Background—As medication spending grows, Medicare Part D will need to adapt its coverage policies according to emerging evidence from a variety of insurance policies. We sought to evaluate the consequences of copayment and coinsurance policies on the initiation of statin therapy after acute myocardial infarction and adherence to therapy in statin initiators using a natural experiment of all British Columbia residents aged 66 years and older.

Methods and Results—Three consecutive cohorts that included all patients who began statin therapy during full drug coverage (2001), coverage with a $10 or $25 copay (2002), and coverage with a 25% coinsurance benefit (2003–2004) were followed up with linked healthcare utilization data (n=51,561). Follow-up of cohorts was 9 months after each policy change. Adherence to statin therapy was defined as ≥80% of days covered. Relative to full-coverage policies, adherence to new statin therapy was significantly reduced, from 55.8% to 50.5%, under a fixed copayment policy (−5.4% points; 95% CI, −6.4% to −4.4%) and the subsequent coinsurance policy (−5.4% points; 95% CI, −6.3% to −4.4%). An uninterrupted increase in the proportion of patients initiating statin therapy after an acute myocardial infarction (1.7% points per quarter) was observed over the study period, similar to a Pennsylvania control population with full coverage. Sudden changes to full out-of-pocket spending, similar to Medicare’s Part D “doughnut hole,” almost doubled the risk of stopping statins (adjusted odds ratio, 1.94, 95% CI, 1.82 to 2.08).

Conclusions—Fixed patient copayment and coinsurance policies have negative effects on adherence to statin lipid-lowering drug therapy but not on their initiation after myocardial infarction. (Circulation. 2007;115:2128-2135.)

Key Words: statins ■ health care costs ■ drugs ■ economics, pharmaceutical

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Hydroxy-methylglutaryl coenzyme A reductase inhibitors (statins) have been shown to reduce mortality in patients with and without prior myocardial infarction (MI).14–16 Including older adults,17,18 Treatment guidelines19–21 and health plan performance measures recommended statin therapy after acute MI (AMI). Although this somewhat improved statin use among seniors,22,23 adherence to statin therapy is <60% 6 months after initiation.24,25 and initiation of statins after AMI was found to be <40%.26

Spending for prescription drugs in the United States reached more than $200 billion, or 12% of all healthcare expenditures, in 2004 and has been one of the fastest-growing components of healthcare spending.1,2 Medicare Part D drug coverage will bring long-needed improvements in access to prescription drugs for elderly US residents but is also likely to increase these expenditures further. A large number of plans covering the elderly offer drug benefits with varying patient cost-sharing arrangements,1 few of which have been rigorously evaluated regarding their clinical and economic outcomes. Well-designed patient cost-sharing policies,4–7 as well as coverage restrictions,8 have been shown to produce net savings from the health plan’s perspective9 without adversely affecting health outcomes. Other interventions that disregard clinical logic, eg, global physician budgets or prescription caps, can lead to unanticipated outcomes, including increased rates of hospitalization10 and nursing home admissions.11 The evidence is inconclusive for the common 3-tiered copay systems.12,13
Such already-suboptimal use of statins makes them a problematic target for patient cost sharing. A study in US employer-sponsored health plans compared use in 3-tiered copay systems with full drug coverage and found a doubling of discontinuation rates among statin users (21% versus 11%, \(P=0.04\)).

PharmaCare, the province-funded drug insurance plan in British Columbia (BC), provided full prescription drug coverage for all elderly before January 2002. In January 2002, a prescription copayment policy for elderly residents of Can $25 (Can $10 for low-income seniors) was implemented. In May 2003, the seniors’ copayment was replaced with 25% coinsurance plus an income-based deductible policy. Linking deductible cost-sharing levels to income was intended to prevent low-income patients from underutilizing essential drugs. This natural experiment among all elderly BC residents provided the opportunity to evaluate the consequences of 2 consecutive patient cost-sharing interventions on adherence to statin therapy and initiation of statin therapy after AMI in a large stable population of older adults.

Methods

Patients
To assess the effects of the copay and coinsurance policies on statin adherence rates among new users of statins, we selected 3 cohorts, which comprised a baseline cohort of seniors initiating statins within 6 months before January 2001, a copayment cohort of seniors who started taking statins within 6 months before the copay policy began in January 2002, and a coinsurance cohort who started taking statins within 6 months before the coinsurance policy began in May 2003 (Figure 1). Each cohort’s time was split into 3 distinct periods: a 6-month period to rule out prior statin use, a 6-month cohort recruitment period, and a 9-month postrecruitment follow-up period. Initiation was defined as filling a first statin prescription during the 6-month cohort recruitment period without having filled a statin prescription in the 6-month rule-out period that preceded it. Follow-up for each subject began on his or her initiation date during the 6-month cohort recruitment period and extended for an additional 9-month follow-up period after the policy changes, or until January 2003 for the baseline cohort (Figure 1). In a secondary analysis, we restricted these new-user cohorts to patients receiving statins for secondary prevention after MI or coronary revascularization in the year before initiation.

All patients were identified in the linked healthcare utilization databases of the publicly funded healthcare system of BC. Regardless of payer, pharmacists enter medication names, dose, and dispensed quantity for all dispensed prescription drugs into a single database via a province-wide network that ensures minimal underreporting and misclassification. The Ministry of Health maintains linkable data on all physician services and hospitalizations for all persons aged 65 years and above. Up to 25 diagnoses for hospital discharges and 1 diagnosis for each medical service are recorded, with good specificity and completeness.

To assess the effects of the policy changes on rates of statin initiation after MI, we identified all patients who were hospitalized for an AMI between January 2000 and December 2004, a period that spanned the baseline and both policy periods. MIs were identified on the basis of the presence of an International Classification of Diseases, 9th Revision (ICD-9) diagnosis code of 410 as a primary or secondary diagnosis and a length of hospitalization between 3 and 180 days; this definition has been found to be highly accurate (positive predictive value 95%). Patients were also required to survive at least 60 days after hospital discharge. The outcome of interest was statin initiation within 60 days of discharge. To control for changes in statin utilization that might have independently occurred at the same time as the policy changes, including factors such as cumulating evidence of the preventive effectiveness of statins and their increasing incorporation into treatment guidelines, we created a control time trend of statin initiation rates among a cohort of elderly patients with a hospitalization for AMI who did not experience the policy changes. This cohort was derived from Medicare beneficiaries enrolled in the Pennsylvania Pharmaceutical Assistance Contract for the Elderly (PACE), a state-funded prescription benefit program for low-income seniors, which offered full drug coverage without copayments throughout the study period. Although differences may exist between the 2 populations, by establishing the relationship between trends in their statin initiation before the policy changes in BC, it is possible to detect disruptions of this relationship by the policy changes.

Measurement of Statin Adherence
Adherence was calculated for each calendar month on the basis of the proportion of patient-days categorized as adherent. First the proportion of days covered (PDC) was calculated for each patient by dividing the number of days with statin supply available by the number of patient-days contributed in that calendar month. On the basis of their PDC, patients were then classified as adherent in that
month if their PDC was $>80\%$, a somewhat arbitrary but widely used cut point.\textsuperscript{25,33,34}

The numerator of the PDC measure was calculated by creating a statin supply diary for each patient-day by stringing together consecutive statin dispensings based on dispensing dates and reported “days’ supply.”\textsuperscript{35} When a dispensing occurred before the previous dispensing should have run out, utilization of the new dispensing was assumed to begin the day after the end of the old dispensing, and days with drug supply were accumulated. If a patient accumulated more than 180 days’ supply on a given day, then accumulated supply was truncated at 180 days. Discontinuation was defined as failing to fill a new statin prescription within 90 days of exhausting a previous dispensing. Discontinuation date was the end of accumulated days’ supply from the last script.

Our approach using a statin supply diary and the pharmacist-recorded days’ supply accommodates potential tablet hoarding before and tablet splitting after the policy changes. Residents who left the province or died were censored from the denominator of the PDC measure at their last service or the date of death.

**Patient Characteristics**

A number of patient characteristics were assessed at the start of each of the 3 cohorts, including age, gender, adjusted family income status (Can $16K, \geq$Can $16K$ to \leq Can $22K$, and $>$Can $22K$, as defined by premium subsidy levels),\textsuperscript{36} number of days with a physician visit, number of acute hospitalizations, number of different diagnoses (3-digit ICD code), Charlson comorbidity index,\textsuperscript{37} history of MI, congestive heart failure (hospitalization with ICD-9 code 425 or 428 plus a prescription for a loop diuretic or digoxin), angina (visit with ICD-9 code 411 or 413 or a nitrate prescription), revascularization procedure, diabetes mellitus (visit with ICD-9 code 250 or 357 plus 2 insulin or oral antiglycemic prescriptions), hypertension (visit with ICD-9 code 401 to 405 plus 2 antihypertensive prescriptions), peripheral vascular disease (visit with ICD-9 code 440), and cerebrovascular disease (visit with ICD-9 code 433, 434, or 436). For the adherence and stopping analyses, the covariate assessment period was 12 months before each patient’s initiation of statin therapy. For the statin initiation analysis after MI, it was 6 months. Income status was imputed based on Medical Service Plan subsidy level, which is a good proxy for family adjusted income, although it tends to slightly underestimate the proportion of elderly in low-income strata.\textsuperscript{38}

**Ethics Approval**

The human subjects review boards of the Brigham and Women’s Hospital and the University of Victoria approved the study.

### TABLE 1. Baseline Covariates for 3 Cohorts of New Statin Users

<table>
<thead>
<tr>
<th>Patient age, y</th>
<th>Cohort 1 (Baseline) (n=12 545)</th>
<th>Cohort 2 ($10 to $25 Copay) (n=13 186)</th>
<th>Cohort 3 (25% Coinsurance) (n=15 830)</th>
<th>$\chi^2$ Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>72.2</td>
<td>72.4</td>
<td>72.8</td>
<td>...</td>
</tr>
<tr>
<td>65–70</td>
<td>5635 (44.9)</td>
<td>5732 (43.5)</td>
<td>6431 (40.6)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>71–75</td>
<td>3658 (29.2)</td>
<td>3857 (29.3)</td>
<td>4622 (29.2)</td>
<td>...</td>
</tr>
<tr>
<td>76–80</td>
<td>2268 (18.1)</td>
<td>2411 (18.3)</td>
<td>3034 (19.2)</td>
<td>...</td>
</tr>
<tr>
<td>≥81</td>
<td>984 (7.8)</td>
<td>1186 (9.0)</td>
<td>1743 (11.0)</td>
<td>...</td>
</tr>
<tr>
<td>Female gender</td>
<td>6288 (50.1)</td>
<td>6676 (50.6)</td>
<td>7929 (50.1)</td>
<td>0.49</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Income status (in Can $/year)</th>
<th>Cohort 1 (Baseline) (n=12 545)</th>
<th>Cohort 2 ($10 to $25 Copay) (n=13 186)</th>
<th>Cohort 3 (25% Coinsurance) (n=15 830)</th>
<th>$\chi^2$ Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>$&gt;$22 000</td>
<td>8139 (65.3)</td>
<td>8705 (66.3)</td>
<td>9844 (62.5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>$&gt;$16 000–22 000</td>
<td>1261 (10.1)</td>
<td>1343 (10.2)</td>
<td>1012 (6.4)</td>
<td>...</td>
</tr>
<tr>
<td>$\leq$16 000</td>
<td>3071 (24.6)</td>
<td>3075 (23.4)</td>
<td>4897 (31.1)</td>
<td>...</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No. of physician visit days</th>
<th>Cohort 1 (Baseline) (n=12 545)</th>
<th>Cohort 2 ($10 to $25 Copay) (n=13 186)</th>
<th>Cohort 3 (25% Coinsurance) (n=15 830)</th>
<th>$\chi^2$ Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–3</td>
<td>585 (4.7)</td>
<td>715 (5.4)</td>
<td>833 (5.3)</td>
<td>0.01</td>
</tr>
<tr>
<td>≥4</td>
<td>11660 (95.3)</td>
<td>12471 (94.6)</td>
<td>14997 (94.7)</td>
<td>...</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No. of hospital admissions</th>
<th>Cohort 1 (Baseline) (n=12 545)</th>
<th>Cohort 2 ($10 to $25 Copay) (n=13 186)</th>
<th>Cohort 3 (25% Coinsurance) (n=15 830)</th>
<th>$\chi^2$ Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–3</td>
<td>12 150 (96.9)</td>
<td>12 793 (97.0)</td>
<td>15 384 (97.2)</td>
<td>0.26</td>
</tr>
<tr>
<td>≥4</td>
<td>395 (3.2)</td>
<td>393 (3.0)</td>
<td>446 (2.8)</td>
<td>...</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No. of different diagnoses</th>
<th>Cohort 1 (Baseline) (n=12 545)</th>
<th>Cohort 2 ($10 to $25 Copay) (n=13 186)</th>
<th>Cohort 3 (25% Coinsurance) (n=15 830)</th>
<th>$\chi^2$ Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–3</td>
<td>12 518 (99.8)</td>
<td>13 152 (99.7)</td>
<td>15 806 (99.9)</td>
<td>0.13</td>
</tr>
<tr>
<td>≥4</td>
<td>27 (0.22)</td>
<td>34 (0.26)</td>
<td>24 (0.15)</td>
<td>...</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Charlson Comorbidity Index</th>
<th>Cohort 1 (Baseline) (n=12 545)</th>
<th>Cohort 2 ($10 to $25 Copay) (n=13 186)</th>
<th>Cohort 3 (25% Coinsurance) (n=15 830)</th>
<th>$\chi^2$ Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–4</td>
<td>12 065 (96.2)</td>
<td>12 646 (95.9)</td>
<td>15 157 (95.8)</td>
<td>0.20</td>
</tr>
<tr>
<td>≥5</td>
<td>480 (3.8)</td>
<td>540 (4.1)</td>
<td>673 (4.3)</td>
<td>...</td>
</tr>
<tr>
<td>Prior MI</td>
<td>1202 (9.6)</td>
<td>1157 (8.8)</td>
<td>1399 (8.8)</td>
<td>0.04</td>
</tr>
<tr>
<td>Prior CHF</td>
<td>653 (5.2)</td>
<td>686 (5.2)</td>
<td>867 (5.5)</td>
<td>0.48</td>
</tr>
<tr>
<td>Prior angina</td>
<td>3366 (26.8)</td>
<td>3345 (25.37)</td>
<td>3746 (23.66)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Prior revascularization</td>
<td>455 (3.6)</td>
<td>527 (4)</td>
<td>683 (4.3)</td>
<td>0.01</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>1777 (14.2)</td>
<td>2028 (15.4)</td>
<td>2489 (15.7)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Hypertension</td>
<td>5734 (45.7)</td>
<td>6138 (46.6)</td>
<td>7851 (49.6)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Peripheral vascular disease</td>
<td>673 (5.4)</td>
<td>717 (5.4)</td>
<td>772 (4.9)</td>
<td>0.06</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>697 (5.6)</td>
<td>681 (5.2)</td>
<td>825 (5.2)</td>
<td>0.31</td>
</tr>
</tbody>
</table>

CHF indicates congestive heart failure. Values are n (%).
agreements were in place with the Ministry of Health in BC and the Center for Medicare and Medicaid Services.

Statistical Analyses

Policy Effects on Statin Adherence
Time trends of monthly adherence proportions were plotted for all 3 cohorts and aligned at the first day of the cohort entry period to achieve comparability of trends. We used segmented linear regression to estimate sudden changes in slopes or levels of monthly rates adjusted for covariates mentioned above. To estimate changes in level and slope attributable to the policy, we used regression models that included a constant term, a linear time trend (months 1 to 6), a binary indicator for a 3-month transition period (months 7 to 9), a binary indicator for the postpolicy period starting at month 10, and linear time trends for the postpolicy periods.49 Policy effects were determined as interaction terms between policy indicators and the level and slope parameters. This analysis leads by design to an underestimation of the decline in adherence during the cohort entry period because of the varying time of cohort entry; however, it will provide valid and the most efficient estimates of the policy effects on adherence. We used a longitudinal repeated-measures design and adjusted standard errors using generalized estimating equations40 adjusted for patient covariates, including age, sex, months since statin initiation, comorbidities, income status, history of coronary heart disease, and risk factors for coronary heart disease. We assessed effect modification by low-income status by including a multiplicative interaction term.

The authors had full access to and take full responsibility for the integrity of the data. All authors have read and agree to the manuscript as written.

Results
The number of new statin starters used to define the 3 study cohorts increased over time from 12 545 (baseline), to 13 186 (copay cohort), to 15 830 (coinsurance cohort; Table 1), which is a 4- to 8-times faster increase than the population growth of BC residents aged 65 years and older.42 There was an increase in patient age and an increase in patients with cardiac risk factors, including a history of diabetes mellitus and hypertension, in the policy cohorts compared with baseline. The proportion of statin users with a history of angina or MI declined over time, which suggests an increased use for primary prevention. Unadjusted discontinuation rates per 100 users per month increased from 3.3 (95% CI, 3.2 to 3.4) during baseline to 4.1 (4.0 to 4.3) and 3.9 (3.8 to 4.1) during copay and coinsurance policies.

Patients identified with AMIs during the study period were older (78 ± 7.2 years) than the group of all statin initiators. They had the following frequencies of preexisting conditions: diabetes mellitus, 7.4%; hypertension, 26.7%; angina, 12.6%; congestive heart failure, 5.7%; peripheral vascular disease, 1.9%; cerebrovascular disease, 2.2%; prior MI, 7%; and prior revascularization, 1.5%. The Pennsylvania time-trend control group was older than the BC MI population (82 ± 7.3 years) and had more comorbidities, including diabetes mellitus (14.3%), hypertension (50%), congestive heart failure (9.9%), peripheral vascular disease (10.1%), cerebrovascular disease (12.1%), and prior MI (16.6%). Rates of angina (13%), and prior revascularization (1%) did not differ from the BC population.

The median patient cost sharing for a 90-day statin supply was Can $21.5 under the copay policy and Can $41.8 under the coinsurance policy. Among statin initiators, there was a sharp reduction in adherence in the 6-month cohort entry periods in all 3 cohorts (−6% per month, P < 0.0001). This decline stabilized 3 months after the policy change (Figure 2), with the rate of decrease in adherence falling to ≈1% per month in all 3 cohorts. However, the proportion of statin adherent patients was significantly lower starting with the third month after policy change in the copayment (−5.4% points; 95% CI, −6.4% to −4.4%) and coinsurance cohorts.

![Figure 2. Adherence for the baseline, copayment, and coinsurance cohorts showing a sudden decline in adherence ~100 days (equal to the median prescription supply) after the policy changes. Adherence was measured as the proportion of patients with ≥80% of days covered during each month. Unadjusted proportions were plotted.](image-url)
The proportion of new initiations of statin therapy after AMI increased steadily by 1.7 percentage points per quarter starting from 41% at baseline (Figure 3). There was no discontinuation of this trend by the policy changes after adjustment for a Pennsylvania time trend (probability values for policy level effects were 0.77 for the copay and 0.29 for the coinsurance policy; probability values for policy slope effects were 0.09 for both policies). In Pennsylvania, the proportion of new initiations was ~20 percentage points lower than in BC throughout the observation period, with similar quarterly increases (+1.7 percentage points).

An analysis that adjusted for patient characteristics confirmed that 100% coinsurance benefit status was associated with an almost 2-fold increase in statin discontinuation compared with full coverage (Table 2). Such 100% out-of-pocket spending affected a fair proportion of elderly beneficiaries, because the coinsurance policy required income-based deductible payments. Before this deductible was reached, patients had to pay 100% out of pocket.

Lower income increased the likelihood of stopping statins independent of insurance status. Having had an AMI or revascularization procedure in the year before initiation decreased a patient’s odds of stopping by 37%. When we modeled the actual amount of patient out-of-pocket payments, it was associated with statin discontinuation compared with full coverage after multivariate adjustment of patient characteristics: >Can $0 to Can $20, odds ratio = 1.76; >Can $20 to Can $50, odds ratio = 2.51; >Can $50 to Can $100, odds ratio = 2.36; and >Can $100, odds ratio = 3.77. Independent of insurance status, patients with a recent history of MI or revascularization or with multiple comorbidities were less likely to discontinue statin therapy (Table 2).

**Discussion**

Although statins are among the most effective drugs to prevent coronary heart disease and reduce the risk for MI and stroke, adherence with statin therapy consistently has been found to be far from optimal even in populations with full drug insurance coverage. It was speculated that patient copayments would worsen this already unfavorable situation.

This evaluation of a population-based natural experiment of older adults found that already had adherence to newly initiated statin therapy was further reduced by 5 percentage points as a consequence of a fixed copayment policy and a subsequent coinsurance policy. Such a decline in adherence can be best put into perspective when compared with the most effective interventions to improve adherence among statin users, which can increase adherence by 5 percentage points, albeit at a substantial price. Statin therapy initiation after AMI was not affected by these cost-sharing policies and increased at a rate comparable to that of a control population with full drug coverage. A closer look at the reasons for reduced statin adherence revealed that patients’ insurance status and actual out-of-pocket payments were significant predictors for stopping statin use.

A subgroup analysis in low-income patients showed that the copay policy reduced statin adherence but not the subsequent coinsurance policy. This can be explained by the fact that all elderly patients in BC had full coverage at baseline and were subsequently subjected to the copayments with little
or no exemptions. The coinsurance, however, came with generous exemptions for low-income patients and resembled almost full coverage for that patient group. It was surprising to find that adherence to statin medications for secondary prevention in patients with prior MI declined comparably with the total study population, which was composed mostly of primary prevention users. This means that the cost-sharing policy may not decrease the initiation of statin therapy after MI but will affect longer-term use in a clinically meaningful way. Consequently, consideration should be given to fully exempt high-risk patients, e.g., patients after an AMI, from drug cost sharing. It has been shown that such strategies would not only prolong life but would also save money for the health plan by reducing the number of nonfatal events.44

The present findings for the copay policy are supported by earlier studies showing that simple fiscal cost-containment measures that do not consider the comparative effectiveness of drugs nor the patients’ health and income status have detrimental effects on drug utilization. A population-based time series study among seniors in Quebec by Tamblyn et al found a 9% reduction in the use of essential prescription drugs after the introduction of a 25% coinsurance policy but also reported that adverse health outcomes more than doubled in elderly patients. A study across 5 US managed-care organizations directly linked out-of-pocket spending to low adherence.46 It found that large increases in cost sharing (> $10 per monthly supply) were associated with immediate and persistent reductions in oral hypoglycemic medication use.

Time-trend analyses or repeated cohort designs are considered valid study designs to study the short-term effects of drug policy changes by adjusting for most time-invariant confounders.47,48 A potential threat to validity in such designs when longer-term effects are studied is the presence of underlying utilization time trends that are independent of the policy interventions, which is why we adjusted for time trends in the secondary prevention use of statins and compared any potential changes in trend with similar changes in a comparable population but without drug cost-sharing. The observation that secondary prevention is lower in Pennsylvania than in BC will not affect this inference because our analysis focuses on the relative change in trend only.48 This lower initiation rate in Pennsylvania can be explained by the generally worse health state of this low-income population and a slightly higher fraction of patients with MI who had already used statins before their MI, which therefore left a more selected population who were thought to be less eligible for starting statins after their MIs.

Another concern would be other interventions that took place at the time of the study intervention. In BC, chronic disease management programs for diabetes mellitus began in Victoria in June 2003 and involved promoting statin use among patients with diabetes mellitus; however, this program was limited to only a small proportion of the province during the study period, and it is unlikely that it would have had a measurable and immediate impact. Also, we found a continuous increase in patients with diabetes mellitus even before the disease management program was initiated that was adjusted for in the present analysis. Statin stockpiling could also not have distorted the present results, because we calculated adherence and discontinuation while accounting for the quantity dispensed.

An important implication for the new Medicare Part D drug coverage for seniors is that policies that simply share the financial burden of buying drugs with patients will lead to suboptimal utilization of medications such as statins that have been shown to prolong life. In contrast, therapeutic substitution policies that provide financial incentives to replace high-priced drugs with lower-priced but therapeutically equivalent drugs have consistently been shown to be effective in reducing drug spending without causing unintended effects, including discontinuations, physician visits, and hospitalizations.47,12,49 An equally important implication is that

| TABLE 2. Independent Risk Factors for Discontinuing Statin Therapy, From Logistic Regression Analysis* |
|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Benefit status                  | Odds Ratio                      | 95% Confidence Interval         | P                               |
| Full coverage                   | Reference                       | ...                             | ...                             |
| Can $10 Copayment              | 1.44                            | 1.36–1.53                       | <0.001                          |
| Can $25 Copayment              | 1.61                            | 1.53–1.70                       | <0.001                          |
| 25% Coinsurance†               | 1.31                            | 1.23–1.38                       | <0.001                          |
| 100% Coinsurance†              | 1.94                            | 1.82–2.08                       | <0.001                          |
| Patient age, y                  |                                  |                                 |                                 |
| 65–70                          | Reference                       | ...                             | ...                             |
| 71–75                          | 0.96                            | 0.92–1.01                       | 0.119                           |
| 76–80                          | 0.90                            | 0.85–0.95                       | <0.001                          |
| ≥81                            | 0.76                            | 0.70–0.82                       | <0.001                          |
| Female gender                  | 1.02                            | 0.98–1.06                       | 0.433                           |
| Income status (in Can $/year)   |                                  |                                 |                                 |
| >22 000                        | Reference                       | ...                             | ...                             |
| >16 000–22 000                  | 1.11                            | 1.03–1.20                       | 0.007                           |
| ≤16 000                        | 1.45                            | 1.37–1.53                       | <0.001                          |
| No. of physician visit days (≥4) | 0.92                            | 0.84–1.00                       | 0.039                           |
| Hospital admissions (≥4)       | 0.86                            | 0.75–0.98                       | 0.027                           |
| No. of different diagnoses (≥4) | 0.98                            | 0.65–1.47                       | 0.908                           |
| Charlson Comorbidity Index (≥5) | 0.47                            | 0.42–0.54                       | <0.001                          |
| Prior MI or revascularization  | 0.63                            | 0.59–0.68                       | <0.001                          |
| Prior angina                   | 0.99                            | 0.95–1.04                       | 0.725                           |
| Prior CHF                      | 1.06                            | 0.96–1.17                       | 0.230                           |
| Diabetes mellitus              | 0.90                            | 0.85–0.95                       | <0.001                          |
| Hypertension                   | 0.91                            | 0.88–0.95                       | <0.001                          |
| Peripheral vascular disease    | 0.74                            | 0.67–0.82                       | <0.001                          |
| Cerebrovascular disease        | 0.59                            | 0.53–0.65                       | <0.001                          |

CHF indicates congestive heart failure.

*Each factor was adjusted for all other factors and represents independent effect estimates. The effects of patient risk factors are therefore independent of the policy effects in this analysis.

†The 100% coinsurance policy affected a fair proportion of elderly beneficiaries because the policy required deductible payments that were based on income. Before this deductible was reached, patients had to pay 100% of costs out of pocket.
abrupt changes from drug coverage to no coverage, a consequence of Medicare’s Part D “doughnut hole” after patients have accumulated $2250 of purchased drugs per year, will double the discontinuation of such important drugs in seniors. Many but not all commercial drug benefit plans under Part D have chosen to close this hole.1

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References
Statin Therapy Under Drug Cost Sharing


**CLINICAL PERSPECTIVE**

Statin therapy is known to be close to only 50% 12 months after initiation, even among patients with generous drug insurance coverage. The present population-based research showed that the addition of a $20 patient copayment or 20% coinsurance to each dispensing of a statin will further reduce adherence by 5 percentage points, and even more so in low-income patients. This patient cost sharing did not reduce initiation of statin after hospitalization for an acute myocardial infarction.

Statins are medications of proven effectiveness to reduce the risk of cardiac events when taken regularly. Adherence to statin therapy is known to be close to only 50% 12 months after initiation, even among patients with generous drug insurance coverage. The present population-based research showed that the addition of a $20 patient copayment or 20% coinsurance to each dispensing of a statin will further reduce adherence by 5 percentage points, and even more so in low-income patients. This patient cost sharing did not reduce initiation of statin after hospitalization for an acute myocardial infarction.
Adherence to Statin Therapy Under Drug Cost Sharing in Patients With and Without Acute Myocardial Infarction: A Population-Based Natural Experiment

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Appendix: Details of the regression models

a) Modeling policy effects on the proportion of statin adherence in each month adjusted for patient characteristics using a generalized linear regression model with a linear link function with normal errors and adjusting for autocorrelation using generalized estimating equations:

\[
\text{adherence} = \text{intercept} + \text{time} + \text{copay} + \text{coinsurance} + \text{post\_month9} + \text{time\_post\_month9} + \\
(\text{post\_month9} * \text{copay}) + (\text{post\_month9} * \text{coinsurance}) + \\
\text{age} \geq 76 + \text{income} < 22k + \text{female} + \text{Charlson} \geq 5 + \text{CHD\_level} + \text{diabetes} + \\
# \text{hospitalizations} \geq 4 + \text{hypertension} + \text{cerebrovascular disease} + \text{peripheral vascular disease} + \text{congestive heart failure} + \epsilon
\]

b) Modeling policy effects on the proportion of statin initiation after acute MI adjusted for time trends (by quarter) and regional differences (1 = intervention region, British Columbia; 0 = control region, Pennsylvania) and patient characteristics using a segmented linear regression model:

\[
\text{post\_MI\_use} = \text{intercept} + \text{quarter} + \text{copay} + \text{coinsurance} + \text{region} + \\
(\text{copay}\_\text{region}) + (\text{copay}\_\text{time}) + (\text{copay}\_\text{region}\_\text{time}) + (\text{coinsurance} \_\text{region}) + \\
(\text{coinsurance}\_\text{time}) + (\text{coinsurance}\_\text{region}\_\text{time}) + \% \text{age} \geq 76 + \% \text{female} + \% \text{prior AMI} + \% \text{prior revascularization} + \epsilon
\]

c) Modeling policy effects on statin discontinuation (yes/no) adjusted for patient characteristics and month since initiation using a generalized linear model with a logit link function and adjusting for autocorrelation using generalized estimating equations:

\[
\text{logit (stopping)} = \text{intercept} + \text{month} (11 \text{ indicators}) + \$10 \text{ copayment} + \$25 \text{ copayment} + 25\% \text{ coinsurance} + 100\% \text{ coinsurance} + \text{age} (3 \text{ indicators}) + \text{income} (2 \text{ indicators}) + \\
\text{female} + \text{Charlson} \geq 5 + \text{AMI or revascularization} + \text{angina} + \text{diabetes} + \# \text{office}
\]
visits ≥ 4 + # hospitalizations ≥ 4 + # diagnoses ≥ 4 + hypertension + cerebrovascular
disease + peripheral vascular disease + congestive heart failure + e