

Increased Persistency in Medication Use by U.S. Medicare Beneficiaries With Diabetes Is Associated With Lower Hospitalization Rates and Cost Savings

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OBJECTIVE— To assess the relationship between annual fills for antidiabetes medications, ACE inhibitors, angiotensin II receptor blockers (ARBs), and lipid-lowering agents on hospitalization and Medicare spending for beneficiaries with diabetes.

RESEARCH DESIGN AND METHODS— Using Medicare Current Beneficiary Survey data from 1997 to 2004, we identified 7,441 community-dwelling beneficiaries with diabetes, who contributed 14,317 person-years of data for the analysis. We used multivariate regression analysis to estimate the effect of persistency in medication fills on hospitalization risk, hospital days, and Medicare spending.

RESULTS— For users of older oral antidiabetes agents, ACE inhibitors, ARBs, and statins, each additional prescription fill was associated with significantly lower risk of hospitalization, fewer hospital days, and lower Medicare spending.

CONCLUSIONS— These results suggest an economic case for promoting greater persistency in use of drugs with approved indications by Medicare beneficiaries with diabetes; however, additional research is needed to corroborate the study's cross-sectional findings.

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Approximately 25% of Medicare beneficiaries have diabetes (1). In 2002, the average beneficiary with diabetes spent \$15,292 on medical services including \$2,349 for prescription medications (1). The economic burden of diabetes is huge—\$27 billion in 2007 (2) rising to possibly \$190 billion by 2020 (3).

Recent studies suggest that better medication management for older individuals with diabetes not only improves health (4) and reduces mortality (5), but also has the potential to reduce future medical care costs (6) and may be cost saving to the Medicare program (4–5, 7–9).

In this article, we examine annual

prescription fill rates for antidiabetes medications, ACE inhibitors, angiotensin II receptor blockers (ARBs), and lipid-lowering agents among Medicare beneficiaries with diabetes between 1997 and 2004. We then test to determine whether increased utilization is associated with lower hospitalization rates and savings in traditional Medicare services.

RESEARCH DESIGN AND METHODS

The study uses Medicare Current Beneficiary Survey (MCBS) data. Cases were selected based on self-reported diabetes or the presence of an ICD-9 code for diabetes and complications (250.xx), polyneuropathy in diabetes (357.2), diabetic retinopathy (362.01,

362.02), or diabetic cataract (366.41) on one hospital, skilled nursing facility, or home health claim or any of these codes on two outpatient or physician claims following a validated protocol (10,11). These selection criteria resulted in a sample of 7,441 individuals with diabetes who contributed 14,317 annual observations for the analysis.

We used MCBS prescription medication files to identify users of the following seven drug classes: older oral antidiabetes drugs (metformin and sulfonylureas), newer oral agents (thiazolidinediones, meglitinides, and α -glucosidase inhibitors), insulins, ACE inhibitors, ARBs, statins, and other lipid-lowering medications (ezetimibe, fibrates, niacin, and others). The primary explanatory variable in our analysis is the annual number of prescription fills per class per year.

We assessed the effect of prescription fill rates for users of each drug class on the risk of hospitalization, total annual hospital days, and spending on Medicare services measured in constant 2006 dollars, using the Consumer Price Index (12). Covariates included an extensive list of demographic, socioeconomic, and health status indicators (see Table A1 in the online appendix available at <http://care.diabetesjournals.org/cgi/content/full/dc08-1311/DC1>).

We estimated seven regression models, one per drug class, for each of the three dependent variables using person-year as the unit of analysis and the full set of covariates listed in the online appendix. Because the study subjects frequently used medications in two or more drug classes, we included fill rates for all seven drug classes in each equation. This procedure assured that the parameter coefficient on prescription fills for the subset of users of a particular drug class was conditioned on utilization of the other medication classes.

We used logistic regression for the hospitalization models and Poisson regression for the hospital day equations. For the Medicare spending models, we used a generalized linear equation with a

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γ distribution and log link to approximate the skewed distribution of Medicare expenditures (13). All models were estimated in Stata (Release 9) with a robust cluster command to correct standard errors for repeated measures among subjects observed in multiple years. Results are reported as conditional marginal probabilities (hospitalization) or conditional marginal effects (dy/dx) of a unit change in prescription fills on the change in the dependent variable (hospital days and Medicare spending), with all other variables held at their mean values.

RESULTS— Almost one-third (30%) of the sample was hospitalized each year with rates ranging from 27.4% for users of older antidiabetes medications to 42.9% for insulin users (Table 1). The mean number of inpatient days varied in a similar fashion. Mean annual Medicare spending ranged between 8,565 USD (older oral antidiabetes medication users) and 16,950 USD (insulin users).

User rates varied widely across the seven drug classes. Annual prevalence of older oral antidiabetes drug use was 47.1% compared with 13.3% for newer agents. Insulin use was infrequent (6.1%). The highest average annual fill rate was for older oral antidiabetes drugs (8.3), with annual fills hovering around 6 for the other classes.

The regression results are summarized in Table 1. Overall, we found a consistent inverse relationship between prescription fill rates and the three dependent variables for older oral antidiabetes agents, ACE inhibitors, ARBs, and statins. The marginal effects of prescription fills for these four classes were negative and statistically significant in every case. Each additional prescription fill by users of older oral antidiabetes agents reduced hospitalization risk by 0.3%, reduced the number of hospital days by 0.04 days, and reduced Medicare spending by \$71. Each added fill for ARB users reduced hospitalization risk by 1.3%, reduced the number of hospital days by 0.12 days, and reduced Medicare spending by \$159. Similar results were seen for the other two drug classes.

The hospital effects may appear to be small, but with an average Medicare cost of \$952 per inpatient day in 2006 (14), the results translate into hospital cost offsets ranging from \$38 per prescription for older oral antidiabetes agents to \$114 for ARBs. For three of the drug classes, estimated Medicare savings exceeded the cost

Table 1—Descriptive statistics and regression results of the relationship between prescription fills by drug class, hospitalization, inpatient days, and Medicare spending for Medicare beneficiaries with diabetes, 1997–2004

Drug classes	Number of drug users (%)	Mean \pm SD annual prescription fills	Hospitalization risk		Inpatient days		Medicare spending (2006 USD)	
			Unadjusted %	Conditional marginal effect of an additional prescription fill on the probability of hospitalization	Unadjusted mean \pm SD	Conditional marginal effect of an additional prescription fill on inpatient days	Unadjusted mean \pm SD	Conditional marginal effect of an additional prescription fill on Medicare spending
Older oral antidiabetes agents*	6,747 (47.1)	8.3 \pm 5.6	27.4	-0.3 (-0.5 to -0.04)†	2.8 \pm 8.4	-0.04 (-0.06 to -0.02)‡	8,565 \pm 16,937	-71 (-114 to -28)§
Newer oral antidiabetes agents	1,910 (13.3)	5.8 \pm 4.1	30.8	0.1 (-0.5 to 0.7)	3.5 \pm 10.1	-0.02 (-0.06 to -0.02)	10,436 \pm 19,533	66 (-41 to 174)
Insulins	875 (6.1)	6.0 \pm 5.1	42.9	-0.6 (-1.5 to 0.2)	6.1 \pm 13.9	0.03 (-0.03 to 0.10)	16,950 \pm 28,412	27 (-165 to 219)
ACE inhibitors	5,490 (38.4)	6.5 \pm 4.0	32.3	-0.9 (-1.3 to -0.5)‡	3.6 \pm 9.5	-0.07 (-0.10 to -0.04)‡	11,019 \pm 20,509	-164 (-238 to -91)‡
ARBs	1,724 (12.0)	5.9 \pm 3.8	31.3	-1.3 (-2.0 to 0.6)‡	3.6 \pm 9.7	-0.12 (-0.16 to -0.07)‡	11,592 \pm 20,992	-159 (-284 to -34)†
Statins	4,641 (32.4)	6.0 \pm 3.8	29.5	-0.5 (-0.9 to -0.04)†	3.1 \pm 9.1	-0.05 (-0.09 to -0.02)§	10,396 \pm 19,847	-107 (-193 to -21)†
Other lipid-lowering agents	936 (6.5)	5.3 \pm 3.8	28.3	—¶	2.7 \pm 8.0	-0.07 (-0.14 to 0.00)	9,828 \pm 20,012	-48 (-204 to 108)

* Includes metformin and sulfonylureas. †P < 0.05, significant difference; ‡P < 0.001, significant difference; §P < 0.01, significant difference; ¶P < 0.001, significant difference. ||Includes thiazolidinediones, meglitinides, and α -glucosidase inhibitors. ††Estimate failed to converge.

per drug fill measured in 2006 dollars. The average unit cost of an older oral antidiabetes agent was \$49 (in constant 2006 dollars) for our study sample or \$22 less than the estimated saving associated with an additional fill. For ACE inhibitors and ARBs, the estimated unit costs were \$58 and \$71, significantly lower than the estimated Medicare savings per fill of \$154 and \$159, respectively.

CONCLUSIONS— We find consistent evidence that more persistent use of older oral antidiabetes drugs, ACE inhibitors, ARBs, and statins is associated with reduced hospitalization and lower spending for traditional Medicare services by beneficiaries with diabetes. These findings are consistent with previous research showing that underuse of these agents is associated with greater risk of hospitalization and higher medical costs for individuals with diabetes (5,7–9,15). The study results suggest a case for promoting greater use of drugs with approved indications by Medicare beneficiaries with diabetes; however, additional research is needed to corroborate the study's cross-sectional findings.

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