Adverse Events Associated With Prescription Drug Cost-Sharing Among Poor and Elderly Persons

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Context Rising costs of medications and inequities in access have sparked calls for drug policy reform in the United States and Canada. Control of drug expenditures by prescription cost-sharing for elderly persons and welfare recipients is a contentious issue because little is known about the health impact in these subgroups.

Objectives To determine (1) the impact of introducing prescription drug cost-sharing on use of essential and less essential drugs among elderly persons and welfare recipients and (2) rates of emergency department (ED) visits and serious adverse events associated with reductions in drug use before and after policy implementation.

Design and Setting Interrupted time-series analysis of data from 32 months before and 17 months after introduction of a prescription coinsurance and deductible cost-sharing policy in Quebec in 1996. Separate 10-month prepolicy control and postpolicy cohort studies were conducted to estimate the impact of the drug reform on adverse events.

Participants A random sample of 93,950 elderly persons and 55,333 adult welfare medication recipients.

Main Outcome Measures Mean daily number of essential and less essential drugs used per month, ED visits, and serious adverse events (hospitalization, nursing home admission, and mortality) before and after policy introduction.

Results After cost-sharing was introduced, use of essential drugs decreased by 9.12% (95% confidence interval [CI], 8.7%-9.6%) in elderly persons and by 14.42% (95% CI, 13.3%-15.6%) in welfare recipients; use of less essential drugs decreased by 15.14% (95% CI, 14.4%-15.9%) and 22.39% (95% CI, 20.9%-23.9%), respectively. The rate (per 10,000 person-months) of serious adverse events associated with reductions in use of essential drugs increased from 5.8 in the prepolicy control cohort to 12.6 in the postpolicy cohort in elderly persons (a net increase of 6.8 [95% CI, 5.6-8.0]) and from 14.7 to 27.6 in welfare recipients (a net increase of 12.9 [95% CI, 10.2-15.5]). Emergency department visit rates related to reductions in the use of essential drugs also increased by 14.2 (95% CI, 8.5-19.9) per 10,000 person-months in elderly persons (prepolicy control cohort, 32.9; postpolicy cohort, 47.1) and by 54.2 (95% CI, 33.5-74.8) among welfare recipients (prepolicy control cohort, 69.6; postpolicy cohort, 123.8). These increases were primarily due to an increase in the proportion of recipients who reduced their use of essential drugs. Reductions in the use of less essential drugs were not associated with an increase in risk of adverse events or ED visits.

Conclusions In our study, increased cost-sharing for prescription drugs in elderly persons and welfare recipients was followed by reductions in use of essential drugs and a higher rate of serious adverse events and ED visits associated with these reductions.

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ADVERSE OUTCOMES OF PRESCRIPTION DRUG COST-SHARING

Table 1. Drugs Included in the Essential and Less Essential Categories

<table>
<thead>
<tr>
<th>Essential drugs</th>
<th>Insulin, anticoagulants, angiotensin-converting enzyme inhibitors, lipid-reducing medication, antihypertensives, furosemide, β-blockers, antiarrhythmics, aspirin, antiviral medication, thyroid medication, neuroleptics, antidepressants, anticonvulsants, antiparkinsonian drugs, prednisone, β-agonists, inhaled steroids, chloroquine, primaquine, and cyclosporine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less essential drugs</td>
<td>Dipryridamole, probenicide, meperidine, and benzodiazepines (excluding clonazepam and clobazam)</td>
</tr>
</tbody>
</table>

Treatment of potentially preventable illnesses. 7,22

Cost-sharing policies that require the consumer to pay a percentage of the cost of the prescribed medication may be less likely to produce unintended health effects. But the impact of this type of cost-sharing on the use of health services has not been evaluated in poor persons, and only one inconclusive evaluation has been conducted for elderly persons. 10

In 1996, the Canadian province of Quebec attempted to enhance equity of access to prescription drugs by legislating mandatory drug insurance for all residents. 23 To help finance this coverage, a deductible and a 25% coinsurance charge was instituted for previously insured beneficiaries who received free medication: elderly persons and welfare recipients. The existence of comprehensive, linkable databases on drug and health care use in Quebec provided a unique opportunity to evaluate the impact of cost-sharing on the use of essential and less essential drugs and determine the rate of emergency department (ED) visits and serious adverse events (hospitalization, nursing home admission, and mortality) associated with reductions in drug use before and after the implementation of the cost-sharing policy.

METHODS

Quebec Drug Policy Reform

Prior to the drug policy reform, welfare recipients and low-income elderly persons (5.7% of the total elderly population in Quebec) received free medication, and all other elderly persons paid $2 per prescription up to a maximum of $100 per year (all values are in Canadian dollars). On August 1, 1996, both groups became subject to a 25% coinsurance fee up to an annual maximum of $200 for welfare recipients and income-indexed ceilings of $200, $500, and $750 for elderly persons. On January 1, 1997, an annual deductible of $100 was added to the 25% coinsurance fee, with the annual deductible and ceiling prorated on a quarterly basis. On July 1, 1997, the annual ceiling and deductible were prorated on a monthly basis to reduce the amount a recipient would have to pay per month to a maximum of $16.67 ($200 plan) to $62.50 ($750 plan). Children and selected subgroups were exempted from cost-sharing and continued to receive free medication. A computerized, real-time link between the provincial health plan administration (Régie de l’assurance maladie du Québec [RAMQ]) and pharmacies was put in place to administer the policy.

Design and Study Populations

To study the intended impact of cost-sharing and to evaluate the health effects of reducing drug use, we identified a subset of essential and less essential drugs for evaluation using published classifications (Table 1). 18,24,25 Essential drugs were defined as medications that prevent deterioration in health or prolong life and would not likely be prescribed in the absence of a definitive diagnosis. Because there was no information on indication for treatment, the second criterion was added to limit the analysis to only those people who were using drugs for which reductions in use would be expected to have an impact on health status. The most commonly used drugs excluded using this criterion were antibiotics and gastroprotective medications, drugs targeted by many intervention programs to reduce overuse. 26 Less essential drugs were defined as medications that may provide relief of symptoms but will likely have no effect on the underlying disease process. 25 Drugs included in the essential and less essential categories were independently identified and then rated by the 7 clinical coinvestigators. A medication was included if 6 of the 7 clinical coinvestigators agreed with the classification of the respective drug and it was insured through the RAMQ provincial health care plan. The subset of drugs included in the evaluation of essential and less essential drug use represented 21% of all insured drugs and 55% of all prescriptions dispensed.

An interrupted time-series design was used to estimate changes in prescription drug use after the introduction of the drug policy. Monthly measures of overall drug use as well as the use of essential and less essential drugs in the 3 years preceding the policy and in the first 17 postpolicy months were calculated for individual persons. A random sample of 120000 welfare recipients and 120000 elderly persons was selected. Persons were eligible for inclusion in the analysis if they were alive on the date of policy implementation, filled at least 1 prescription for a drug in the year before the policy, and were not exempted from the cost-sharing policy. The evaluation of essential and less essential drugs was limited to persons who had filled at least 1 prescription for drugs within these categories in the prepolicy year. Individuals contributed to the analysis only during the months in which they were enrolled.

Separate prepolicy control and postpolicy cohort studies were conducted to determine the impact of the policy on the rates of adverse events and ED visits associated with reductions in use of essential and less essential drugs. Each study produced an estimate of the risk associated with reduction in drug use, the proportion of the population making reductions, the population attributable fraction, and the rate of adverse events and ED visits associated with reductions in drug use. The 2 stud-
The difference in the perceptions about the importance of forgetfulness, adverse effects, or misunderstandings in needed therapy, because ofverse drug events due to injudicious re-
dree, individuals will experience ad-
portant because even when drugs are
timate of an expected rate was im-
prepolicy control study provided an es-
ies were designed to estimate both the
was assumed that the impact of reduc-
vatively assumed that expected drug use
were limited to regular recipients of es-
and postpolicy cohort studies, reductions in drug use
es were measured first by estimating an ex-
and postpolicy control study approach veri-
was excluded because of possible pre-
ials were linked by unique encrypted health numbers. The beneficiary demo-
graphic database provided data on drug
was used to measure ED visits and hos-
hospitalization-institutionalization. The hos-
vised measures were used to summarize dif-
min ceilings instituted a pattern whereby reductions in one month may be
compensated for by increases in the next when drugs were free for those per-
sions reaching the spending ceiling. Cum-
ulative mean monthly increases (ob-
erved > expected) and reductions (observed < expected) in drug use were
calculated as the sum (from the first fol-
low-up month) of the monthly differ-
ence in observed and expected drug use
divided by the number of follow-up months. For example, an individual
who had an expected value of 5 drugs per month and who filled prescrip-
tions for 3 drugs in the first 2 months of follow-up and 8 in the third month
would have a mean cumulative reduc-
ies were conducted in comparable 10-
month periods before (August 1995 to
1996) and after (August 1996-1997)
policy implementation (FIGURE 1). The
prepolicy control study provided an es-
imate of the expected rate of adverse
events due to reductions in drug use
prior to policy implementation. The es-
timation of an expected rate was im-
portant because even when drugs are
free, individuals will experience ad-
verse drug events due to injudicious re-
ductions in needed therapy, because of
forgetfulness, adverse effects, or mis-
perceptions about the importance of
drug treatment.27 The difference in
the rate in the prepolicy control study
vs the postpolicy study was used to esti-
mate the impact of the drug reform on
adverse events. This approach had sev-
eral advantages. First, it voided biases
related to ecological fallacy28 because
changes in drug use were linked at the
level of the individual with the occur-
cence of adverse events and ED visits.
Second, it provided a means of isolat-
ing the effect of the drug policy from
other health care policies that were
implemented in the same 4-year pe-
riod that may have reduced the rate of
ED visits and hospitalizations, unre-
lated to prescription drug use (hospi-
tal closures and reallocation of service
locations). Finally, the prepolicy and
postpolicy cohort study approach veri-
fied the assumption that the primary
impact of cost-sharing would be to in-
crease the prevalence of reductions
of drug use rather than changing the
“biological risk” associated with ration-
ing or stopping therapy. Thus, the stu-
dies were designed to estimate both the
risk and the population attributable
fraction of the share of adverse events
and ED visits due to reductions in drug
use, in the prepolicy and postpolicy
periods.
For this analysis, study populations
were limited to regular recipients of es-
ential or less essential drugs, defined
as persons who had a supply of the re-
spective medication in each of the 12
months prior to the follow-up period
or new users with a minimum of 6
months of continuous use.

Data Sources
Four provincial health databases, vali-
dated in previous research,29-31 were
linked by unique encrypted health
numbers. The beneficiary demo-
graphic database provided data on drug
plan eligibility, death, and beneficiary
characteristics. The prescription claims
database, which includes the drug,
quantity, date, and duration for each
prescription dispensed from community-
based pharmacies, was used to
measure medication use. The physi-
cian claims database, which includes
the date, type, and location of service
delivery (eg, inpatient, emergency, clinic),
was used to measure ED visits and hos-
hospitalization-institutionalization. The hos-
hospitalization database was used to
validate claims-based measures of hos-
hospitalization-institutionalization.

Prescription Drug Use
The number of drugs available each day
was calculated from prescription claims
records using methods developed to
convert the date, drug, and duration of
prescriptions dispensed into a drug-
by-day matrix.32 In each of the 53
months of the time series, a matrix of
monthly mean daily drug use was then
constructed for each beneficiary (for all
drugs and separately for essential and
less essential drugs). The first 3 months
of the time series and of coverage for
newly eligible recipients were ex-
cluded to avoid artificially lower val-
es for drug use in the first few months
of available prescription information.
The month immediately prior to policy
implementation also was excluded be-
cause of possible prescription stockpil-
ing, leaving 49 months for analysis.
For the prepolicy and postpolicy co-
hort studies, reductions in drug use
were measured first by estimating an ex-
pected daily drug use for each person.
The resulting expected values were then
compared with observed use in the 10-
month follow-up period. The ex-
pected use value was estimated as the
level predicted for the last baseline
month by a linear trend fit to each per-
son’s mean monthly daily drug use
in the baseline year. This method conser-

Figure 1. Time Series and Prepolicy Control and Postpolicy Cohort Design

The first 3 months of the time series and of an indi-
vidual’s enrollment in the public plan were excluded
because prescriptions filled prior to these dates were
unknown and created artificially low values for monthly
drug use. The month immediately prior to policy imple-
mentation also was excluded because of possible pre-
scription stockpiling.
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The impact of the drug policy on monthly drug use was adjusted for linear trend across time, season (11 monthly indicator variables), and individual characteristics (age, sex, type of insurance plan, baseline medication use, education, and income). Education and income were approximated by the mean census value for residents within the same postal code area (mean, 366 households). Analysis of adverse events and ED visits was adjusted for age, sex, number of months hospitalized, Charlson comorbidity values in the baseline year, expected level of medication use, and mean cumulative increases in drug use. For ED visits, we also adjusted for the individual’s frequency of ED visits in the baseline year.

Analysis
To estimate the impact of the policy on the level of drug use over time, random-effects, pooled-time series regression was used based on 49 prepolicy and postpolicy months. The individual was the unit of analysis, and an autoregressive first-order correlation structure (AR[1]) was assumed to represent the dependence among subsequent observations. Alternate correlation structures were also assessed (AR[2] and AR[12]), but there was no material impact of the choice of correlation structure on the estimated regression coefficients or SEs. AR[1] results were presented. To assess postpolicy reductions in drug use, we first used the 32 prepolicy months to estimate the effect of time, seasonal variation, and beneficiary characteristics and then to predict, for each person, expected use for the 17 months postpolicy as well as the absolute and relative differences between observed and expected use.

The occurrence of adverse events associated with reduction in use of essential and less essential drugs was estimated by hazard ratios derived from a Cox model using time-dependent covariates, modeled as continuous variables, to represent monthly changes in drug use. Proportional hazards and linearity assumptions were verified. The frequency of ED visits was modeled by Poisson regression, assuming a first-order autoregressive correlation structure in a generalized estimating equation approach and empirical SEs to account for overdispersion. Outcomes in a particular month were examined in relation to cumulative mean monthly measures of drug use in the previous month. For the prepolicy control and postpolicy cohort studies, the overall fraction of adverse events and ED visits associated with reductions in drug use was estimated separately using the approach of Greenland and Drescher and multiplied by the overall adverse event and ED visit rates to estimate the monthly rate of adverse events and ED visits associated with reductions in drug use. As no estimate of the intercept is available in the Cox model, logistic regression was used to estimate the proportion of adverse events associated with reductions (population-attributable fraction) for adverse events. The regression coefficients produced by the Cox and logistic models were almost identical. Standard errors and confidence intervals (CIs) for the difference in these adverse event rates in the prepolicy and postpolicy studies were estimated by bootstrapping, using 200 bootstrap samples.

RESULTS
Among the 120000 elderly persons sampled, 117408 were eligible for cost-sharing. Of the 117408, 93950 (80.0%) used prescription medication in the prepolicy year, and 70801 of the 93950 (75.3%) used essential drugs (TABLE 2). Among the 120000 welfare recipients sampled, 84272 were adults of whom 55333 (65.7%) used medication in the prepolicy year and 25820 (46.7%) used medications classified as essential drugs. Elderly persons used more drugs per day and had higher costs for therapy than welfare recipients. However, the proportions hospitalized in the prepolicy year were similar. Elderly persons and welfare recipients used at least twice as many essential as less essential drugs.

The most commonly used essential drugs in the elderly group were aspirin (13.2%), levothyroxine sodium (7.5%), and furosemide (6.0%). Among welfare recipients, the most commonly used essential drugs were salbutamol (5.9%) and levothyroxine sodium (5.0%). Benzodiazepines were the most commonly used less essential medication in the elderly and welfare recipient groups.

The introduction of the drug policy was followed by substantial and statistically significant reductions in the overall number of drugs used per day by both elderly persons (9.1%; 95% CI, 8.8%-9.5%) and adult welfare recipients (15.94%; 95% CI, 15.0%-16.9%). Similar reductions also were seen for the use of essential drugs as well as a slower rate of increase in drug use over time (policy/time interaction: elderly persons: β = -0.02; P < .001; welfare recipients: β = -0.009; P < .001) (FIGURE 2).
showed a 9.12% (95% CI, 8.7%-9.6%) reduction in the number of essential drugs used per day (0.17 drugs; 95% CI, 0.16-0.18). Absolute and relative reductions were higher among welfare recipients (14.4%; 95% CI, 13.3%-15.6% and absolute reduction: 0.21; 95% CI, 0.19-0.23 essential drugs per day).

Relative reductions were greater in the use of less essential drugs by elderly persons and welfare recipients (15.14%; 95% CI, 14.4%-15.9% and 22.39%; 95% CI, 20.9%-23.9%, respectively) than for essential drugs (FIGURE 3). However, because fewer less essential drugs were used per day, the absolute size of the reduction was smaller for less essential drugs (elderly persons, 0.10 and welfare recipients, 0.15) than for essential drugs (elderly persons, 0.17 and welfare recipients, 0.21). Also, there was a significant decrease in the slope of less essential drug use over time in the postpolicy period (policy/time interaction) for the elderly persons ($\hat{b}^2=−0.009; P<.001$) and for the welfare recipients ($\hat{b}^2=−0.008; P<.001$).

As expected, in both the prepolicy and postpolicy studies, there was a significantly higher rate of adverse events and ED visits in those individuals who reduced their use of essential drugs vs those who did not (TABLE 3). Dose-response relationships were evident between the magnitude of the reduction and the rates of both outcomes. For example, in the prepolicy control study, the rates of adverse events in those with no reduction ($\leq 0.1$ drugs/d), minor reduction ($>0.1$ to 0.5 drugs/d), and major reductions ($\geq 1$ drugs/d) were 256, 272, and 385 per 10000 person-months, respectively. Reduction of 1 medication would be equivalent to stopping 1 drug or rationing 2 drugs to half the expected use. Risks associated with reductions

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**Table 2.** Characteristics of the Recipients of Essential and Less Essential Drugs in the Prepolicy Year (August 1995-July 1996)

<table>
<thead>
<tr>
<th></th>
<th>Elderly Persons</th>
<th>Adult Welfare Recipients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Essential Drugs</td>
<td>Less Essential Drugs</td>
</tr>
<tr>
<td>Total No. of medication recipients</td>
<td>93 950</td>
<td>55 333</td>
</tr>
<tr>
<td>Medication recipients, No. (%)</td>
<td>70 801 (75.3)</td>
<td>38 065 (69.5)</td>
</tr>
<tr>
<td>Demographics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female, %</td>
<td>61.4</td>
<td>68.9</td>
</tr>
<tr>
<td>Age, mean (SD), y</td>
<td>73.1 (5.6)</td>
<td>73.4 (5.6)</td>
</tr>
<tr>
<td>Plan type for medication recipients by income-indexed ceiling, No. (%)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$200/y</td>
<td>4011 (5.7)</td>
<td>2387 (6.3)</td>
</tr>
<tr>
<td>$500/y</td>
<td>26 157 (36.9)</td>
<td>14 944 (39.3)</td>
</tr>
<tr>
<td>$750/y</td>
<td>40 633 (57.4)</td>
<td>20 734 (54.5)</td>
</tr>
<tr>
<td>Drugs used per day, mean (SD), No.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total†</td>
<td>3.1 (7.2)</td>
<td>4.3 (8.0)</td>
</tr>
<tr>
<td>Essential</td>
<td>1.7 (4.3)</td>
<td>1.5 (4.8)</td>
</tr>
<tr>
<td>Less essential</td>
<td>0.3 (1.6)</td>
<td>0.6 (1.6)</td>
</tr>
<tr>
<td>Monthly drug costs, mean (SD), $</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total†</td>
<td>87 (272)</td>
<td>89 (292)</td>
</tr>
<tr>
<td>Essential</td>
<td>48 (154)</td>
<td>42 (163)</td>
</tr>
<tr>
<td>Less essential</td>
<td>3 (18)</td>
<td>7 (20)</td>
</tr>
<tr>
<td>Health service use, mean (SD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergency department visits/mo</td>
<td>0.1 (0.9)</td>
<td>0.1 (1.0)</td>
</tr>
<tr>
<td>Hospitalized per year, %</td>
<td>27.9</td>
<td>30.2</td>
</tr>
</tbody>
</table>

*Welfare recipients were subject to an annual maximum of $200.
†Also includes drugs other than those listed in Table 1 that were covered by provincial formulary.
in drug use leveled off at higher reductions, reaching a plateau at approximately 1.5 medications per day. The estimated risk ratio for a 1-drug reduction, adjusted for cumulative increases, was similar for the prepolicy (1.57) and postpolicy (1.56) studies. Adjustment for beneficiary characteristics lowered the estimated risk ratios, primarily because individuals who had a greater number of comorbidities and used more medication were more likely to reduce their use of drugs and to experience adverse events and ED visits.

A greater proportion of elderly persons (7.4% more) in the postpolicy study compared with the prepolicy control study reduced their use of essential drugs (Table 3). As a result, the estimated proportion of adverse events associated with drug reductions increased from 2.0% in the prepolicy to 3.9% in the postpolicy period. This change was accompanied by an estimated increase in the monthly rate of adverse events related to reductions in essential drug use from 5.8 to 12.6 per 10000 in the prepolicy and postpolicy periods; a net increase of 6.8 adverse events per 10000 per month. Reduction in the use of essential drugs also was associated with a significant increase in the rate of ED visits (risk ratio, 1.17-1.19). The higher frequency of reductions in essential drug use in the postpolicy period resulted in a net increase in the rate of adverse events and ED visits.

Figure 3. Observed and Predicted Use of Less Essential Medication in the Prepolicy and Postpolicy Periods

Table 3. Risk of Adverse Events With Reductions in Essential Drugs and Rates Associated With Reductions in the Prepolicy (n = 50398) and Postpolicy (n = 56548) Elderly Population*

<table>
<thead>
<tr>
<th>Event Rates (No. per 10000 Person-Months by Level of Reduction in Essential Drug Use)†</th>
<th>Risk Ratio Per Reduction of 1 Drug/d (95% CI)</th>
<th>Population Impact of Reductions</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>Minor</td>
<td>Moderate</td>
</tr>
<tr>
<td>Adverse events</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prepolicy study</td>
<td>256</td>
<td>272</td>
</tr>
<tr>
<td>Postpolicy study</td>
<td>282</td>
<td>304</td>
</tr>
<tr>
<td>Difference¶</td>
<td>+7.4</td>
<td>+1.9</td>
</tr>
<tr>
<td>Emergency department visits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prepolicy study</td>
<td>787</td>
<td>902</td>
</tr>
<tr>
<td>Postpolicy study</td>
<td>863</td>
<td>972</td>
</tr>
<tr>
<td>Difference¶</td>
<td>+7.4</td>
<td>+1.1</td>
</tr>
</tbody>
</table>

*CI indicates confidence interval.
†No reduction is person-months in which an individual’s cumulative mean monthly reduction of ≤0.1 essential drugs per day; minor reduction is person-months with cumulative mean monthly reduction of >0.1 to 0.5 essential drugs per day; moderate reduction is person-months with cumulative mean monthly reduction of >0.5 to ≤1.0 essential drugs per day; and major reduction is person-months with an individual’s cumulative mean monthly reduction of >1.0 essential drugs per day.
‡Adjusted only for cumulative mean monthly increases in drug use during the follow-up period.
§Adjusted for individual age, sex, comorbidity, predicted drug use, months hospitalized in the baseline year, and mean rate of emergency department visits (for this respective outcome).
¶The proportion of regular recipients who had a cumulative mean monthly reduction value >0.1 essential drugs per day in any month during follow-up.
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increased rate in monthly ED visits related to reductions in drug use of 14.2 per 10000.

Welfare recipients, as compared with elderly persons, experienced similar risks of adverse events and ED visits in relationship to reductions in essential drug use (Table 4); however, the frequency of postpolicy reductions in essential drug use was considerably greater (13.6% and 7.4%, respectively). As a result, the drug policy was associated with a substantially greater net increase in the rates of adverse events and ED visits in relation to reductions in the use of essential drugs. In the postpolicy study, relative to the prepolicy study, the monthly rate of adverse events increased by 12.9 per 10000 and ED visit rates by 54.2 per 10000 person-months.

Reductions in less essential drug use had no significant impact on adverse events or ED visits among elderly persons and welfare recipients in either the prepolicy control or postpolicy studies (Table 5).

**COMMENT**

Increased cost-sharing for prescription drugs had the desired effect of reducing the use of less essential drugs but also the unintended effect of reducing the use of drugs that are essential for disease management and prevention. As a result, in the postpolicy period, there was an increase in the rate of adverse events and ED visits related to reductions in essential drug use. These effects are consistent with those reported by Soumerai et al.\(^{18,20}\) in the evaluation of prescription reimbursement caps in US Medicaid programs.

This study had several limitations. In the absence of an out-of-province control group, we cannot confirm that reductions in drug use were solely related to cost-sharing policies. However, no other plausible explanation has emerged and the suddenness of reductions in drug use that occurred immediately after the introduction of the cost-sharing policy strengthens the conclusion that changes in drug use were

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### Table 4. Risk of Adverse Events With Reductions in Essential Drugs and Rates Associated With Reductions in the Prepolicy (n = 11491) and Postpolicy (n = 13311) Welfare Recipients*  

<table>
<thead>
<tr>
<th>Study Period</th>
<th>Event Rates (No. per 10000 Person-Months) by Level of Reduction in Essential Drugs†</th>
<th>Risk Ratio per Reduction of 1 Drug/d (95% CI)‡</th>
<th>Events Associated With Reductions, %§</th>
<th>Events Associated With Reductions, No. per 10000 Person-Months (95% CI)²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>None</td>
<td>Minor</td>
<td>Moderate</td>
<td>Major</td>
</tr>
<tr>
<td>Prepolicy study</td>
<td>232</td>
<td>249</td>
<td>319</td>
<td>349</td>
</tr>
<tr>
<td>Postpolicy study</td>
<td>207</td>
<td>242</td>
<td>257</td>
<td>349</td>
</tr>
<tr>
<td>Difference</td>
<td>+13.6</td>
<td>+5.3</td>
<td>+12.9 (10.2-15.5)</td>
<td></td>
</tr>
<tr>
<td>Emergency department visits</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prepolicy study</td>
<td>975</td>
<td>1109</td>
<td>1475</td>
<td>1802</td>
</tr>
<tr>
<td>Postpolicy study</td>
<td>998</td>
<td>1127</td>
<td>1271</td>
<td>1677</td>
</tr>
<tr>
<td>Difference</td>
<td>+13.6</td>
<td>+4.2</td>
<td>+54.2 (33.5-74.8)</td>
<td></td>
</tr>
</tbody>
</table>

*CI indicates confidence interval.  
†See Table 3 for definitions of none, minor, moderate, and major reductions.  
‡Crude and adjusted risk ratios were estimated using the same approach as in elderly persons (see Table 3 footnote). Similar to elderly persons, the risk ratios associated with reductions in essential drug use were nonlinear. Nonlinear effects of reduction in essential drug use were estimated using the regression coefficients for the linear and squared terms to estimate the risk of reduction associated with a cumulative reduction of 1 medication per day in comparison with no reduction.  
§The proportion of regular recipients who had a cumulative mean monthly reduction value >0.1 essential drugs per day in any month during follow-up.  
Difference = postpolicy value - prepolicy value.

---

### Table 5. Prepolicy and Postpolicy Study Estimates of the Risk of Serious Adverse Events and Emergency Department Visits Associated With Reductions in Less Essential Drug Use in Elderly Persons and Welfare Recipients*  

<table>
<thead>
<tr>
<th>Proportion of Persons With Any Reduction, %†</th>
<th>Serious Adverse Events Adjusted Hazard Ratio per Reduction of 1 Drug/d (95% CI)‡</th>
<th>Emergency Department Visits Adjusted Rate Ratio per Reduction of 1 Drug/d (95% CI)‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elderly persons</td>
<td></td>
<td></td>
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<tr>
<td>Prepolicy study</td>
<td>17813</td>
<td>46.8</td>
</tr>
<tr>
<td>Postpolicy study</td>
<td>19120</td>
<td>50.5</td>
</tr>
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<td>Welfare recipients</td>
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</tr>
<tr>
<td>Prepolicy study</td>
<td>5161</td>
<td>49.6</td>
</tr>
<tr>
<td>Postpolicy study</td>
<td>5553</td>
<td>59.3</td>
</tr>
</tbody>
</table>

*CI indicates confidence interval.  
†The proportion of regular recipients who had a cumulative mean monthly reduction value >0.1 essential drugs per day in any month during follow-up.  
‡Risk ratio estimates, determined in the same manner as for essential drugs, were adjusted for age, sex, prior hospitalization, comorbidity, predicted number of less essential drugs used per day in the last month of the baseline year, and mean monthly rate of emergency department visits for the models estimated to predict this outcome.

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likely to be related to the cost-sharing policy. Prescription claims files do not indicate what drugs were taken, only medication purchased. Although prescription refill rates provide a reasonably accurate measure of medication compliance, reductions in drug use could have been overestimated if individuals received free samples or purchased equivalent over-the-counter preparations (eg, aspirin) after policy implementation. However, these individuals would be falsely classified as having reduced medication use, and as a result, the risk associated with reductions in drug use in the postpolicy studies would be underestimated.

Indications for therapy were unknown. Drugs classified as less essential may have been required therapy for some individuals (eg, benzodiazepines for panic disorder), whereas some essential therapeutic drugs may have been prescribed without adequate clinical indication (eg, diuretics for transitory elevation in blood pressure). This misclassification would likely lead to an underestimation of both the potential benefits of reducing the use of less essential drugs and the risks of reducing essential drug therapy.

Our study suggests that the primary mechanism by which cost-sharing affected the rate of adverse events was by increasing the proportion of people who made reductions in the use of essential drugs. We cannot confirm that reductions in essential drug use led to a deterioration in health status, but we believe that this is a plausible explanation for several reasons. First, there was a dose-response relationship between the magnitude of the reduction in the use of essential drugs and the risk of adverse events and ED visits. Second, reductions were associated with an increase in the risk of adverse events in the prepolicy and postpolicy period, a phenomenon that would be expected if reductions represented medication non-compliance. Finally, the risk associated with reduction was specific to essential drugs, for which there is clinical trial evidence of efficacy.

The challenge for insurers has been to craft health care policies that provide adequate access to drug therapy while simultaneously exercising fiscally responsible control over the drug budget. Consumer cost-sharing has been the principal method of fiscal control because it assumes that people will value what they pay for and as a result, they will reduce their use of unnecessary medication when they are required to contribute a portion of the payment. While this reasoning may apply to many consumer goods, cost-sharing has been shown to have unintended effects in health care, such as increasing hospital admissions.

Consumers may not have the information needed to make wise decisions about necessary treatment. We estimate that for elderly persons alone, the drug policy reform in Quebec may result in 7000 additional adverse events per million annually. In light of the substantial impact that drug policy can have on the population’s health, there is a need to redress the relative scarcity of scientific data on the outcomes of policy interventions. Our results suggest that more stringent cost-sharing pharmaceutical cost containment policies in other parts of Canada and the United States may contribute to avoidable illnesses.

Author Contributions: Dr Tamblyn participated in study concept and design, acquisition of data, analysis and interpretation of data, drafting of manuscript, critical revision of manuscript for important intellectual content, and provided statistical expertise, obtained funding, provided administrative, technical, or material support, and supervision. Dr Laprise participated in study concept and design, acquisition of data, analysis and interpretation of data, critical revision of manuscript for important intellectual content, and provided statistical expertise, obtained funding, provided administrative, technical, or material support, and supervision. Dr Hanley participated in study concept and design, analysis and interpretation of data, critical revision of manuscript for important intellectual content, provided statistical expertise, obtained funding, provided administrative, technical, or material support, and supervision. Dr Huang participated in analysis and interpretation of data, critical revision of the manuscript for important intellectual content, and provided statistical expertise. Dr Perreault participated in study concept and design, analysis and interpretation of data, and obtained funding.

Dr Hurley participated in acquisition of data and critical revision of manuscript for important intellectual content, and provided statistical expertise.

Dr Grad, Mallet, and McLeod participated in study concept and design, drafting of the manuscript, and study supervision.

Dr Latimer participated in analysis and interpretation of data, critical revision of the manuscript for important intellectual content, and provided statistical expertise.

Dr Perreault participated in study concept and design, analysis and interpretation of data, and obtained funding.

Dr Huang participated in analysis and interpretation of data, critical revision of the manuscript for important intellectual content, and provided statistical expertise.

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REFERENCES


ADVERSE OUTCOMES OF PRESCRIPTION DRUG COST-SHARING


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