

SPECIAL ARTICLE

The Effect of Medicare Part D on Drug and Medical Spending

Yuting Zhang, Ph.D., Julie M. Donohue, Ph.D., Judith R. Lave, Ph.D.,
Gerald O'Donnell, M.S., and Joseph P. Newhouse, Ph.D.

ABSTRACT

BACKGROUND

It is not known what effect the increased use of prescription drugs by enrollees in Medicare Part D has had on spending for other medical care.

METHODS

We compared spending for prescription drugs and other medical care 2 years before the implementation of Part D in January 2006 with such expenditures 2 years after the program's implementation in four groups of elderly beneficiaries: Medicare Advantage enrollees with stable, uncapped, employer-based drug coverage throughout the study period (no-cap group), those who had no previous drug coverage, and those who had previous limited benefits (with either a \$150 or a \$350 quarterly cap) before they were covered by Part D in 2006.

RESULTS

Between December 2005 and December 2007, as compared with the increase in the no-cap group, the increase in total monthly drug spending was \$41 higher (95% confidence interval [CI], \$33 to \$50) (74%) among enrollees with no previous drug coverage, \$27 higher (95% CI, \$20 to \$34) (27%) among those with a previous \$150 quarterly cap, and \$13 higher (95% CI, \$8 to \$18) (11%) among those with a previous \$350 cap. The use of both lipid-lowering and antidiabetic medications rose in the groups with no or minimal previous drug coverage. As compared with expenditures in the no-cap group, monthly medical expenditures (excluding drugs) were \$33 lower (95% CI, \$29 to \$37) in the group with no previous coverage and \$46 lower (95% CI, \$29 to \$63) in the group with a previous \$150 quarterly cap, whereas medical spending was \$30 higher (95% CI, \$25 to \$36) in the group with a previous \$350 cap.

CONCLUSIONS

Enrollment in Medicare Part D was associated with increased spending on prescription drugs. Groups that had no or minimal drug coverage before the implementation of Part D had reductions in other medical spending that approximately offset the increased spending on drugs, but medical spending increased in the group that had more generous previous coverage.

From the Department of Health Policy and Management, Graduate School of Public Health, University of Pittsburgh (Y.Z., J.M.D., J.R.L.); and Highmark (G.O.) — both in Pittsburgh; the Department of Health Care Policy, Harvard Medical School, and the Department of Health Policy and Management, Harvard School of Public Health — both in Boston (J.P.N.); and the Harvard Kennedy School, Harvard University, Cambridge, MA (J.P.N.). Address reprint requests to Dr. Donohue at the Department of Health Policy and Management, University of Pittsburgh, 130 De Soto St., Crabtree Hall 613, Pittsburgh, PA 15261, or at jdonohue@pitt.edu.

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THE MEDICARE PRESCRIPTION-DRUG BENEFIT (Part D), which was implemented in January 2006, was enacted to protect beneficiaries from ever-increasing drug expenditures and to reduce cost-related underuse of medications, thereby potentially improving the health of enrollees. Despite the likelihood of improved adherence to pharmacotherapy, the Congressional Budget Office (CBO), in estimating the program's cost, assumed that spending on medical care other than drugs would not decrease.¹ This assumption was based on conflicting evidence with respect to the relationship between increased medication use and total costs for medical care. Some earlier studies had shown that changes in pharmaceutical benefits not only affected prescription-drug use but also had offsetting effects on the use of inpatient and outpatient services.²⁻⁸ A few studies even projected that expanding coverage of certain medications would on balance save money.^{9,10} However, the CBO reasoned that if enrollees had better drug coverage, they might be more inclined to seek care. The agency also judged that increased use of prescription drugs could increase adverse drug events, causing greater use of health services.^{11,12} Because of the high cost of Part D, an estimated \$45.5 billion in 2008,¹³ and the potential implications for health outcomes, it is important to establish whether Part D results in any offsetting savings in Medicare's spending on charges by hospitals and physicians.

METHODS

STUDY DESIGN

We used Medicare's implementation of Part D as a quasirandom experiment among four groups of elderly beneficiaries who were continuously enrolled in Medicare Advantage plans offered by a large Pennsylvania insurer. The study design called for a time-series analysis with the use of a comparison group.¹⁴ Medicare enrollees in the comparison group had stable, uncapped drug coverage through their previous employer, which did not change after the implementation of Part D (no-cap group). They had copayments of \$10 to \$20 per monthly prescription, with no spending limits or coverage gaps.

The three intervention groups had no or limited coverage before the implementation of Part D and were enrolled as individuals in a Part D plan

in January 2006. One intervention group had no previous drug coverage, and the other two had drug benefits with quarterly expenditure caps on plan payments of \$150 and \$350, respectively, with a two-tiered system of copayments (\$12 for generic drugs and \$20 for brand-name drugs). The previous drug coverage of these three groups depended solely on their county of residence. Selection bias was therefore probably small.

Like most Part D plans nationally, no plan in this study included a deductible.¹⁵ Instead, members had two-tiered copayments (\$8 for generic drugs and \$20 for brand-name drugs in the groups with caps of \$150 or \$350 per quarter and \$10 for generic drugs and \$30 for brand-name drugs in the group previously without drug coverage) until their drug spending reached the coverage gap (\$2,250 in 2006 and \$2,400 in 2007). Members could choose a drug plan with no benefits in the coverage gap or one that covered generic drugs in the gap with a copayment of \$8 or \$10. Once members' annual drug spending reached the threshold for catastrophic coverage (\$5,100 in 2006 and \$5,451 in 2007), they paid 5% of the excess amount or a small copayment, whichever was higher. Medical benefits were similar in all four groups and did not change during the study period. The study design was approved by the institutional review board at the University of Pittsburgh.

DATA SOURCE AND POPULATION

We obtained deidentified data on enrollment, benefits, and claims from a random sample of 36,858 members (40% of 92,145) who were continuously enrolled in the Medicare Advantage plan from January 2003 through December 2007. We measured the use of prescription drugs and medical care 2 years before and 2 years after the implementation of Part D. We excluded 1756 members of the sample who were under the age of 65 years. Of the remaining 35,102 enrollees, 9487 (27%) were in the comparison (no-cap) group; the intervention groups comprised 3939 enrollees with no previous coverage (11%), 2662 with a \$150 quarterly cap (8%), and 19,014 with a \$350 quarterly cap (54%).

Members who had no previous drug coverage or who exceeded their quarterly coverage cap (and those reaching the coverage gap) had an incentive to fill prescriptions at contracted pharmacies because they received an average 15%

discount, as compared with the cost of filling prescriptions elsewhere. Moreover, for those with drug benefits, the plan paid only for prescriptions that were filled at contracted pharmacies both before and after the implementation of Part D.

OUTCOMES

We calculated expenditures for drugs and non-drug medical care per member per month. Expenditures included insurance payments plus copayments. We adjusted all monthly expenditure data for inflation from January 2004 through December 2007, using the pharmaceutical and medical care components of the Producer Price Index.¹⁶

We also measured prescription refills for two chronic conditions with a high disease burden for which medication has been shown to improve health outcomes: hyperlipidemia and diabetes mellitus.¹⁷⁻¹⁹ We identified patients who had submitted at least two claims with a diagnosis of

either hyperlipidemia or diabetes, according to criteria in the *International Classification of Diseases*, ninth edition (ICD-9), in 2003 and who had filled at least one prescription for an indicated medication in 2003. For these patients, we measured the number of prescriptions they had filled for oral medications that were used to treat these conditions per member per month from January 2004 through December 2007.

STATISTICAL ANALYSIS

To balance each of the three intervention groups with the comparison group, we used propensity-score weighting. In calculating propensity scores, we accounted for individual-level characteristics, including age group (65 to 74 years, 75 to 84 years, and ≥ 85 years), sex, and annual prospective risk scores during the baseline years (2004 and 2005). We used risk-grouper software involving a series of proprietary algorithms (DxCG) to gen-

Table 1. Characteristics of the Study Population.*

Variable	Intervention Groups			Comparison Group
	No Coverage (N=3939)	\$150 Cap (N=2662)	\$350 Cap (N=19,014)	No Cap (N=9487)
Female sex (%)	55.4	62.3	62.1	52.5
Age (%)				
65–74 yr	47.4	49.7	52.5	60.7
75–84 yr	44.3	40.6	39.3	34.1
≥ 85 yr	8.3	9.7	8.2	5.3
Diagnosed chronic condition (%)				
Hypertension	54.5	62.8	62.6	61.2
Hyperlipidemia	48.2	55.7	57	60.4
Diabetes	19.6	22.5	22.3	23.3
Prospective risk score [†]				
2004	0.83 \pm 0.01	0.85 \pm 0.01	0.86 \pm 0.01	0.84 \pm 0.01
2005	0.92 \pm 0.01	0.95 \pm 0.02	0.94 \pm 0.01	0.92 \pm 0.01
2006	1.03 \pm 0.02	1.04 \pm 0.02	1.04 \pm 0.01	1.03 \pm 0.01
2007	1.15 \pm 0.02	1.19 \pm 0.02	1.18 \pm 0.01	1.14 \pm 0.01
Use of medical services in 2005				
Emergency department visit (%)	26.8	24.1	25.9	24.4
Hospitalization (%)	18.5	16.8	18.3	17.1
Outpatient visit (no.)	23 \pm 0	25 \pm 1	25 \pm 0	26 \pm 0
Outpatient cost (\$)	3,498 \pm 93	3,533 \pm 124	3,741 \pm 47	3,869 \pm 66
Nondrug medical cost (\$)	6,000 \pm 187	5,838 \pm 227	6,209 \pm 88	6,267 \pm 130

* Plus-minus values are means \pm SE.

[†] 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.

erate risk scores on the basis of each member's ICD-9 diagnoses or Healthcare Common Procedure Coding System codes reported on claims. The resulting scores were similar to weights provided in the Hierarchical Condition Categories of the Centers for Medicare and Medicaid Services for adjustment of payments by the Medicare Advantage plan, reflecting the expected expenditures for each enrollee.²⁰

After estimating each enrollee's probability of being in the comparison group, we assigned a weight to each observation that was proportional to the estimated probability of the enrollee's assignment to the other group in the pairwise comparisons. This procedure effectively gave higher weight to enrollees in each intervention group who had characteristics similar to those of enrollees in the comparison group.²¹⁻²⁴ We then calculated weighted average monthly expenditures for drugs and medical care.

We used segmented time-series regression models to estimate the time trend of weighted spending for drugs and medical care in the different groups. In the case of drug spending, we compared spending and use in three intervals: before the implementation of Part D (January 1, 2004, to December 31, 2005), in the first year after the implementation of Part D (January 1, 2006, to December 31, 2006), and in the second year after the implementation of Part D (January 1, 2007, to December 31, 2007). We assumed that there could be an immediate increase in drug spending in January 2006 for the three intervention groups and that the monthly trend in drug spending in 2006 could differ from that in 2004 and 2005. We also assumed that the trend could differ between 2006 and 2007 because of initial issues during the implementation of Part D and unfamiliarity with the new system on the part of physicians and patients.

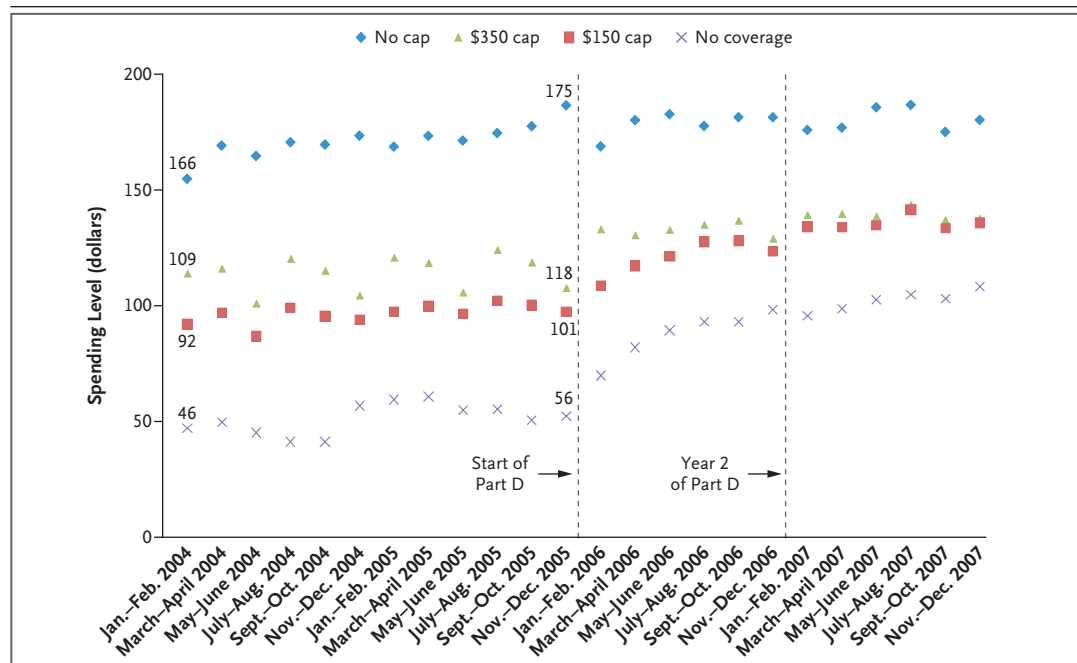


Figure 1. Time-Series Analysis of Monthly Drug Spending.

For graphic purposes, the data points show 2-month rather than monthly averages of spending after adjustment with propensity-score weighting. The data points for the no-cap group have been weighted with the use of propensity scores calculated in the comparison of the no-cap group with the no-coverage group. The dollar values are the predicted spending levels from a regression analysis of the monthly data after propensity-score weighting. After the implementation of Part D in 2006, spending in the no-coverage group jumped immediately by \$17 (95% CI, \$9 to \$25), as compared with the spending in the group without a cap on coverage (no-cap group). From December 2005 through December 2007, the average monthly drug spending in the no-coverage group increased by \$41 (95% CI, \$33 to \$50), as compared with that in the no-cap group; spending in the \$150-cap group increased by \$27 (95% CI, \$20 to \$34), and that in the \$350-cap group increased by \$13 (95% CI, \$4 to \$22).

As chronic conditions come under control, offsets in medical costs might be seen, but we did not know how quickly they would occur. We assumed for simplicity that any such offsets would begin immediately in January 2006 and would continue at a constant rate over the subsequent 2 years.

We tested for serial correlation by assuming a first-order autoregressive correlation structure. All reported P values are two-sided. We used SAS software, version 9.2, for estimation. All estimated equations are provided in the Supplementary Appendix, available with the full text of this article at NEJM.org.

RESULTS

STUDY POPULATION

Even before propensity-score weighting, the groups we studied were reasonably similar in their prospective risk scores. However, as compared with the other groups, the no-cap group was younger and more likely to be male. Hypertension and hyperlipidemia had been diagnosed in at least half the enrollees in all four groups, and diabetes had been diagnosed in 20% (Table 1).

EFFECTS ON DRUG SPENDING

The average monthly drug expenditure in the no-cap group was \$166 in January 2004. This amount increased by an average of \$0.39 per month (95% confidence interval [CI], \$0.26 to \$0.50) each month from 2004 through 2007 (Fig. 1). At the other extreme, members of the no-coverage group spent only about a quarter as much, \$46 per month, on medications in January 2004 but had approximately the same average monthly increase, \$0.40, before the implementation of Part D. After the implementation of Part D, however, this group's spending immediately jumped by \$17 (95% CI, \$9 to \$25), as compared with that in the no-cap group, representing a 31% increase over the change in the no-cap group in December 2005. From December 2005 through December 2007, the average monthly drug spending in the no-coverage group increased by \$41 (95% CI, \$33 to \$50), as compared with that in the no-cap group, which was a 74% increase over the December 2005 spending.

Members of the \$150-cap group and the \$350-cap group spent \$92 and \$109, respectively, on drugs in January 2004 (Fig. 1). Before the implementation of Part D, both groups had rates of

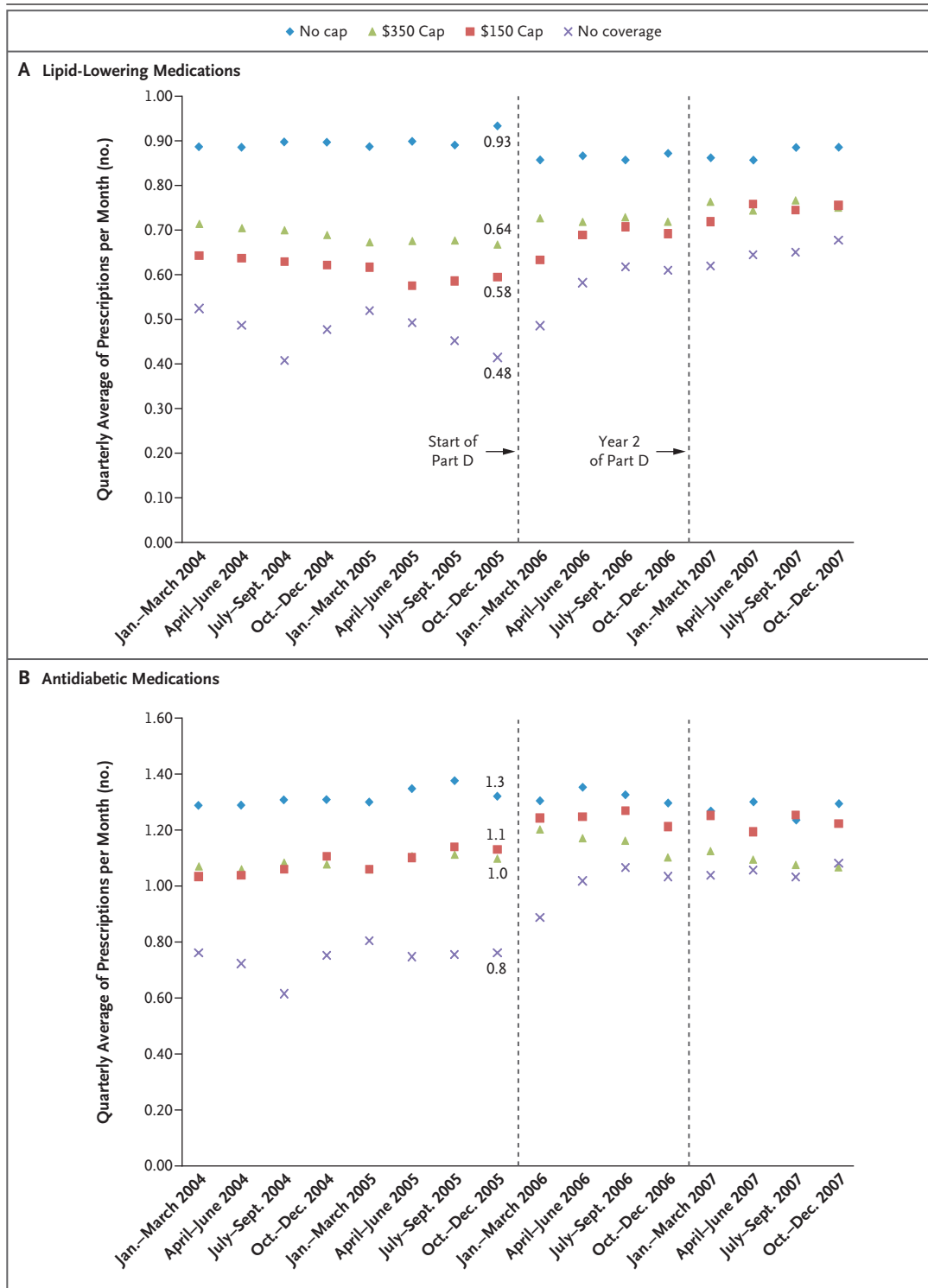
Figure 2 (facing page). Effect of Implementation of Part D on the Use of Lipid-Lowering and Antidiabetic Drugs.

The data points represent the quarterly averages of the number of prescriptions that were filled per month from January 2004 through December 2007 for 10,285 patients with hyperlipidemia (Panel A) and 4778 patients with diabetes (Panel B). The numbers in the center of the panels denote the estimated numbers of monthly prescriptions in December 2005, before the implementation of Part D. During the next 2 years, the number of monthly prescriptions for lipid-lowering drugs in the no-coverage group increased by 0.21 (95% CI, 0.15 to 0.27), as compared with that among Medicare enrollees who had no cap on their coverage (no-cap group); the number of prescriptions in the \$150-cap group increased by 0.18 (95% CI, 0.13 to 0.23), and those in the \$350-cap group increased by 0.11 (95% CI, 0.05 to 0.17). The number of monthly prescriptions for antidiabetic drugs in the no-coverage group increased by 0.27 (95% CI, 0.19 to 0.35), as compared with that in the no-cap group, and the number of prescriptions in the \$150-cap group increased by 0.11 (95% CI, 0.03 to 0.19). No significant changes were observed in the number of prescriptions for antidiabetic drugs in the \$350-cap group. The absolute decline in the use of oral antidiabetic drugs in the no-cap group may reflect a number of factors, including an increase in the use of insulin and a decrease in the use of thiazolidinediones.

monthly increases that were similar to those in the no-coverage group and the no-cap group. After implementation of Part D, as compared with expenditures in the no-cap group, spending in the \$150-cap group immediately increased by \$8 (95% CI, \$1 to \$15), and spending in the \$350-cap group increased by \$10 (95% CI, \$2 to \$19). By December 2007, average monthly drug spending had increased by \$27 (95% CI, \$20 to \$34) in the \$150-cap group, which was a 27% increase over the December 2005 level relative to the no-cap group; at the same time, average spending had increased by \$13 (95% CI, \$4 to \$22) in the \$350-cap group, an 11% increase, as compared with the December 2005 level.

DRUGS FOR HYPERLIPIDEMIA AND DIABETES

Figure 2 shows the increase in medication use among enrollees with hyperlipidemia or diabetes who gained coverage after the implementation of Part D, as compared with the no-cap group. During the next 2 years, the number of monthly prescriptions for lipid-lowering drugs among enrollees with hyperlipidemia in the no-coverage group increased by 0.21 (95% CI, 0.15 to 0.27), as compared with that in the no-cap group, a 44% increase from the December 2005 level; the number



of prescriptions in the \$150-cap group increased by 0.18 (95% CI, 0.13 to 0.23), a 31% increase; and the number of prescriptions in the \$350-cap group increased by 0.11 (95% CI, 0.05 to 0.17), a 17% increase.

Among enrollees with diabetes, the number of monthly antidiabetic prescriptions in the no-coverage group increased by 0.27 (95% CI, 0.19 to 0.35), as compared with that in the no-cap group, a 44% increase from the December 2005

level, and the number of prescriptions in the \$150-cap group increased by 0.11 (95% CI, 0.03 to 0.19), a 13% increase. No significant change was observed in the use of oral antidiabetic drugs in the \$350-cap group, as compared with the no-cap group.

MEDICAL SPENDING

Average monthly nondrug medical spending in the no-cap group was \$380 in January 2004. This amount increased by an average of \$4.98 per month during the entire 4 years (Fig. 3A). The no-coverage group had similar average monthly spending and a similar underlying time trend before the implementation of Part D. In that group, however, the monthly trend in spending fell to \$3.60 (95% CI, \$3.28 to \$3.93) after the implementation of Part D. As a result of this trend, after 2 years, the cumulative medical spending in the no-coverage group had declined by \$33 (95% CI, \$29 to \$37), as compared with that in the no-cap group.

Average monthly medical spending in the \$150-cap group was similar to that in the no-cap group before the implementation of Part D (Fig. 3B). Medical spending went down in the \$150-cap group beginning in 2006, with a decrease of \$1.93 per month (95% CI, \$1.22 to \$2.64). After 2 years, the cumulative decrease in spending was \$46 (95% CI, \$29 to \$63). In contrast, 2 years after the implementation of Part D, medical spending in the \$350-cap group increased by \$30 (95% CI, \$25 to \$36) (Fig. 3C). The results are summarized in Table 2 and Figure 4 and in the Supplementary Appendix.

DISCUSSION

The implementation of Medicare Part D was associated with an increase in spending on prescription drugs, and the magnitude of the increase varied according to the enrollees' previous drug coverage. Two years after the implementation of Part D, enrollees who had no previous coverage or whose pharmacy benefits were capped at \$150 or \$350 per quarter had increased their drug spending by 74%, 27%, and 11%, respectively, as compared with spending in the no-cap group, which had stable coverage during the same period. Enrollees with either hyperlipidemia or diabetes who had no previous coverage had an increase of 44% in the number of prescriptions they

Figure 3 (facing page). Time-Series Analysis of Monthly Nondrug Medical Spending.

The data points show 2-month averages of spending, rather than monthly averages, for graphic purposes, from January 2004 through December 2007. As compared with Medicare enrollees who had no cap on drug coverage (no-cap group), monthly spending on nondrug medical services decreased by \$33 (95% CI, \$29 to \$37) in the group that had no drug coverage before the implementation of Part D (Panel A), decreased by \$46 (95% CI, \$29 to \$63) in the group that had a previous \$150 quarterly cap (Panel B), and increased by \$30 (95% CI, \$25 to \$36) in the group that had a previous \$350 quarterly cap (Panel C).

filled for medications to treat those conditions, as compared with that in the no-cap group. Among enrollees with a \$150 quarterly cap, the number of prescriptions for antihyperlipidemic drugs increased by 31%, and the number of prescriptions for antidiabetic drugs increased by 13%.

After 2 years of Part D, enrollees in the no-coverage group had increased their monthly drug spending by \$41, as compared with that in the no-cap group, but that was roughly offset by a decrease of \$33 in their monthly medical spending, perhaps because increased use of medication led to improved control of chronic illnesses. Similarly, the group with a previous \$150 quarterly cap on drug spending increased their drug spending by \$27, which was offset by a decrease of \$46 in their medical spending. The group with a previous \$350 quarterly cap spent \$13 more on drugs and \$30 more on other medical services.

Before the implementation of Part D, 18% of Medicare beneficiaries nationally did not have prescription-drug coverage.²⁵ In addition, most enrollees in Medicare Advantage plans had an annual cap of \$1,000 or less on their pharmacy benefits.²⁶ Hsu et al.⁸ reported that a \$1,000 cap in a large Medicare managed-care plan in 2003 was associated with reduced adherence to drug regimens and higher rates of emergency-department visits, nonelective hospitalizations, and death. The savings that were associated with lower drug expenditures from the \$1,000 annual cap were almost fully offset by increased costs for hospitalizations and emergency-department visits.

The offsetting reduction in medical spending in the two groups with the most limited previous benefits was probably due to improved medication adherence among enrollees with chronic conditions. The increase in the number of pre-

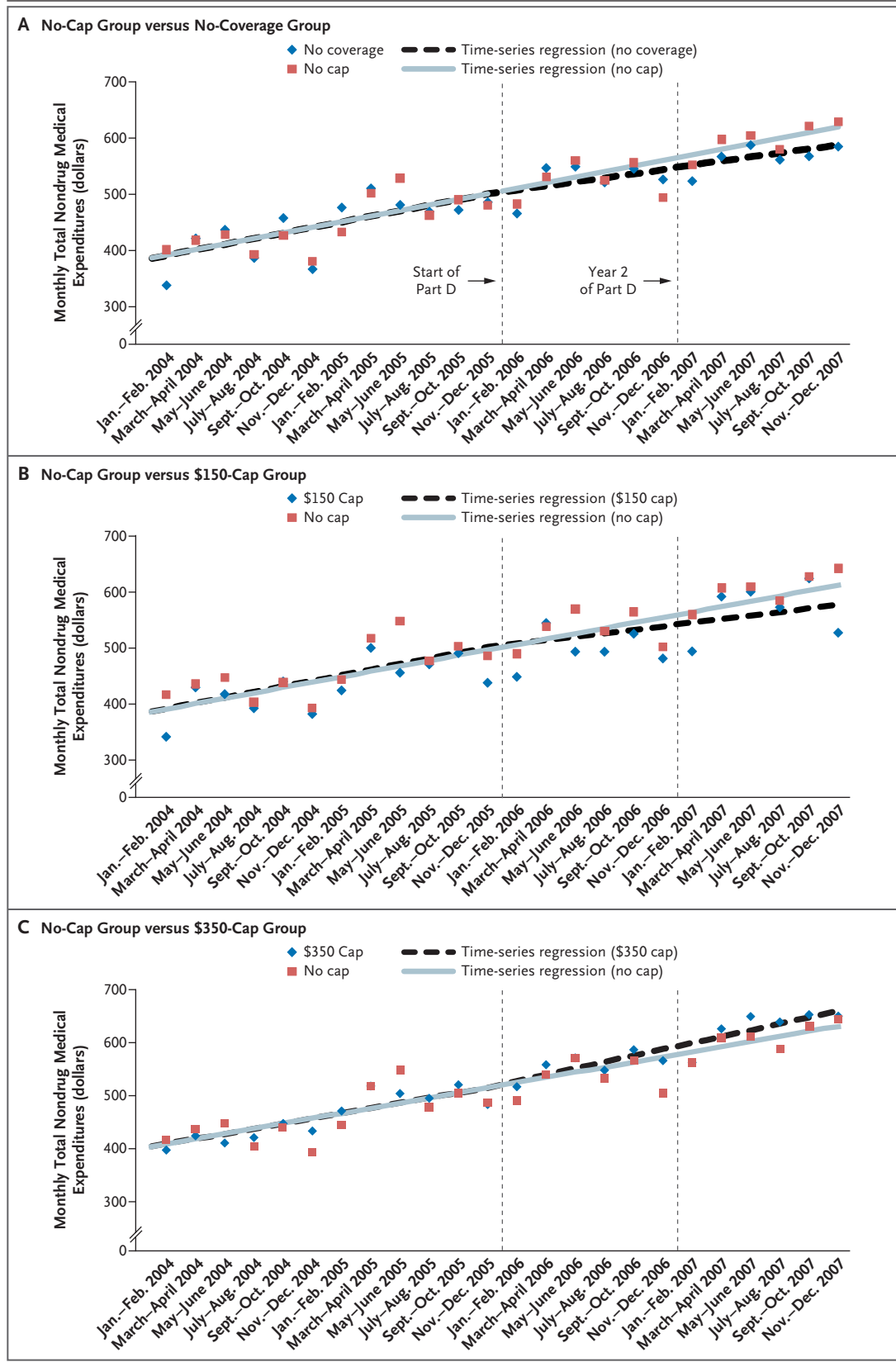
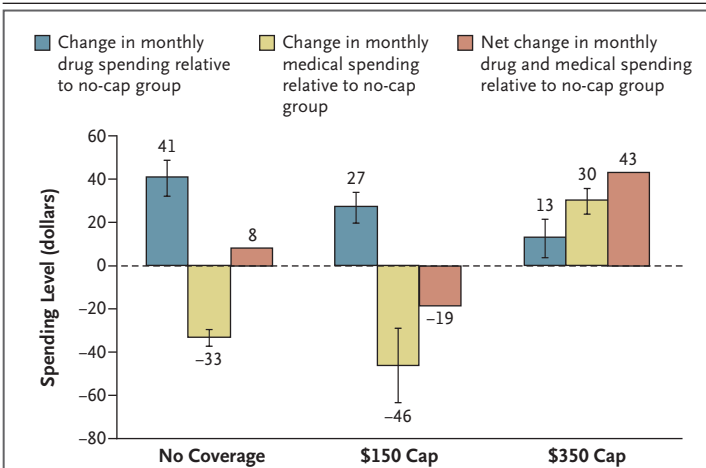


Table 2. Effect of Part D on Drug and Medical Spending among Enrollees with No Previous Drug Coverage and Those with No Cap on Coverage.*

Variable	No-Cap Group	No-Coverage Group
	<i>dollars</i>	
Pharmacy spending		
2 yr before Part D (January 2004)	166	46
At start of Part D (December 2005)	175	56
2 yr after Part D (December 2007)	184	107
Change from January 2004–December 2005	10	10
Change from December 2005–December 2007	10	51
Difference in change between 2 years before Part D and 2 years after Part D	0	41
Medical spending		
2 yr before Part D (January 2004)	380	380
At the start of Part D (December 2005)	500	500
2 yr after Part D (December 2007)	619	586
Change from January 2004–December 2005	119	119
Change from December 2005–December 2007	119	86
Difference in change between 2 years before Part D and 2 years after Part D	0	–33

* Between December 2005 and December 2007, in the group that had no previous drug coverage before the implementation of Part D, total monthly drug spending increased by \$41 (95% CI, \$33 to \$50), whereas monthly nondrug medical expenditures decreased by \$33 (95% CI, \$29 to \$37), as compared with spending in the comparison group of enrollees with no cap on their drug coverage.

**Figure 4. Effect of the Implementation of Part D on Drug and Medical Spending after 2 Years.**

The bars indicate the average changes in drug spending, medical spending, and a combination of the two categories 2 years after the implementation of Part D in a group of Medicare enrollees who previously had no drug coverage and in groups with previous quarterly caps (\$150 or \$350), as compared with a group of enrollees who had no cap on drug coverage (no-cap group). The I bars represent 95% confidence intervals.

scriptions that we observed among enrollees with hyperlipidemia or diabetes is consistent with this observation, as was the finding by Madden et al.²⁷ that the proportion of Medicare enrollees who skipped or reduced doses or did not fill prescriptions because of cost decreased from 14.1% in 2005 to 11.5% in 2006.

Why did medical spending rise in the group with a previous \$350 quarterly cap (the most generous previous coverage among the three intervention groups), as compared with the no-cap group? The additional use of prescription drugs in all three groups probably included both overuse of some drugs and underuse of others, but the proportion of the increase that was overuse may have been highest in the group with the most generous previous coverage. Our finding that the use of oral antidiabetic drugs did not change significantly in this group is consistent with this hypothesis.

Our findings are subject to several limitations. They come from a Medicare Advantage plan and may not hold for stand-alone Part D plans, because Medicare Advantage plans have an incentive to structure copayments and formularies to minimize spending in Parts A and B, whereas stand-alone plans do not. Our study used data from a single insurer in one region, although the drug benefits before the implementation of Part D in our study span a range of benefits, as did coverage nationally.²⁵ To the degree that enrollees without drug benefits filled prescriptions from non-network pharmacies in 2004 and 2005, we overestimate the effect of Part D on pharmacy utilization. We believe this bias is small because enrollees received a 15% discount at network pharmacies and because the plan contracted with a large pharmacy-benefit manager with a network of 58,000 pharmacies nationwide, so there were few pharmacies that did not participate. In addition, for enrollees who had some drug coverage before Part D, the plan paid benefits only for prescriptions that were filled at participating pharmacies.

Our findings suggest that Part D increased the use of prescription drugs among enrollees who previously had either no drug coverage or modest benefits and that the cost of the increased use was approximately offset by decreases in other medical spending. Whether Part D overall had any effect on the total cost of Parts A and B, however, is less clear in light of our finding that enrollees with the most generous benefits before the im-

plementation of Part D increased their medical spending. Thus, the CBO estimate of no net effect of Part D on Parts A and B of Medicare spending may well have been approximately correct.

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Dr. Newhouse reports being a director of and having equity in Aetna, which sells Medicare Advantage and Part D products, and serving on the CBO Board of Health Advisers. No other potential conflict of interest relevant to this article was reported.

REFERENCES

1. Issues in designing a prescription drug benefit for Medicare. Washington, DC: Congressional Budget Office, October 2002. (Accessed June 8, 2009, at <http://www.cbo.gov/ftpdocs/39xx/doc3960/10-30-PrescriptionDrug.pdf>.)
2. Fortess EE, Soumerai SB, McLaughlin TJ, Ross-Degnan D. Utilization of essential medications by vulnerable older people after a drug benefit cap: importance of mental disorders, chronic pain, and practice setting. *J Am Geriatr Soc* 2001; 49:793-7.
3. Soumerai SB, Ross-Degnan D, Avorn J, McLaughlin TJ, Chodnosky I. Effects of Medicaid drug payment limits on admission to hospitals and nursing homes. *N Engl J Med* 1991;325:1072-7.
4. Heisler M, Langa KM, Eby EL, Fendrick AM, Kabeto MU, Piette JD. The health effects of restricting prescription medication use because of cost. *Med Care* 2004;42:626-34.
5. Gaynor M, Li J, Vogt WB. Substitution, spending offsets, and prescription drug benefit design. *Forum for Health Economics & Policy* 2007;10:1-31.
6. Tamblin R, Laprise R, Hanley JA, et al. Adverse events associated with prescription drug cost-sharing among poor and elderly persons. *JAMA* 2001;285:421-9.
7. Stuart B, Doshi JA, Briesacher B, Wrobel MV, Baysac F. Impact of prescription coverage on hospital and physician costs: a case study of Medicare beneficiaries with chronic obstructive pulmonary disease. *Clin Ther* 2004;26:1688-99.
8. Hsu J, Price M, Huang J, et al. Unintended consequences of caps on Medicare drug benefits. *N Engl J Med* 2006;354: 2349-59.
9. Choudhry NK, Avorn J, Antman EM, Schneeweiss S, Shrank WH. Should patients receive secondary prevention medications for free after a myocardial infarction? An economic analysis. *Health Aff (Millwood)* 2007;26:186-94.
10. Rosen AB, Hamel MB, Weinstein MC, Cutler DM, Fendrick AM, Vijan S. Cost-effectiveness of full Medicare coverage of angiotensin-converting enzyme inhibitors for beneficiaries with diabetes. *Ann Intern Med* 2005;143:89-99.
11. Field TS, Gilman BH, Subramanian S, Fuller JC, Bates DW, Gurwitz JH. The costs associated with adverse drug events among older adults in the ambulatory setting. *Med Care* 2005;43:1171-6.
12. Curtis LH, Østbye T, Sendersky V, et al. Inappropriate prescribing for elderly Americans in a large outpatient population. *Arch Intern Med* 2004;164:1621-5.
13. March 2008 baseline. Medicare. Washington, DC: Congressional Budget Office, March 2008. (Accessed June 8, 2009, at <http://www.cbo.gov/budget/factsheets/2008b/medicare.pdf>.)
14. Cook TD, Campbell DT. Quasi-experimentation: design and analysis issues for field settings. Boston: Houghton Mifflin, 1979.
15. Fact sheet: the Medicare prescription drug benefit. Washington, DC: Henry J. Kaiser Family Foundation, 2007. (Accessed June 8, 2009, at <http://www.kff.org/medicare/upload/7044-05.pdf>.)
16. Producer Price Index industry data. Washington, DC: Bureau of Labor Statistics, 2008. (Accessed June 8, 2009, at <http://data.bls.gov/PDQ/outside.jsp?survey=pc>.)
17. LIPID Study Group. Prevention of cardiovascular events and death with pravastatin in patients with coronary heart disease and a broad range of initial cholesterol levels. *N Engl J Med* 1998;339:1349-57.
18. Shetty S, Secnik K, Oglesby AK. Relationship of glycemic control to total diabetes-related costs for managed care health plan members with type 2 diabetes. *J Manag Care Pharm* 2005;11:559-64.
19. The CDC Diabetes Cost-Effectiveness Group. Cost-effectiveness of intensive glycemic control, intensified hypertension control, and serum cholesterol level reduction for type 2 diabetes. *JAMA* 2002;287: 2542-51.
20. Pope GC, Kautter J, Ellis RP, et al. Risk adjustment of Medicare capitation payments using the CMS-HCC model. *Health Care Financ Rev* 2004;25:119-41.
21. Hirano K, Imbens GW. Estimation of causal effects using propensity score weighting: an application to data on right heart catheterization. *Health Serv Outcomes Res Methodol* 2001;2:259-78.
22. Kurth T, Walker AM, Glynn RJ, et al. Results of multivariable logistic regression, propensity matching, propensity adjustment, and propensity-based weighting under conditions of nonuniform effect. *Am J Epidemiol* 2006;163:262-70.
23. Sato T, Matsuyama Y. Marginal structural models as a tool for standardization. *Epidemiology* 2003;14:680-6.
24. Li F, Zaslavsky AM, Landrum MB. Propensity score analysis with hierarchical data. In: Proceedings of the American Statistical Association Joint Statistical Meetings, Salt Lake City, Utah, July 29–August 2, 2007.
25. Medicare chartbook. 3rd ed. Washington, DC: Henry J. Kaiser Family Foundation, 2005. (Accessed June 8, 2009, at <http://www.kff.org/medicare/upload/Medicare-Chart-Book-3rd-Edition-Summer-2005-Report.pdf>.)
26. Gold M. Medicare+Choice: an interim report card. *Health Aff (Millwood)* 2001; 20(4):120-38.
27. Madden JM, Graves AJ, Zhang F, et al. Cost-related medication nonadherence and spending on basic needs following implementation of Medicare Part D. *JAMA* 2008;299:1922-8.

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