cohort of RAAS Inhibitor Users (N=1,766)	Cohort of Statins Users (N=1,139)
Has Medicare supplement (%)	93.3	93.8
Has drug coverage (%)		
Medicaid	22.8	21.0
Employer plan	35.6	41.1
Self-purchased	12.9	12.5
Other public	8.0	7.6
Other private	2.0	1.7
None	24.0	22.0
Diabetes type (%)		
Type 1	15.1	12.1
Type 2	76.7	80.8
Type not determined	3.6	3.4
Self-reported health (%)		
Excellent/very good	21.2	22.6
Good	30.9	30.7
Fair	30.8	29.5
Poor	17.0	17.0
Body mass index (%)		
<18.5 (underweight)	0.9	0.3
18.5 – 24.9 (normal)	20.7	18.8
25.0 – 29.9 (overweight)	35.3	37.8
30.0 – 34.9 (obese 1)	24.2	25.0
35.0 – 39.9 (obese 2)	9.0	9.5
40.0+ (obese 3)	6.8	5.8
Comorbidities (%)		
Diabetes complications	27.2	25.1
Chronic kidney disease	5.6	5.6
Hypertension	81.0	72.8
Ischemic heart disease	43.3	51.7
Heart failure	28.8	25.1
Hyperlipidemia	45.2	74.4
COPD	13.1	12.6
Osteoarthritis	17.0	15.9
Count of limitations in activities of daily living (ADL)(mean, sd)	1.1 (1.6)	1.0 (1.4)
Count of hierarchical coexisting conditions (HCCs) (mean, sd)	11.5 (5.6)	11.8 (5.4)
Died (%)	14.3	10.2
Lost to follow-up (%)	9.2	10.6
Long-term care facility admission (%)	5.3	3.9
MCBS induction year (%)		
1997	11.0	10.0
1998	13.9	12.5

Beneficiary Characteristics	Cohort of RAAS Inhibitor Users (N=1,766)	Cohort of Statins Users (N=1,139)
1999	16.2	14.4
2000	18.3	16.9
2001	19.1	20.6
2002	21.5	25.6

† Values weighted to be nationally representative

Source: Medicare Current Beneficiary Surveys, 1997–2005

Table 2

Diabetes Treatment, Knowledge, and Care Management[†]

Variables	Cohort of RAAS Inhibitor Users (N=1,766)	Cohort of Statin Users (N=1,139)
Medication adherence		
RAAS inhibitors		
Median 3-year MPR	0.88	0.85
Statins		
Median 3-year MPR	0.77	0.77
User of antidiabetic drugs (%)		
Older oral agents alone [††]	41.0	41.0
Newer oral agents alone[†††]	7.2	8.1
Older and newer oral agents	18.4	22.7
Insulin alone	6.0	5.9
Insulin plus oral agent(s)	5.2	6.3
Diabetes knowledge[††††]		
Good (%)	59.9	62.4
Some (%)	21.5	20.9
Poor (%)	8.2	8.7
Diabetes behaviors[††††]		
DM management class (%)	32.1	32.9
Tests own blood sugar (%)	80.2	81.9
Diets to control DM (%)	76.4	77.4
Exercises to control DM (%)	50.4	53.9
Takes daily aspirin (%)	40.7	48.2
Checks for sores on feet (%)	81.5	81.6

[†]Values weighted to be nationally representative of Medicare beneficiaries with self-reported diabetes.

[††]Includes metformin and sulfonylureas.

[†††]Includes thiazolidinediones, meglitinides, and α-glucosidase inhibitors

[††††]Diabetes knowledge and behaviors percentages reported only

Source: Medicare Current Beneficiary Surveys, 1997–2005.

Table 3

Bivariate Relationships Between Medication Possession Ratio (MPR) and Drug User, Diabetes Knowledge, and Diabetes Care Management Variables

	Median Medication Possession Ratios (standard errors)	
Variables	**Cohort of RAAS Inhibitor Users (N=1,766)**	**Cohort of Statin Users (N=1,139)**
Drug user variables		
RAAS inhibitors		
Yes	--	0.77 (0.03)
No	--	0.77 (0.02)
Statins		
Yes	0.85 (0.02)	--
No	0.90 (0.02)	--
Older oral antidiabetic drugs†		
Yes	0.88 (0.02)	0.77 (0.01)
No	0.85 (0.02)	0.77 (0.01)
Newer oral antidiabetic drugs††		
Yes	0.88 (0.03)	0.79 (0.02)
No	0.88 (0.02)	0.77 (0.01)
Insulin		
Yes	0.90 (0.06)	0.81 (0.03)
No	0.88 (0.01)	0.77 (0.01)
Diabetes knowledge		
Good	0.88 (0.02)	0.77 (0.01)
Some	0.88 (0.03)	0.74 (0.03)
Poor	0.82 (0.05)	0.77 (0.05)
Diabetes (DM) management		
DM management class		
Yes	0.90 (0.03)	0.79 (0.02)
No	0.87 (0.02)	0.76 (0.01)
Tests own blood sugar		
Yes	0.88 (0.02)	0.79 (0.02)
No	0.85 (0.02)	0.74 (0.02)
Uses diet to control DM		
Yes	0.90 (0.02)	0.79 (0.01)
No	0.81 (0.02)	0.74 (0.02)
Uses exercise to control DM		
Yes	0.88 (0.02)	0.77 (0.02)
No	0.88 (0.02)	0.77 (0.02)
Takes daily aspirin		
Yes	0.90 (0.03)	0.75 (0.02)
No	0.85 (0.02)	0.77 (0.02)
Checks for sores on feet		

	Median Medication Possession Ratios (standard errors)	
Variables	**Cohort of RAAS Inhibitor Users (N=1,766)**	**Cohort of Statin Users (N=1,139)**
Yes	0.90 (0.02)	0.77 (0.01)
No	0.85 (0.02)	0.74 (0.02)

Table 4

Estimated Marginal Effects of Medication Possession Ratios, Drug User, Diabetes Knowledge, and Diabetes Care Management on Cumulative 3-Year Medicare Spending

	Marginal Effects (Standard Errors)	
Drug Use, Diabetes Knowledge, and Behavioral Variables	**Cohort of RAAS Inhibitor Users**	**Cohort of Statin Users**
Unadjusted Results		
Drug measures		
RAAS-IMPR (scaled 0 to10)	−$38 (237)	--
Statin MPR (scaled 0 to10)	--	−$806 (450)*
Adjusted Results†		
Drug adherence measures		
RAAS-IMPR (scaled 0 to10)	−285 (114) **	--
Statin MPR (scaled 0 to10)	--	−832 (219) ***
Drug user variables (yes/no)		
RAAS inhibitors	-	513 (2,039)
Statins	−371 (1,693)	-
Older oral antidiabetic drugs††	−1,325 (2,181)	−3,947 (2,784)
Newer oral antidiabetic drugs†††	−773 (3,304)	−9,571 (2,656) ***
Insulin fills	2,812 (3,354)	5,212 (3,861)
Older and newer oral drug	2,634 (4,084)	16,114 (4,985) ***
Insulin plus oral drug(s)	3,279 (5,134)	−1,699 (4,925)
Diabetes knowledge		
Good (referent)		
Some	−1,763 (2,093)	−9 (2,372)
Poor	−3,532 (2,390)	5,896 (3,790)
Diabetes (DM) management		
DM management class	−2,636 (1,690)	−2,958 (1,902)
Tests own blood sugar	847 (2,224)	2,408 (2,524)
Uses diet to control DM	1,750 (1,912)	5,713 (2,092) ***
Uses exercise to control DM	−3,582 (1,722) **	−1,622 (2,048)
Takes daily aspirin	3,312 (1,763) *	1,387 (1,895)
Checks for sores on feet	−3,882 (2,345) *	−3,297 (2,816)

* p<.1,

** p<.05,

*** p<.01

† Results adjusted for age, former SSDI status, sex, race, marital status, education, income, region, insurance coverage, self-reported health, BMI, comorbidity, ADLs, HCCs, diabetes ascertainment, and censoring variables.

†† Includes metformin and sulfonylureas.

†††Includes thiazolidinediones, meglitinides, and α-glucosidase inhibitors