The Impact of Medicare Part D on Medication Adherence Among Older Adults Enrolled in Medicare-Advantage Products

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Background: Little is known about how Medicare Part D affects the medication refill adherence for cardiovascular and diabetes medications, particularly among beneficiaries without prior drug coverage.
Objectives: To evaluate Medicare Part D's effect on medication adherence among beneficiaries with hyperlipidemia, hypertension, and/or diabetes enrolled in Medicare Advantage products.
Research Design: We used a quasi-experimental pre-post design, with 3 treatment groups and a comparison group, to assess the effect of Part D on several measures of adherence to prescription medications.
Subjects: Adults aged 65 or older with hyperlipidemia, hypertension, and/or diabetes in 2003 continuously enrolled between 2004 and 2007 in a large Pennsylvania insurer's Medicare Advantage products.
Measures: Medication possession ratios (MPR), good adherence with MPR >0.8, and intensity of treatment measured by average daily counts of pills per day of treatment.
Results: Part D improved MPRs in the group without prior drug coverage by 13.4 percentage points (95% CI, 10.1–16.8), 17.9 (95% CI, 13.7–22.1), and 13.5 (95% CI, 11.5–15.5) for those with hyperlipidemia, diabetes, and hypertension, respectively. Adherence improved less in the other 2 groups with limited prior drug benefits. Although the proportion of beneficiaries in the intervention groups who attained good adherence levels increased after Part D, less than 50%, 68%, and 78% of beneficiaries with hyperlipidemia, diabetes, and hypertension, respectively, attained good adherence.
Conclusion: Part D increased adherence to medications that reduce the risk of cardiovascular events for patients with hypertension, diabetes, and hyperlipidemia. This should improve the health of the elderly people in the long run.

Key Words: medication adherence, pharmacy benefit design, Medicare Part D

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Medicare Part D, which offers prescription drug coverage for Medicare beneficiaries, took effect January 1, 2006. Its primary goals were to reduce the burden of high drug costs on the elderly people and to reduce underuse of medication due to cost. Before Part D over a quarter of elderly patients reported cost-related nonadherence to medication treatment (ie, failing to fill their prescriptions or skipping or reducing doses of medications).[1] Cost-related nonadherence to pharmacotherapy among the elderly patients has been shown to lead to higher rates of hospitalization, emergency department use, and mortality.[2–4]

Although results from trials showing the effectiveness of therapy for chronic conditions strongly suggest that better adherence improves health, a substantial proportion of individuals with chronic diseases do not adhere to their prescribed regimen.[5–8] Even among patients with hypertension or hyperlipidemia, who could benefit from treatment, more than half the patients who initiate treatment discontinue medication use within the first year.[9–11] Previous studies found that Part D raised overall spending on pharmaceuticals and reduced out-of-pocket spending.[12–16] To date, however,

only one study has examined changes in adherence subsequent to Part D's implementation.[17] Madden et al, using data from Medicare Current Beneficiary Survey, found that rates of self-reported cost-related medication nonadherence fell from 14.1% in 2005 to 11.5% in 2006 among beneficiaries overall with no change among those in fair or poor health. However, that study lacked information on prescription drug coverage and did not report results by clinical condition.

In this article, we evaluate the effect of Part D on medication refill adherence for essential medicines used to treat or prevent cardiovascular disease and/or diabetes. We hypothesize that Part D will improve adherence measures for these conditions and that the degree of improvement will be related to the change in the level of drug coverage. We focus on patients with 3 chronic diseases—hyperlipidemia, diabetes, and hypertension—because the effectiveness of medications for these diseases has been established through clinical trials.[5,18–20]

METHODS

Setting

We compared the changes in prescription refill adherence 2 years before and after the implementation of Part D in 3 intervention groups, adjusting for secular trends using a comparison group whose coverage did not change with the implementation of Part D. All 4 groups were enrolled in Medicare Advantage products, offered by a large insurer in Pennsylvania, which cover both medical services and prescription drugs. Throughout the study period, 2004 through 2007, the medical benefit remained unchanged across all 4 groups, but the drug benefit improved post-Part D in the 3 intervention groups.

Prior to Part D, 1 of the 3 intervention groups had no drug coverage ("no-coverage group"); a second group had relatively poor drug coverage with a $150 quarterly cap (or a maximum of $600 per year) in plan payment ("$150-cap group"), and the third group had relatively good coverage with a $350 quarterly cap ("$350-cap group"). The level of drug coverage pre-Part D in the latter 2 groups depended only on members' county of residence (ie, the insurer only offered one plan per county). This mitigates selection bias. Prior to Part D the $150-cap and $350-cap groups paid an $8 or $20 copayment before their total pharmacy spending reached the quarterly cap, and paid full drug costs after reaching the cap level per quarter.

In January 2006, all members in the 3 intervention groups switched to Part D products. The standard Part D benefit in 2006 included a $250 deductible, 25% coinsurance before drug spending reaches $2250, a coverage gap for drug spending between $2250 and $5100, and a 5% coinsurance in the catastrophic coverage period for drug spending more than $5100 or out-of-pocket drug spending over $3600. However, Part D plans were permitted to offer a benefit actuarially equivalent to the standard benefit or better; and many plans modified the benefit by eliminating the deductible and substituting copayments for coinsurance. The beneficiaries in the 3 intervention groups did not have a deductible; faced tiered copayments ($8/$20 generic/brand) rather than 25% coinsurance; and could, for a higher premium, add coverage of generic drugs in the coverage gap (70% in our sample chose the plan that covered generics versus 63% at the national level, a proportion that was comparable across the 3 intervention groups).[21]

Throughout the study period the comparison group, which was covered by retiree health benefits, had no deductible and faced copayments of $10/$20 per monthly prescription irrespective of their total drug spending. Selection into this group should be minimal because coverage depended on whether members' former employers offered it, and few people declined such coverage because it was almost always more generous than Part D coverage.

Data Source and Population

We obtained enrollment and pharmacy and medical claims on a 40% random sample of de-identified individuals who were enrolled with the insurer between January 2003 and December 2007. The insurer provided us with a random sample since its policy is to provide researchers with the minimal data necessary to complete the study aims. Our study population included individuals (1) who had at least 2 claims with a diagnosis for one or more of the selected chronic diseases in 2003 (hypertension [ICD-9 401, 402, 403, 404], hyperlipidemia [ICD-9 272.0–272.4], and diabetes [ICD-9 250]) and who filled at least one prescription in 2003 for a medication for the diagnosed condition (Web Supplementary Table 1, online only, Supplemental Digital Content 1, available at: http://links.lww.com/MLR/A73; for diabetes we only focus on oral antidiabetic medications), and (2) who were continuously enrolled between 2004 and 2007, 24 months before and 24 months after the implementation of Part D.

Outcome Measures

We examined 3 outcome measures related to medication use a continuous Medication Possession Ratio (MPR), a categorical measure of good adherence, and a measure of treatment intensity.

The Medication Possession Ratio

The MPR is the proportion of days during a given year that a subject had possession of any drugs used to treat the chronic illness. For these conditions, most patients prescribed a medication that they will need to continue taking it to obtain clinical benefit. Since the study sample included only existing medication users (from 2003), MPR measures are more appropriate than the alternative of days covered starting from the first prescription filled in the year. For example, if a patient filled their first antihypertensive prescription on February 1, 2005 and continuously refilled for the rest of 2005, our MPR for hypertension for 2005 is 334/365 = 91.5. The alternative MPR measure starting from the first prescription filled in the year would yield an MPR = 1.

Good Medication Adherence

We used an indicator for MPR $\geq$0.80 as a measure of good adherence. This measure has been validated and has been shown to lead to better control of chronic conditions.[6]

TABLE 1. Characteristics of the Study Population*

Variable	Intervention Groups			Comparison Group
	No Coverage	$150 Cap	$350 Cap	No Cap
Hyperlipidemia (N = 9185)	N = 418	N = 647	N = 5093	N = 3027
Female sex (%)	68.4	65.4	61.5	50.9
Age (%)				
65–74 yr	40.2	52.4	54.7	62
75–84 yr	53.6	41.1	40.3	34.3
≥85 yr	6.2	6.5	5	3.7
Median income				
Among 65–74 yr ($)	26,440 (261)	25,865 (153)	28,782 (92)	28,948 (118)
Among ≥75 yr ($)	19,798 (200)	19,124 (123)	20,796 (63)	20,992 (79)
Proportion of white beneficiaries	92.3	96.0†	92	92.2
Proportion of living in urban areas	72.1†	60.5†	80	80.2
Prospective risk score,‡ mean (SE)				
2004	1.00 (0.038)	0.90 (0.028)	0.92 (0.010)	0.96 (0.015)
2005	1.07 (0.039)	0.95 (0.027)	0.98 (0.011)	1.05 (0.017)
Use of medical services in 2005				
Emergency-department visit (%)	31.1†	21.6	25.8	25.2
Hospitalization (%)	19.6	14.5	18.6	18.7
Outpatient visit (number)	28 (1)	26 (1)	26 (0)	29 (1)
Outpatient cost ($)	3584 (245)	3527 (235)	3926 (80)	4418 (128)
Nondrug medical cost ($)	5947 (521)	5601 (425)	6390 (161)	7124 (253)
Diabetes (N = 4018)	N = 247	N = 304	N = 2214	N = 1253
Female sex (%)	60.3	58.2	56.7	47.6
Age (%)				
65–74 yr	41.3	50	54	60.7
75–84 yr	49.8	42.8	39.7	34.9
≥85 yr	8.9	7.2	6.3	4.5
Median income				
Among 65–74 yr ($)	26,740 (361)	25,713 (207)	27,854 (130)	28,611 (178)
Among ≥75 yr ($)	19,968 (260)	19,024 (167)	20,290 (92)	20,642 (113)
Proportion of white beneficiaries	92.8	96.2†	92.1	91.5
Proportion of living in urban areas	74.1	58.5†	77.5	77.6
Prospective risk score,† mean (SE)				
2004	1.27 (0.064)	1.28 (0.052)	1.22 (0.020)	1.30 (0.030)
2005	1.44 (0.062)	1.42 (0.063)	1.34 (0.022)	1.42 (0.034)
Use of medical services in 2005				
Emergency-department visit (%)	33.2†	26.6	30.3	29.4
Hospitalization (%)	21.1	20.4	22.8	22.3
Outpatient visit (number)	32 (2)	34 (2)	31 (1)	35 (1)
Outpatient cost ($)	4536 (462)	4461 (461)	4546 (141)	5169 (246)
Nondrug medical cost ($)	7203 (806)	7925 (951)	7876 (291)	8781 (487)
Hypertension (N = 14,735)	N = 980	N = 1234	N = 8380	N = 4141
Female sex (%)	69.3	66.4	64.7	53.8†
Age (%)				
65–74 yr	37.3	44.7	48.1	55.9†
75–84 yr	48.6	44.6	42.5	37.9†
≥85 yr	14.1	10.8	9.4	6.2†
Median income				
Among 65–74 yr ($)	26,940 ± 182	25,784 (107)	28,427 (71)	28,688 (100)
Among ≥75 yr ($)	19,868 ± 128	19,168 (89)	20,563 (47)	20,875 (67)

(*Continued*)

TABLE 1. (*Continued*)

Variable	Intervention Groups			Comparison Group
	No Coverage	$150 Cap	$350 Cap	No Cap
Proportion of white beneficiaries	91.6	96.0†	91.6	91.7
Proportion of living in urban areas	75.4	57.9†	79.7	80.3
Prospective risk score,‡ mean (SE)				
2004	1.00 (0.025)	0.98 (0.024)	0.99 (0.009)	1.00 (0.014)
2005	1.12 (0.028)	1.09 (0.027)	1.07 (0.010)	1.10 (0.015)
Use of medical services in 2005				
Emergency-department visit (%)	32.7†	25.4	28.9	27.3
Hospitalization (%)	21.1	18.6	20.7	19.5
Outpatient visit (number)	27† (1)	28 (1)	29 (0)	30 (0)
Outpatient cost ($)	3853† (176)	3865† (210)	4176 (75)	4513 (116)
Nondrug medical cost ($)	6498 (347)	6585 (375)	7061 (141)	7406 (225)

*These numbers are unweighted raw data. Beneficiaries who had more than one of the 3 diseases were included in each disease. Standard errors (SE) are in the parenthesis for each continuous variable.

†$P < 0.05$. If $P < 0.05$ is indicated for the comparison group, it means the variable is statistically significant difference between each intervention group and the comparison group. If $P < 0.05$ is indicated for an intervention group, it means for that particular intervention group compared with the comparison group. We used χ^2 tests for categorical variables and 1-way analysis of variance (ANOVA) test for continuous variables. Some percentages do not sum up to one because of rounding effects.

‡Prospective risk scores were calculated with the use of an algorithm that is described in the text, with higher scores indicating greater expected future medical spending.

Treatment Intensity

Although our MPR and adherence measures indicate whether patients are persistent on medications they have already started, problems with medication adherence can also result in patients not filling prescriptions for a new medication if their physician intensifies their treatment regimen. In that case, drug coverage can make it easier for patients to fill new prescriptions and lead to greater intensity of treatment. More than one medication (either in the same or different drug subclasses) is often needed to control hypertension and diabetes. For instance, more than two-thirds of patients with hypertension require more than one medication to achieve adequate control,[22] and combinations of low-dose drug treatments increase efficacy and reduce adverse events.[23] Recent American Diabetes Association guidelines promote combination therapy for diabetes care.[24,25] Multidrug therapy for hyperlipidemia is less common.

To measure the intensity of treatment for the disease in a year, we calculated the average number of pills per day during which a patient was receiving medication treatment for the disease in a year. If a patient with hypertension started with an angiotensin-converting enzyme inhibitor on January 1, 2007 and switched to an Angiotensin II Receptor Blockers (ARB) on July 1, 2007 and continued to take the ARB through December 31, 2007 then the intensity measure is 1 for 2007. If the patient started with a beta-blocker on January 1, 2007 and added an ARB on July 1, 2007, then the intensity measure is 1.5. Thus the intensity measure increases with augmentation but not switching across subclasses.

Statistical Analysis

Although we believe there was little selection with respect to the group to which a beneficiary belonged, we used propensity score weighting to balance each intervention group with the comparison group. Propensity score weighting effectively gives higher weight to those in each intervention group with characteristics similar to those in the comparison group and lower weight to others.[26–29]

To calculate propensity scores, we used 3 logistic regression models to estimate the probability of being in each intervention group instead of the comparison group based on (1) zip code level information such as income, race, poverty rate, proportion of seniors residing in the zip code, and (2) individual-level characteristics such as age (65–74, 75–84, and >85), gender, and annual prospective risk scores during the baseline years (2004 and 2005). The risk scores are calculated using Risk Grouper Software from Veriskhealth(r) (Waltham MA). The software uses a series of proprietary algorithms to generate risk scores based on each member's ICD-9 diagnoses and/or Healthcare Common Procedure Coding System codes reported on claims. The resulting scores are similar to The Centers for Medicare & Medicaid Services - Hierarchical Condition Categories (CMS-HCC) weights used to adjust Medicare Advantage plan payments, with higher scores indicating worse health status and greater expected future medical spending.[30] After estimating each enrollee's probability of being in each intervention group instead of the comparison group, we assigned a weight to each observation proportional to the estimated probability of his/her being in the other group than that to which they actually belonged.[26–29]

In our full analytical models, we applied these inverse weights and included as covariates the observables used to calculate propensity scores.[31] In addition, we created the following 3 independent variables: (1) an indicator for each intervention group (no-coverage, $150-cap, and $350-cap); (2) a post-Part D indicator, which was 1 after January 1, 2006, when all members in the intervention groups switched to Part D; and (3) their interaction terms. The effect of interest ("Multivariate 2-year Part D Effect") is measured by the interaction terms; they capture the pre-post changes in outcome measures in each

TABLE 2. The Impact of Medicare Part D on Medication Possession Ratios Expressed as a Percent

	Unadjusted*		Multivariate 2-Year Part D Effect†		% Change, Estimated Effects/Pre Value	
	Pre	Post	Estimate	(95% CI)	%	(95% CI)
Hyperlipidemia						
Comparison						
No cap	74.4	73.0	Ref			
Intervention groups						
No coverage	47.3	59.9	13.4	(10.1, 16.8)	28.5	(21.4, 35.8)
$150 cap	57.6	63.3	7.3	(4.8, 9.8)	12.6	(8.3, 17.0)
$350 cap	62.3	65.1	4.4	(3.3, 5.6)	7.1	(5.3, 9.1)
Diabetes						
Comparison						
No cap	81.8	78.2	Ref			
Intervention groups						
No coverage	57	69.6	17.9	(13.7, 22.1)	31.4	(24.0, 38.8)
$150 cap	77.3	76.2	4.5	(1.0, 7.9)	5.8	(1.3, 10.3)
$350 cap	75.4	73.3	3.6	(1.8, 5.3)	4.8	(2.4, 7.1)
Hypertension						
Comparison						
No cap	85.1	84.0	Ref			
Intervention groups						
No coverage	62.4	75.2	13.5	(11.5, 15.5)	21.8	(18.6, 25.0)
$150 cap	81.1	82.6	2.6	(1.2, 4.1)	3.2	(1.5, 5.0)
$350 cap	82.7	83.7	2.5	(1.7, 3.2)	3.0	(2.0, 3.9)

All estimates are significant at $P < 0.05$.

*Pre and Post comparison are unadjusted raw numbers.

†"Multivariate 2-yr Part D Effects" are adjusted difference-in-difference estimates from GEE regression models with propensity score weighting. "Multivariate 2-year Part D Effects" measure changes in outcomes 2-year pre- and post-Part D in each intervention group, relative to the changes in outcomes in the comparison group.

There were 926 members with federal low-income subsidies under Part D benefit in the intervention groups. We did sensitivity analysis by excluding these individuals; the results of Part D effects reduced slightly (see Web Supplementary Table 2, online only). Thus, the effects demonstrated in this Table were not driven by a few individuals with low-income subsidies.

Appendix Table 3 (online only) reports results from full models with all other covariates included.

intervention group, adjusted for the pre-post changes in the comparison group.

We used general estimating equations to adjust for correlations across 4 years of repeated measures within individuals.[32,33] We used generalized linear models to estimate the effect of Part D on MPR measures, and intensity of medication treatment measured by counts of average daily medication use.[34–37] We used a logistic regression to estimate Part D's effect on the likelihood of good medication adherence.[38]

All reported *P* values are 2-sided. We conducted all analyses using SAS software, version 9.2 (SAS Institute Inc, Cary, NC).

RESULTS

Background Characteristics of Study Population

There were 14,965 elderly beneficiaries in the 3 intervention groups and 5924 in the comparison group. Table 1 shows sample sizes as well as baseline characteristics (unweighted) for each disease and drug coverage group. Members in the comparison group were more likely to be male and younger than the intervention groups; this reflects the population with employer-supplemented benefits. However, there was no difference across the groups with respect to the prospective risk scores, rates of hospitalization, outpatient costs, and total medical costs. Higher proportions of individuals in the $150-cap group were white and live in rural areas, compared with the other groups. There were no differences in zip code level median income across 4 groups.

Effects of Medicare Part D on Medication Compliance

The Medication Possession Ratio

Table 2 presents unadjusted (raw) differences in MPR (multiplied by 100) pre- and post-Part D in each group, as well as the effect of Part D after propensity score weighting ("Multivariate 2-year Part D Effects"). Even for the unadjusted raw data, MPR measures in all 3 intervention groups increased post- Part D, whereas MPR measures pre- and post-Part D across the 3 conditions were relatively stable in the comparison group.

Before the implementation of Part D, there was a positive association between the generosity of drug coverage and the MPRs for any lipid-lowering medication among beneficiaries with hyperlipidemia, increasing from 47.3% of days covered among patients without drug coverage to 57.6% in the $150-cap, 62.3% in the $350-cap, and 74.4% in the comparison group.

After adjusting for covariates and weights, the increase in adherence due to Part D enrollment was greatest in the no Coverage group, 13.4 percentage points (95% confidence interval [CI], 10.1–16.8), a 28.5% increase from prelevel of 47.3. The MPR increased 7.3 percentage points (95% CI, 4.8–9.8) in the $150-cap group, a 12.6% increase and 4.4 percentage points (95% CI, 3.3–5.6) in the $350-cap group, a 7.1% increase.

The findings for oral antidiabetic medications differed slightly. As with hyperlipidemia, prior to Part D, the MPRs were lowest in the no coverage group and highest in the comparison group, but the MPRs in the $150-cap group were slightly higher than those in the $350-cap group. The estimated effects of Part D, however, were similar to those for hyperlipidemia. Relative to the comparison group where the MPRs decreased slightly, the absolute levels of MPRs increased most in the no Coverage group, 17.9 percentage points (95% CI, 13.7–22.1), with increases of 4.5 (95% CI, 1.0–7.9) and 3.6 percentage points (95% CI, 1.8–5.3) in the $150- and $350-cap groups, respectively.

Pre-Part D, the MPRs for any antihypertensive drug increased with coverage from 62.4% days covered in the No Coverage group to 81.1 in the $150-cap group, 82.7 in the $350-cap group, and 85.1 in the comparison group. The MPR in the comparison group did not change after introduction of part D. As with the other 2 diseases, the increase in the MPR for antihypertensives was the greatest for the no Coverage group, 13.5 percentage points (95% CI, 11.5–15.5).

TABLE 3. The Impact of Medicare Part D on Likelihood of Good Medication Adherence (Proportion of Patients With MPR ≥0.8)

	Unadjusted*		Multivariate 2-Year Part D Effect†	
	Pre	Post	Odds Ratio	(95% CI)
Hyperlipidemia				
Comparison				
No cap	57.4	61.3	1.00	
Intervention groups				
No coverage	27.5	43.9	1.67	(1.35, 2.07)
$150 cap	39.2	48.2	1.22	(1.04, 1.43)
$350 cap	42.1	49.3	1.14	(1.06, 1.24)
Diabetes				
Comparison				
No cap	70.6	66.6	1.00	
Intervention groups				
No coverage	39.7	57.2	2.36	(1.81, 3.08)
$150 cap	68.0	67.1	1.17	(0.9, 1.51)
$350 cap	62	61.9	1.21	(1.06, 1.39)
Hypertension				
Comparison				
No cap	78.4	78.5	1.00	
Intervention groups				
No coverage	47	66.6	2.09	(1.82, 2.4)
$150 cap	73.3	76.6	1.13	(0.99, 1.29)
$350 cap	74.9	77.4	1.14	(1.05, 1.23)

*Pre and Post comparison are unadjusted proportions of MPR ≥0.80.

†Multivariate 2-year Part D Effects are adjusted difference-in-difference estimates from logistic regression models with propensity score weighting. Multivariate 2-year Part D Effects measure changes in outcomes pre- and post-Part D in each intervention group, relative to the changes in outcomes in the comparison group.

Appendix Table 4 (online only) reports results from full models with all other covariates included.

Likelihood of Good Adherence

Table 3 displays Part D's effect on the categorical adherence measure MPR ≥0.80. The results are similar to those for the MPRs with the exception of patients in the $150-cap group with diabetes or hypertension who show no statistically significant effect. Although the proportion of beneficiaries in the intervention groups who attained good adherence increased after Part D, there was still ample room for further improvement. Among all 3 intervention groups, fewer that 50% of beneficiaries with hyperlipidemia attained good adherence; less than 68% of beneficiaries with diabetes attained good adherence, and less than 78% of beneficiaries with hypertension attained good adherence.

Treatment Intensity

Table 4 presents the unadjusted differences in intensity measures (average count of pills per day of treatment) pre- and post-Part D as well as the "Multivariate Part D Effects." Among people with diabetes the intensity measure in the comparison group pre-Part D was 1.29, implying that patients were on about 1.5 oral antidiabetic medications on average (1.5 is approximately equal to 1.29/0.82; 0.82 indicates 82% of the days in a year were covered by any antidiabetic oral medications as shown in Table 2); pre-Part D patients with hypertension on average were on 1.9 antihypertensive medications (1.9 is approximately equal to 1.65/0.85). For those with diabetes and/or hypertension prior to Part D, the intensity of medication was always lowest for the No Coverage group and highest for the comparison group. Relative to the comparison group, intensity increased significantly in all 3 intervention groups for both conditions, with the greatest increase in the no Coverage group. For hypertension, Part D was associated with an increase of 0.22 (95% CI, 0.16–0.28) antihypertensive pills taken per day of treatment, a 17.6% increase compared with the pre-Part D intensity measure (Table 4).

DISCUSSION

We found that Medicare Part D was associated with improved medication adherence and increased treatment intensity for patients with hyperlipidemia, hypertension, and/or diabetes, conditions that impose a high burden of disease on the elderly patients and for which adherence levels are suboptimal. We also found that more generous coverage in-

TABLE 4. The Impact of Medicare Part D on Treatment Intensity

	Unadjusted*		Multivariate 2-Year Part D Effect†		% Change, Estimated Effects/Pre Value	
	Pre	Post	Estimate	(95% CI)	%	(95% CI)
Diabetes						
Comparison						
No cap	1.29	1.34				
Intervention groups						
No coverage	0.98	1.16	0.184	(0.1, 0.27)	18.8	(10.4, 27.2)
$150 cap	1.12	1.26	0.095	(0.03, 0.16)	8.5	(2.50, 14.4)
$350 cap	1.11	1.18	0.02	(−0.01, 0.05)	1.8	(−1.2, 4.8)
Hypertension						
Comparison						
No cap	1.65	1.75				
Intervention groups						
No coverage	1.26	1.56	0.221	(0.16, 0.28)	17.6	(13.0, 22.1)
$150 cap	1.48	1.63	0.054	(0.02, 0.09)	3.7	(1.1, 6.2)
$350 cap	1.52	1.64	0.028	(0.01, 0.05)	1.8	(0.4, 3.3)

All estimates are significant at $P < 0.05$.

*Pre and Post comparison are unadjusted raw numbers.

†Multivariate 2-year Part D Effects are adjusted difference-in-difference estimates from GEE regression models with propensity score weighting. Multivariate 2-year Part D Effects measure changes in outcomes pre-2-year and post-2-year Part D in each intervention group, relative to the changes in outcomes in the comparison group.

Appendix Table 5 (online only) reports results from full models with all other covariates included.

creased the intensity of medication treatment among beneficiaries using cardiovascular and/or diabetes medications.

Medication compliance improved post-Part D, with the degree of improvement dependent on beneficiaries' prior drug coverage. Not surprisingly, members without prior drug coverage showed the largest improvement. There was only limited improvement in adherence in the $350-cap group, consistent with the Part D benefit being only slightly better on an actuarial basis than the $350 quarterly capped benefit except for the small minority of patients who reach the catastrophic coverage region ($5100 in total drug spending).

Our findings on improvements in compliance are consistent with those of earlier studies that examined changes in compliance in response to price changes, except for members in the $150-cap group with hypertension and diabetes. Actuarially the benefit in this group more than doubled post-Part D, but the number of antihypertensive and antidiabetic prescriptions filled only improved by 12% and 8%, respectively. This is at the lower bound of previous literature on medication use in response to price changes.[39–41]

Although adherence improved with Part D, overall levels of adherence remained suboptimal even among those beneficiaries with the best coverage (the comparison group). Thus, although the price that the beneficiaries must pay for their drugs is an important determinant of adherence, it is not the only factor. Other things such as adequate follow-up, a patient's perception of the benefit of treatment, provider-patient relationships, comorbid conditions especially mental health problems are also key predictors of poor adherence.[6]

The magnitude of the improvement in adherence due to the drug benefit was similar across the 3 medication classes we studied, consistent with previous research, which found that patients' use of essential medications that prolong life and prevent complications is no less sensitive to changes in price than use of other drugs.[39,42,43]

Our study is subject to certain limitations. First, like most research using claims data, we lack accurate data on household income. However, our quasi-experimental design controls for any time invariant effects of income. Moreover, we used zip code level income in estimating the propensity score and balancing the study groups. Moreover, our Medicare Advantage population has few individuals who enrolled in the federal low-income subsidy program and our sensitivity analysis, which excluded these 926 individuals, yielded similar results (Supplementary Table 2, online only, Supplemental Digital Content 2, available at: http://links.lww.com/MLR/A74).

Second, because the individuals we studied were all enrolled in Medicare-Advantage Part D plans, the results might not generalize to beneficiaries enrolled in stand-alone Part D plans. In February 2009, 9 million beneficiaries were enrolled in Medicare Advantage Part D and 17.5 were enrolled in stand-alone Part D plans. Third, we obtained data year by year as recent data became available; we only had post-Part D data for those who were in the network in previous years. Thus, we focused our analyses on those who were continuously enrolled and did not die during the entire study period. This is a cleaner design, but it might undermine the generalizability to the overall population where people enter and leave plans and die. Fourth, our results are based on drugs purchased at network pharmacies, but we believe any bias from missing claims is negligible for several reasons. Previous studies have shown that prescription refill rates are an accurate measure of adherence in a closed pharmacy

system such as the health plan we studied, provided the refills are measured at several points in time, as was the case here.[44,45] For the period in which beneficiaries paid entirely out-of-pocket (the pre-Part D period for those with no coverage or who had spending above the $150 or $350 caps, and the donut hole for the 3 intervention groups in the post period) those using a network pharmacy received a 15% discount from the plan's negotiated prices, which were typically well below a retail price. And network pharmacies were numerous (around 58,000 nationwide) and covered almost all local pharmacies. We would not, however, have captured drugs filled through the Veteran's Administration healthcare system or $4 generic drugs filled at Wal-Mart or other retail pharmacies if pharmacies did not report them to the insurance company. Fifth, we used propensity score weighting to enhance comparability of plans, but it does not eliminate selection effects due to unobserved and unmeasured variables. Selection across plans, however, should be minimal because in each county only one type of plan was available.

In sum, the improvement in medication adherence among those with chronic illnesses that Part D brought about strengthens the case that Part D is achieving its intended goal of improving access to care and potentially health outcomes. The clinical effectiveness of medications for hypertension, diabetes, and hyperlipidemia is well established from clinical trials. However, prior research has documented that many patients with these 3 conditions are not adequately treated. Given this widespread under-treatment, the clinical implications of increased adherence are significant, especially among those previously lacking drug coverage. We expect that in the long run increased adherence and more intense treatment will lead to lower hospital and physician spending that will partially offset the higher drug costs for those with these diseases.[12,46–48] Studies with longer term follow-up of Medicare part D beneficiaries will be needed to establish whether these cost savings are eventually realized.

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