

Effect of Copayments on Drug Use in the Presence of Annual Payment Limits

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Objective: To test the hypothesis that deductibles (copayment combined with annual limits on out-of-pocket payments) may reduce the effect of copayments on drug use for patients who expect to reach the annual limit, using as a natural experiment the introduction of copayments with an annual maximum to the seniors' drug plan in Nova Scotia.

Study Design: An interrupted time-series design estimated effects of the introduction of and subsequent increase in drug copayments on the use (vs nonuse) of medications and on the mean daily quantity of use among users by patients' likelihood of exceeding the annual maximum copayment. Effects on the use of less essential medications (histamine₂-receptor antagonists) and more essential medications (oral antihyperglycemic agents) were examined.

Methods: Data were drug claims for beneficiaries 65 years and older from April 1, 1989, through September 30, 1992. Regression models (applied to person-month data) estimated effects of the policies on the use and quantity of medication use.

Results: Copayments (\$3 per prescription and 20% of the prescription cost) were associated with reductions in the quantity of medication use, ranging from 5% to 15%, but only when the annual maximum copayment was unlikely to be reached. Introducing a 20% copayment increased the percentage who reached the annual maximum, decreasing the proportion of patients who reduced their drug use.

Conclusion: Although copayment policies are associated with reductions in the use of essential and less essential medications, annual limits on total copayments paid will limit copayment effects to patients who are unlikely to reach the annual maximum copayment.

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Cost-sharing strategies such as copayments (a fixed fee per prescription), coinsurance (a proportion of ingredient cost or dispensing fee), and charges that vary with the total number or cost of prescriptions filled (eg, deductibles and limits on total payouts) are widely used to control expenditure growth in drug plans. For most individuals, modest charges have a less than proportional effect on drug use, with larger effects on those who spend a larger share of their budgets on drugs, namely, the sick and the poor.¹⁻⁵ Copayments reduce the use of essential and less essential drugs^{2,6-11} and may be associated with adverse health consequences.^{2,8,12,13}

Copayment policies are commonly combined with annual maximums on out-of-pocket copayments^{14,15}; however, little is known about how such deductibles may modify the effect of copayments on patient drug use.^{6,16} Ellis¹⁷ hypothesized that a forward-looking patient who expects to exceed the deductible would treat the marginal cost of all drugs used as \$0. Moffit¹⁸ made similar observations. If this is correct, the combination of copayments (or coinsurance) with a deductible (eg, an annual maximum on the total amount of copayments paid) may modify the effect of copayment policies on patient drug use behavior and mediate the potential for adverse effects on patients.

This study examined the effect of introducing 2 types of copayment policies, fixed copayments and coinsurance (both referred to generally as copayments) on the use and quantity of use of prescription drugs in the presence of an annual maximum copayment. Consistent with Ellis,¹⁷ we hypothesized that effects of copayment policies on drug use would vary depending on patients' expectations of reaching the annual maximum copayment. For patients with a high expectation of exceeding the annual maximum copayment, the perceived marginal cost of a prescription would be \$0, and they would not reduce their drug use as a result of the copayments. Conversely, patients who did not expect to exceed the annual maximum copayment would perceive marginal out-of-pocket costs and reduce their drug use. We also hypothesized that the use (vs nonuse) of drugs would be less affected by copayments than the quantity of medications used, because the latter is more controlled by the patient and the former is more controlled by the physician's decision to prescribe. Finally, we hypothesized that price sensitivity and policy effects would be greater for seniors living in lower-income neighborhoods.

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METHODS

Study Population and Setting

Nova Scotia, a province of roughly 1 million people in Atlantic Canada, has provided publicly funded comprehensive drug coverage for seniors via the Nova Scotia Seniors' Pharmacare Program (NSSPP) since the 1970s. Medications were provided free of charge to seniors until June 1990, when a fixed \$3 copayment per prescription, subject to an annual maximum copayment of \$150 (after which drugs were provided free of charge), was implemented. In July 1991, the policy was changed from a fixed fee per prescription to a 20% (\$3 minimum) coinsurance of the total cost (drug cost plus dispensing fee). The annual maximum copayment remained at \$150. Throughout, dispensing fees were covered and were invisible to patients.

Although subsequent policy changes followed, these initial policy changes in the NSSPP provided an excellent natural experiment for understanding how annual deductibles mediate the effect of copayments on patient drug use. Introducing and subsequently increasing copayments, while retaining the same annual limit, resulted in within-patient variation in out-of-pocket costs and in the likelihood of reaching the annual maximum copayment.

Subjects were all persons living in urban areas and enrolled in the NSSPP at any time between April 1, 1989, and September 30, 1992. During this period, the NSSPP provided prescription drug coverage to almost all persons 65 years and older in the province. Subjects were included in the study for all months during which they were alive and enrolled in the program (2 407 758 person-months [mean, 61 737 persons/month]). The study was limited to urban areas because neighborhood income could not be reliably measured in rural areas. Urban areas were census subdivisions in which most enumeration areas were classified as urban.

The study was approved by the Dalhousie University Research Ethics Committee. Data were accessed through Dalhousie University's Population Health Research Unit, and analysis was subject to data access guidelines to ensure confidentiality and data security.

Data Sources

The primary data source was NSSPP drug claims. Records included patient identifier, date filled, type of medication, quantity, and days' supply. Drugs were coded using the World Health Organization anatomic therapeutic chemical classification and the drug identification numbers assigned by Health Canada. The NSSPP registry was used to identify subjects' periods of program enrollment (generally from the 65th birth-

day until death or migration out of the province) and place of residence (based on the full postal code). Data on mean household income by enumeration areas were obtained from the 1991 Census of Canada. The mean household income was linked to claims data by postal code.¹⁹

Study Design

An interrupted time-series design was used with person-month data as the unit of analysis.²⁰ The outcomes were monthly drug use (vs nonuse) and the mean quantity of medications used per month by medication users. Policy effects were measured as changes in the level and slope in medication use rates and in the mean quantity of medications used per month. Policy effects were compared by region, neighborhood income group, and a time-varying measure of each patient's likelihood of reaching the annual maximum copayment. The use of person-month time-series data as the units of analysis enabled evaluation of how within-person effects of 2 sequential policies varied by neighborhood income and by likelihood of reaching the annual maximum copayment, while controlling for patients' age, sex, and prepolicy drug use.

We examined policy effects on the use of 2 specific classes of drugs, histamine₂-receptor antagonists (H₂RAs) and oral antihyperglycemic agents (OHAs). The 2 classes provided a contrast between a less essential drug and a more essential drug. Histamine₂-receptor antagonists are used to treat symptomatic conditions of peptic ulcer disease, gastroesophageal reflux, and dyspepsia. Histamine₂-receptor antagonists are one of the most commonly used drugs in the study population,²¹ and there is some evidence that they may be overused.^{22,23} Antacids and lifestyle changes may be appropriate for infrequent mild symptoms.²⁴ Histamine₂-receptor antagonists were not available as over-the-counter medications during the study period. Although proton pump inhibitors (PPIs) were available as an alternative treatment during the study period, their rate of use was low relative to that of H₂RAs, and the introduction of PPI reimbursement restrictions in September 1992 was found not to significantly affect rates of H₂RA use.²¹ Oral antihyperglycemic agents are the primary medications used to treat type 2 diabetes mellitus, which is often a non-symptomatic condition. Oral antihyperglycemic agents are clearly essential drugs. Poor compliance can lead to complications such as kidney disease, blindness, and heart disease.²⁵

Outcomes and Measurement

Claims data were used to estimate beneficiaries' use of medications by month. An algorithm, described in detail elsewhere,²⁶ was used to estimate whether or not a patient used a medication in each month and, if so, the mean daily quantity

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used. The quantity of medications used was measured as the mean number of mean standardized daily doses (SDDs) used per day between prescription dates.²⁶⁻²⁸ The SDD is estimated directly from the NSSPP claims data and reflects the mean use patterns over time in the study population. The number of SDDs is the mean number of “typical” daily doses consumed per day and is similar to the defined daily dose used by the World Health Organization.²⁹

To measure patients’ likelihood of reaching the annual maximum copayment, we computed a variable to measure each patient’s expectation to exceed the annual maximum copayment by the end of each yearly accounting period. Computed for each patient in each month, it is an estimate of the probability of exceeding \$150 in copayments by the end of the annual accounting period. It was estimated based on medication use in the previous 3 months and on the total copayments accumulated from the start of the accounting period up to that month. It was set to 1.0 once the maximum was reached.

The mean annual household income for each senior’s neighborhood of residence was assigned to 1 of 3 categories (<\$30 000, \$30 000-\$50 000, and >\$50 000). Region of residence was defined as Halifax versus all other urban areas in the province. Halifax is the largest metropolitan area in the province and includes the acute care hospitals and most specialists.

Statistical Analysis

Logistic regression models with person-month data as the unit of analysis and estimated by generalized estimating equations were used to estimate policy effects on the use (vs nonuse) of study drugs. The form of the model was as follows:

$$y_{it} = \beta_0 + \beta_1 T_{it}^1 + \beta_2 T_{it}^2 + \beta_3 T_{it}^3 + \beta_4 T_{it}^2 E_{it} + \beta_5 T_{it}^3 E_{it} + \sum_j \lambda_j X_{jit} + \epsilon_{it}$$

where E_{it} is the expectation of person i in month t of exceeding the annual maximum copayment. The T are splines such that β_1 is the trend (ie, slope) in odds of use by month before the introduction of copayments, β_2 is the change in trend associated with the \$3 per prescription policy, and β_3 is the change in slope associated with the 20% of the prescription cost policy. β_4 and β_5 capture interactions between changes in trend and expectation to exceed. The X are additional covariates, including age-sex group, season, region, and income group. We also included a covariate indicating a 6-month lagged value of the use to adjust for bias that could result from the effect of study drug use on the expectation to exceed. Interactions were added to test for differences in policy effects by income group. Effects in changes in level

were also estimated but were not found to be statistically significant.

The quantity of use analysis examined the quantity of drug use among those using the study drug. The unit of analysis was person-months in which a study drug was used. Policy effects were estimated using conditional fixed-effect regression models on the log of the mean SDDs used per person per month. This approach estimates mean within-person effects and adjusts for unobserved individual-level factors that may affect the quantity of drug use (eg, disease severity), as well as variables that were constant within individuals (eg, region of residence and neighborhood income).³⁰ Reported policy effects were estimated as a change in level, as changes in trend (ie, slope) were not found to be statistically significant. Estimated policy effects were adjusted for age and season. Because we expected the policy effects to diminish nonlinearly with increasing expectation to exceed, polynomial terms of the expectation to exceed variable were included in the model. A model with squared and cubic terms for expectation to exceed provided the best fit. Interactions between the indicator variables for the policy periods and the expectation to exceed variables were then estimated to test the study hypotheses. All analyses were conducted using STATA version 8 software (StataCorp LP, College Station, Tex).³¹

RESULTS

Policy Effects on Use vs Nonuse

Figure 1 shows how estimated changes in trend (ie, slope) in the odds of drug use associated with each policy change varied by expectation to exceed the annual maximum copayment. The change in trend is estimated as the relative odds of use under the new policy relative to the previous trend. For example, a relative odds of 0.97 indicates that the odds of use were 0.97 the level in the month following the policy than they would have been if previous trends had continued (ie, a shift in slope toward decreasing rates of use).

When the expectation to exceed was low (ie, close to 0), the introduction of a \$3 per prescription copayment was associated with a shift in trend toward reduced odds of H₂RA use (0.970 [95% confidence interval, 0.960-0.978]) and, to a much lesser degree, OHA use (0.990 [95% confidence interval, 0.984-0.996]). However, effects diminished as the expectation to exceed increased for H₂RAs and for OHAs ($P < .001$ for both).

The effect of introducing a 20% copayment policy on a change in trend for those with a low expectation to exceed was insignificant for H₂RAs (0.994 [95% confidence interval, 0.985-1.003]) and was small and not in the expected direction

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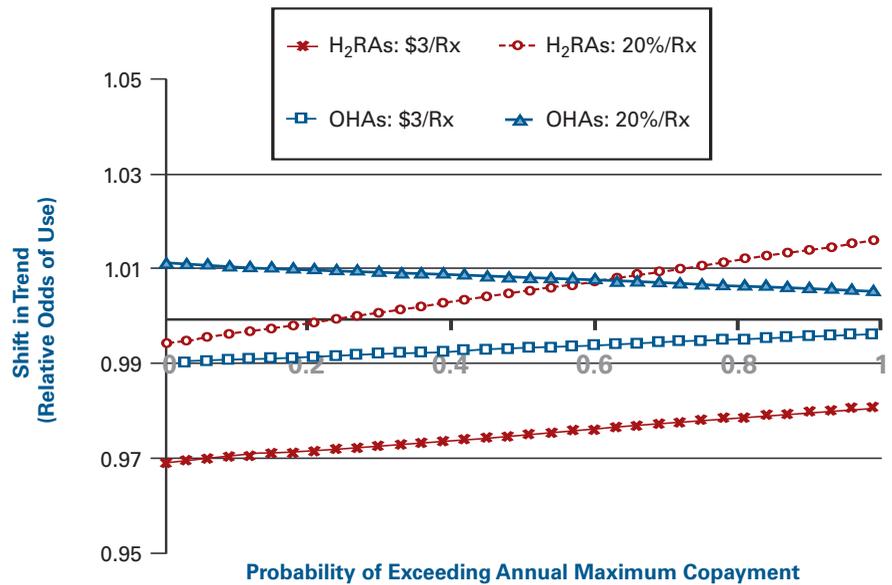
for OHAs (1.011 [95% confidence interval, 1.005-1.017]). However, in the case of H₂RAs, a strong interaction with expectation to exceed was observed ($P < .009$). A shift in trend to increasing odds of H₂RA use was observed for those with high expectations of exceeding the maximum copayment but not for those with low expectations. The interaction of expectation to exceed with the use of OHAs was statistically nonsignificant ($P = .18$). Policy effects on drug use by expectation to exceed were not found to vary by neighborhood income level.

Policy Effects on the Quantity of Medication Use Among Users

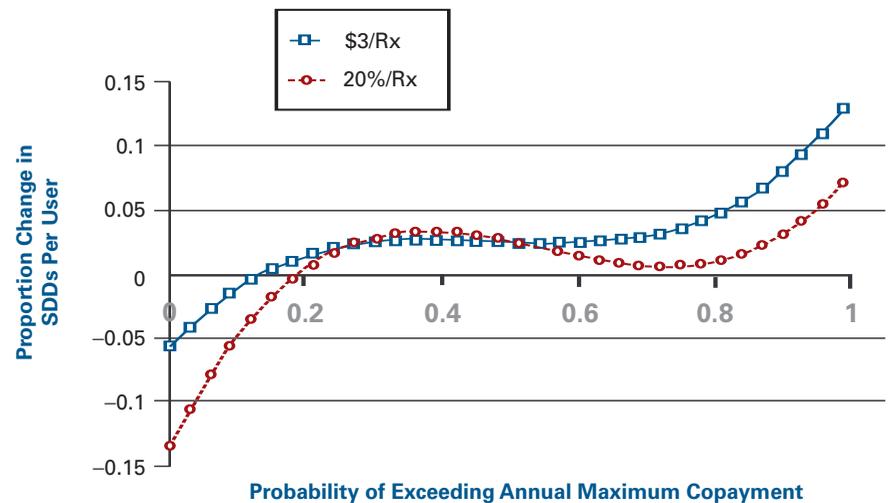
Policy effects on the quantity of use of both drugs were strong and varied by expectation of exceeding the annual maximum copayment. **Figure 2** and **Figure 3** show how the estimated proportionate change in the mean SDD use associated with each of the 2 copayment policies varied by expectation of exceeding the annual maximum copayment. Change is expressed as a change in level relative to the previous policy period (ie, relative to no copayment for the \$3 per prescription policy and relative to \$3 per prescription for the 20% of cost copayment policy).

For patients with low expectation to exceed, both policies were associated with substantial and significant decreases in the mean quantity of medications used. For H₂RAs (Figure 2), the \$3 per prescription policy was associated with about a 5% decrease in the quantity used ($P < .001$), while the 20% coinsurance policy was associated with an additional 15% decrease in the quantity used ($P < .001$). Results for OHAs (Figure 3) were similar, although the reduction in the quantity of medications used associated with the 20% coinsurance policy was smaller than that for H₂RAs.

■ **Figure 1.** Estimated Policy Effects on the Monthly Use Rates of Histamine₂-Receptor Antagonists (H₂RAs) and Oral Antihyperglycemic Drugs (OHAs) by Expectation of Exceeding the Annual Maximum Copayment



■ **Figure 2.** Estimated Policy Effects on the Mean Quantity of Histamine₂-Receptor Antagonists Used per Month by Expectation of Exceeding the Annual Maximum Copayment

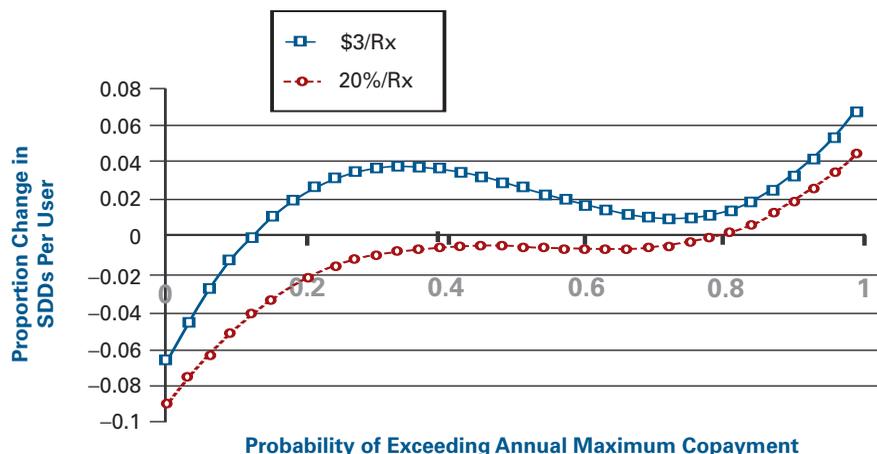


SDDs indicates standardized daily doses.

For both study drugs, effects of both policies diminished as expectation to exceed increased ($P < .001$). At a higher expectation to exceed, no policy effect on the quantity of medication use was observed. This is consistent with the hypothesis of no reduction in medication use for persons who expect to exceed the annual maximum copayment. Policy effects on the quantity of drug use by expectation to exceed were not found to vary significantly by neighborhood income level.

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■ **Figure 3.** Estimated Policy Effects on the Mean Quantity of Oral Antihyperglycemic Drugs Used per Month by Expectation of Exceeding the Annual Maximum Copayment



SDDs indicates standardized daily doses.

Policy Effects on the Expectation of Reaching the Annual Maximum Copayment

The shift from a \$3 per prescription copayment to 20% coinsurance had countervailing effects. On the one hand, it resulted in additional declines in the quantity of medication use for persons with a low expectation to exceed the maximum copayment. On the other hand, it also increased dramatically the percentage of persons expected to exceed the maximum copayment (Table), reducing the percentage of patients affected by the policy. For example, based on the distribution of the expectation to exceed variable and our estimated effects on the quantity of use, about 65% of seniors would reduce their OHA use under the \$3 copayment policy, but only about 33% of seniors would reduce their OHA use under the 20% coinsurance policy.

The data given in the Table also indicate that policy effects are indirectly associated with neighborhood income. Although policy effects did not vary by income group, persons in

lower-income neighborhoods are more likely to reach the annual maximum copayment and are less likely to reduce their drug use in response to the policies.

DISCUSSION

This study exploited a unique opportunity to examine how patients changed their drug use in response to the introduction of 2 subsequent copayment policies in the presence of an annual maximum copayment. The use of individual-level population-based data enabled examination of how patients' responses to copayments varied by neighborhood income

level and by their likelihood of exceeding the annual maximum copayment in out-of-pocket copayments. Validity was enhanced by the stability of the study population (little mobility) and by the lack of other policy changes or events likely to confound results. Although the policies were instituted in the 1990s, their effects on patient drug use behavior are salient and generalizable to the current policy environment in which copayments are often combined with annual out-of-pocket limits.^{6,14}

Consistent with our hypothesis, the effect of copayments on patients' drug use varied by patients' likelihood of exceeding an annual maximum in copayments. We observed a "dose-response" relationship; the policy effect on reductions in drug use diminished with increasing likelihood of exceeding the annual maximum copayment. Moreover, this dose-response relationship was replicated across 2 drug classes and across 2 types of copayment policies introduced in the same population at different points in time. Consistent with Ellis¹⁷ and Moffit,¹⁸

these results suggest that patients are forward thinking and perceive the marginal out-of-pocket cost as \$0 if they expect that their total copayments will exceed an annual maximum. Conversely, patients who do not expect to exceed the annual maximum copayment perceive a marginal prescription cost as greater than \$0 and tend to reduce

■ **Table.** Percentage Exceeding the Annual Maximum Copayment by Income and by Type of Copayment Policy*

Copayment Policy	Income Group		
	Low	Middle	High
\$3 Per prescription	2.2	1.6	0.5
20% Of the prescription cost	35.2	33.4	28.5

*Data are given as percentages reaching the annual maximum copayment in the last accounting year of each policy period.

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medication use. Our results are also consistent with findings by Contoyannis et al⁴ that the elasticity of drug expenditures with respect to price is affected by deductibles. Lack of patient knowledge about drug costs under the coinsurance policy may introduce uncertainty in expectation of exceeding the maximum copayment, which may also mediate the effects we observed.³²

A rival explanation for our results is that patients with a high expectation of exceeding the annual maximum copayment will tend to be taking more medications and may respond to copayments by reducing the use of medications with lower perceived utility. If so, the reduced policy effect with higher expectation to exceed may reflect greater opportunity to reduce the use of another medication instead of the study drug. Future studies should examine how price effects on use vary across types of medications used by a patient. Another possible explanation is that patients who are not price sensitive may be more likely to reach the annual maximum copayment.

Consistent with previous studies,^{2,7-12} we found that copayments affect the use of essential drugs (OHAs) and less essential drugs (H₂RAs). Our study did not examine whether changes in drug use resulting from policy changes affected health outcomes; however, we expect that OHAs are likely vital among a higher percentage of patients than H₂RAs and that there is more concern about reductions in their use. Recent studies^{2,8,12,13} provide some evidence to suggest that copayments are associated with negative health outcomes. Prudence suggests that policy makers should proceed on the basis that copayments and coinsurance can result in negative health outcomes.

Combining annual maximums on out-of-pocket payments with copayment policies may reduce the potential for negative health outcomes and for inequities from copayment policies. Selecting a combination of copayments and annual maximums may reduce the potential for deleterious policy effects among vulnerable patients, such as those with chronic and multiple health problems or those requiring multiple or more expensive medications. Low-income seniors will be more represented in this group. However, there is also a “moral hazard” that annual maximum copayments may limit reductions or may even increase the use of less essential medications.³³ Future work should examine how copayments interact with other cost-sharing and cost-shifting policies, such as annual premiums, reference-based pricing,³⁴ and prior authorization.³⁵

We found that copayment policies have a much bigger effect on the quantity of medication use by users than on whether or not a drug is used. This finding is notable given

Take-away Points

Copayments are often combined with annual limits on out-of-pocket payments. It is hypothesized that this may reduce the effects of copayments on drug use for patients who expect to reach the annual limit. The introduction of copayments with an annual maximum to the seniors' drug plan in Nova Scotia provided a setting to test this hypothesis.

- Copayments reduced the quantity of medications used from 5% to 15%, but only when the annual maximum was unlikely to be reached.
- Persons in lower-income neighborhoods were more likely to reach the annual maximum and were thus less likely to reduce their drug use in response to policies.

that we estimated consumption based on prescriptions filled and may have underestimated actual medications consumed. Stronger effects on the quantity of use may reflect that consumption is under the control of the patient, while the decision to prescribe rests largely with the physician. Future studies on effects of cost-sharing policies on drug use should differentiate effects on the use vs on the quantity of use rather than simply using overall measures of utilization or expenditure.

Inconsistent with other studies,^{1,5} we did not find that copayments had stronger effects on drug use for low-income patients. This could reflect the use of an ecological measure of income; however, because our neighborhood income measure was strongly associated with rates of drug use, it seems viable. Nevertheless, neighborhood income may be a poor proxy for household income.^{36,37}

However, we found that the use of an annual maximum copayment leads to an indirect income effect. Persons in lower-income neighborhoods were more likely to reach the annual maximum copayment and were less likely to reduce their drug use in response to copayment policies.

CONCLUSIONS

We confirmed findings of previous studies^{2,7-12} showing that copayment policies are associated with reductions in the quantity of use of essential and less essential medications. However, our results show that annual limits on out-of-pocket copayments restrict these effects to patients who are unlikely to reach the annual maximum copayment. Therefore, the use of such deductibles may reduce potential risks to patients resulting from reductions in the use of essential medications, but may increase the use of less essential medications.

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REFERENCES

- Lexchin J, Grootendorst P. Effects of prescription drug user fees on drug and health services use and on health status in vulnerable populations: a systematic review of the evidence. *Int J Health Serv*. 2004;34:101-122.
- Gibson TB, Ozminkowski RJ, Goetzel RZ. The effects of prescription drug cost sharing: a review of the evidence. *Am J Manag Care*. 2005;11:730-740.
- Smith DG, Kirking DM. Impact of consumer fees on drug utilisation. *Pharmacoeconomics*. 1992;2:335-342.
- Contoyannis P, Hurley J, Grootendorst P, Jeon SH, Tamblin R. Estimating the price elasticity of expenditure for prescription drugs in the presence of non-linear price schedules: an illustration from Quebec, Canada. *Health Econ*. 2005;14:909-923.
- Adams AS, Soumerai SB, Ross-Degnan D. The case for a Medicare drug coverage benefit: a critical review of the empirical evidence. *Annu Rev Public Health*. 2001;22:49-61.
- Dormuth CR, Glynn RJ, Neumann P, Maclure M, Brookhart AM, Schneeweiss S. Impact of two sequential drug cost-sharing policies on the use of inhaled medications in older patients with chronic obstructive pulmonary disease or asthma. *Clin Ther*. 2006;28:964-978.
- Federman AD, Adams AS, Ross-Degnan D, Soumerai SB, Ayanian JZ. Supplemental insurance and use of effective cardiovascular drugs among elderly Medicare beneficiaries with coronary heart disease. *JAMA*. 2001;286:1732-1739.
- Johnson RE, Goodman MJ, Hornbrook MC, Eldredge MB. The impact of increasing patient prescription drug cost sharing on therapeutic classes of drugs received and on the health status of elderly HMO members. *Health Serv Res*. 1997;32:103-122.
- Pilote L, Beck C, Richard H, Eisenberg MJ. The effects of cost-sharing on essential drug prescriptions, utilization of medical care and outcomes after acute myocardial infarction in elderly patients. *CMAJ*. 2002;167:246-252.
- Goldman DP, Joyce GF, Escarce JJ, et al. Pharmacy benefits and the use of drugs by the chronically ill. *JAMA*. 2004;291:2344-2350.
- Roblin DW, Platt R, Goodman MJ, et al. Effect of increased cost-sharing on oral hypoglycemic use in five managed care organizations: how much is too much? *Med Care*. 2005;43:951-959.
- Tamblin R, Laprise R, Hanley JA, et al. Adverse events associated with prescription drug cost-sharing among poor and elderly persons. *JAMA*. 2001;285:421-429.
- 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;42:626-634.
- Grootendorst P. Beneficiary cost sharing under Canadian provincial prescription drug benefit programs: history and assessment. *Can J Clin Pharmacol*. 2002;9:79-99.
- Stuart B, Briesacher BA, Shea DG, Cooper B, Baysac FS, Limcangco MR. Riding the rollercoaster: the ups and downs in out-of-pocket spending under the standard Medicare drug benefit. *Health Aff (Millwood)*. 2005;24:1022-1031.
- Angus DE, Karpetz HM. Pharmaceutical policies in Canada: issues and challenges. *Pharmacoeconomics*. 1998;14(suppl 1):81-96.
- Ellis RP. Rational behavior in the presence of coverage ceilings and deductibles. *RAND J Econ*. 1986;17:158-175.
- Moffitt R. The economics of kinked budget constraints. *J Econ Perspect*. 1990;4:119-139.
- Wilkins R. *PPCF+ Version 3G User's Guide (Geocodes/PPCF): Automated Geographic Coding Based on the Statistics Canada Postal Code Conversion Files*. Ottawa, Ontario: Statistics Canada; 2002.
- Schneeweiss S, Maclure M, Soumerai SB, Walker AM, Glynn RJ. Quasi-experimental longitudinal designs to evaluate drug benefit policy changes with low policy compliance. *J Clin Epidemiol*. 2002;55:833-841.
- Nagpal S. *Effect of the Omeprazole Benefit Guidelines: Evaluation of Health Policy*. Halifax, Nova Scotia: Department of Community Health and Epidemiology, Dalhousie University; 1998.
- Wadibia EC, Lucas BD, Hilleman DE, Mooss AN. Economic impact of inappropriate histamine₂-receptor antagonist use. *Clin Ther*. 1997;19:1085-1091.
- Jacobson BC, Ferris TG, Shea TL, Mahlis EM, Lee TH, Wang TC. Who is using chronic acid suppression therapy and why? *Am J Gastroenterol*. 2003;98:51-58.
- Gray J. *Therapeutic Choices*. 4th ed. Ottawa, Ontario: Canadian Pharmacists Association; 2003.
- Stephens JM, Botteman MF, Hay JW. Economic impact of antidiabetic medications and glycemic control on managed care organizations: a review of the literature. *J Manag Care Pharm*. 2006;12:130-142.
- Kephart G, Skedgel C, Sketris I, Grootendorst P, Hoar J, Sommers E. *The Effects of Changes in Co-Payment and Premium Policies on the Use of Prescription Drugs in the Nova Scotia Seniors' Pharmacare Program: Final Report*. Ottawa, Ontario: Canadian Health Services Research Foundation; 2003.
- Soumerai SB, McLaughlin TJ, Ross-Degnan D, Casteris CS, Bollini P. Effects of a limit on Medicaid drug-reimbursement benefits on the use of psychotropic agents and acute mental health services by patients with schizophrenia. *N Engl J Med*. 1994;331:650-655.
- Schneeweiss S, Soumerai SB, Glynn RJ, Maclure M, Dormuth C, Walker AM. Impact of reference-based pricing for angiotensin-converting enzyme inhibitors on drug utilization. *CMAJ*. 2002;166:737-745.
- Sketris IS, Metge CJ, Blackburn JL, et al. The use of the WHO anatomical therapeutic chemical/defined daily dose methodology in Canada. *Drug Information J*. 2004;38:15-27.
- Greene WH. *Econometric Analysis*. 5th ed. Upper Saddle River, NJ: Prentice Hall; 2003.
- STATA Statistical Software: Release 8.0. College Station, Tex: StataCorp LP; 2003.
- Dor A, Encinosa W. *Does Cost Sharing Affect Compliance? The Case of Prescription Drugs*. Cambridge, England: National Bureau of Economic Research; 2004. Working paper 10737.
- Pauly MV. Medicare drug coverage and moral hazard. *Health Aff (Millwood)*. 2004;23:113-122.
- Schneeweiss S, Maclure M, Dormuth C, Avorn J. Pharmaceutical cost containment with reference-based pricing: time for refinements. *CMAJ*. 2002;167:1250-1251.
- Ridley DB, Axelsen KJ. Impact of Medicaid preferred drug lists on therapeutic adherence. *Pharmacoeconomics*. 2006;24(suppl 3):65-78.
- Finkelstein MM. Ecologic proxies for household income: how well do they work for the analysis of health and health care utilization? *Can J Public Health*. 2004;95:90-94.
- Geronimus AT, Bound J. Use of census-based aggregate variables to proxy for socioeconomic group: evidence from national samples. *Am J Epidemiol*. 1998;148:475-486. ■