# Appendix 2 (as supplied by the authors): Description of model parameters

## Data sources

This study draws on data from multiple sources. From IMS Health Canada Inc., we obtained product-level data describing the number and total cost of all prescriptions dispensed at retail pharmacies in each individual province during 2015. These data came from the CompuScript dataset, which projects data from over 5,700 independent and chain retail pharmacies to estimated totals for each province based on audits of manufacturer and wholesale sales data. Total costs in the IMS database included private and public payment for the drug products and dispensing fees.

From the Canadian Institute for Health Information, we obtained data from the National Prescription Drug Utilization Information System (NPDUIS) describing the number and cost of prescriptions that were paid, in whole or in part, by public drug plans in 2015 in all provinces but Quebec.

Though we had total expenditure and prescription volumes for all provinces, including Quebec, we had to estimate the share of each type of prescription that would have been publicly covered in Quebec based on observed shares for the same drugs in all other provinces combined. Data for 2013 indicate that this method may understate (by 7%) the public share of prescriptions currently being covered in Quebec.[1] Thus, if public proportions of expenditure in 2015 were comparable to 2013, the results of this study may overstate the incremental public cost of expanded public coverage of the essential medicines in Quebec.

## Therapeutic coding

After eliminated over-the-counter medications, we had data on 9,674 different drug products identified by active ingredient(s), form, dose, and manufacturer. We used the World Health Organization's Anatomical Therapeutic Chemical (ATC) drug classification system to assign medicines to mutually exclusive groupings.[2]

The ATC system allowed us to identify medicines for which drugs on the essential medicines list may be suitable substitutes for some patients. We use the chemical subgroups of the ATC system to define relatively close substitutes (e.g., A02BC = "Proton pump inhibitors") and the pharmacologic/therapeutic subgroups of the ATC system to define broader range of substitutes (e.g., A02B = "Drugs for peptic ulcer and gastro-oesophageal reflux disease"). We further grouped medicines into 50 broad therapeutic categories for reporting purposes.[1]

Appendix to: Morgan SG, Li W, Yau B, et al. Estimated effects of adding universal public coverage of an essential medicines list to existing public drug plans in Canada. *CMAJ* 2017. DOI:10.1503/cmaj.161082. 

The ATC subgroups used to identify potential therapeutic substitutes are a relatively conservative definition of therapeutic substitutes, in many of the largest primary care drug classes (e.g., drugs to treat hypertension, hyperlipidemia, or acid disorders), as they do not treat plain medications as substitutes for combination drugs within the same therapeutic category. Similarly, the ATC coding structure used does not treat distinct pharmacologic groupings as substitutes even when from the same broad therapeutic category: e.g., ACE inhibitors are not considered substitutes for Angiotensin II antagonists, and neither is considered a substitute for beta blockers, calcium channel blockers, or other medicines used in the treatment of hypertension.

## Drug price data

We obtained prices for the most common dosage forms of each generic drug on the essential medicines list from public formularies in Canada, the United States (US Department of Veterans Affairs), Sweden, and New Zealand. Two researchers (WL and BY) independently looked up each drug's price in each country and resolved discrepancies by discussion. Canadian prices were obtained from the Ontario drug benefit formulary whenever available, and from the British Columbia formulary or Saskatchewan formulary when the drug was not listed as a benefit in Ontario. Prices were considered comparable only when generic versions of the same drug type and dosage form could be obtained in Canada and the comparator country.

Because brand-name prices do not include confidential price rebates received by domestic or foreign governments, we obtained a weighted average of net prices of essential medicines available only from brand-name manufacturers in Canada from the US Department of Veterans Affairs (VA Pharmacy Benefits Management Group, Hine, IL). To protect confidentiality of product rebates, we gave Veterans Affairs a list of the most common dosage forms of the 25 top-selling brand-name drugs on the essential medicine along with Canadian unit prices and weights for computing a weighted-average of price differences for products that could be matched. The information request was designed such that the results returned would reflect aggregated weighted-averages that did not identify the specific products for which the price differences applied. We received the results in October 2016.

Foreign prices were converted to Canadian dollars using exchange rates and using GDP purchasing power parities. Results using those two approaches to currency conversion were compared.

## Statistical methods

For baseline measurement of current volume of prescriptions used in Canada, we computed the total number and cost of prescriptions on and off the essential medicines list, for each province and each of the broad therapeutic categories. To gauge the potential scope of clinical needs that the essential medicines may be suitable substitutes for, we calculated the number and cost of prescriptions within the same ATC chemical subgroups and within the same ATC pharmacologic/therapeutic subclasses as drugs on the essential medicines list.

We used economic modeling to estimate the total cost of prescriptions – stratified by province, therapeutic category, and source of financing – under a scenario wherein universal public coverage of the essential medicines is added to the existing complement of public drug plans in Canada. The models were based on economic frameworks developed for analyses of the determinants of prescription drug expenditure as a function of the volume of purchases made, products selected, and prices paid for selected products.[3,4]

The economic models involved a number of pricing and utilization parameters chosen based on Canadian and international evidence. The modelling parameters are summarized in Table A1.

Table 1: Summary of parameters for economic model of the cost of adding universal public coverage of an essential medicines list to the existing complement of public drug plans in Canada

| Parameter | Explanation | Base case assumption | Best-case scenario | Worst-case scenario |
|---|---|---|---|---|
| Direct change in the use of the essential medicines | Increased accessibility of essential medicines to Canadians who are presently uninsured or under-insured.[5] | 30% increase in utilization | 12% increase in utilization | 39% increase in utilization |
| Indirect change in the use of the essential medicines | Expected product substitutions among patients currently filling prescriptions for drugs similar to the essential medicines.[6] | An average of 37% of such patients switch | An average of 66% of such patients switch | An average of 7% of such patients switch |
| Changes in prices of generic versions of the essential medicines | Expected reductions achieved with tendering and other generic pricing tools, gauged based on prices in comparable single-payer stems: USA Veterans Affairs, Sweden, and New Zealand.[7,8] | Median comparator prices | Best comparator prices | Worst comparator prices |
| Changes in net prices of brand-name essential medicines | Expected price reductions achieved with universal application of negotiated rebates, gauged based on published estimates of prices and rebates, and average net price information for the USA Veterans Administration.[9-11] | 15% lower net prices | 20% lower net prices | 10% lower net prices |
| Changes in prices of drugs not on the essential medicine list | Expected changes in the prices of drugs not on the essential medicines list. | No change | No change | No change |
| Standard co-payment per prescription for the essential medicines | Expected co-payment for standard beneficiaries, set as a maximum dispensing fee that could be lowered if pharmacies competed on price to patient. | $11 or less, depending on pharmacy | $11 or less, depending on pharmacy | $11 or less, depending on pharmacy |
| Percentage of prescriptions filled by patients exempted from co-payments for essential medicines | Expected co-payment exemptions for vulnerable populations (e.g., elderly, low-income, children) as a share of all prescriptions filled for the essential medicines. | 30% | 30% | 30% |
| Other changes in existing public drug plans in Canada | Expected changes in public coverage of drugs not on the essential medicines list. | None | None | None |
| Patient savings from shopping at pharmacies with lower dispensing fees | Expected patient savings arising from pharmacies competing for business by lowing dispensing fees. | Not included in estimates | Not included in estimates | Not included in estimates |
| Indirect reduction in government cost of extended health benefits for public sector employees | Expected governments savings from reduced cost of private insurance for public sector employees, which would be equal to approximately 20% of the total private sector savings.[12] | Not included as government savings in estimates | Not included as government savings in estimates | Not included as government savings in estimates |
| Health care system savings from increased adherence to essential medications | Expected savings to the broader health care system resulting from increased adherence to necessary medicines.[13-16] | Not included in estimates | Not included in estimates | Not included in estimates |

## Model parameters

**Direct increases in the use of covered medicines:** Coverage of medicines on the essential medicines list will address unmet needs of uninsured and under-insured Canadians. Evidence suggests that newly-insured patients may be expected to increase their utilization of covered medicines by 12% to 16%.[5] Coverage of medicines on an essential medicines list is unique insofar as it can meet unmet demands for those specific drugs and for drugs that are therapeutically comparable to them. This roughly doubles the potential unmet demands that coverage of the essential medicines would address (see Table 2A of article). We therefore assumed that universal public coverage of the essential medicines would increase the use of those medicines by Canadians who are under and uninsured by 30% in our base scenario, with increases of 12% (best case) and 39% (worst case) used in sensitivity analyses.

Although it is estimated that approximately 20% of the Canadian population are uninsured and under-insured,[17] and that approximately 20% of all retail expenditure on prescription drugs in Canada is by patients who are uninsured or below the deductibles of their public or private drug plans,[1] we conservatively assumed that the size of the uninsured and underinsured accounted for 33% of the latent demands for therapies. Thus, universal coverage of the essential medicines had the direct effect of increasing their total use (use of insured and uninsured patients combined) by 10% in our base scenario, with increases of 4% (best case) and 13% (worst case) used in sensitivity analyses.

**Indirect increases in the use of covered medicines:** Coverage of the essential medicines will also cause some product substitutions among patients already filling prescriptions. Uninsured patients who currently purchase comparable medicines will have strong incentive to use covered options from the essential medicines list. Further, sponsors of private drug plans will have incentive to lower co-payments for the essential medicines (which would be free from the view of the plan sponsors). Canadian and US experiences in differential co-payment structures have been associated with switching toward "preferred" drugs by 5% to 50% of insured patients.[6]

We used the 5% to 50% range of switches found in research evidence in our models, with the mid point (27.5%) as our base assumption. We further assumed that under and uninsured Canadians would be twice as likely to switch to covered Essential medicines from comparable alternatives as insured Canadians. We defined comparable medicines based on chemical subgroups, which is a more conservative assumption than defining substitutions at the pharmacological subgroup (which would involve roughly 40% more potential switches to the fully covered drugs).

Including currently insured and currently uninsured users of relevant medicines, our base model is based on the assumption that 37% of users of medicines from the same chemical subgroup as a drug on the essential medicines list would switch to the fully covered drug, with 66% (best case) and 7% (worst case) used in sensitivity analyses.

**Price changes:** A universal, public system of covering medicines in Canada is expected to bring Canadian prices in line with international comparators. We used the median of available generic prices in the US, Sweden, and New Zealand to estimate the likely price attainable under a universal plan for CLEAN Meds prescriptions. For sensitivity, we compared that to the minimum available price and the maximum available price in comparator countries. If equivalent generic prices could not be found in comparator countries, we assumed that price reductions for generics would be equal to the reductions modeled for brand-name products.

We assumed that generic versions of the essential medicines would be used by 95% of patients and that the public program would pay full brand-name prices for 5% of patients who will not accept the generic. In all cases, we assumed that the Canadian prices of generic drugs on the essential medicines list would not increase as a result of their universal coverage under a public program since there is no reason to assume that such a program would make their pricing less competitive than it is today.

For brand name drugs on the essential medicines list that are not available in generic form, we assumed that negotiated prices would fall given the significant increased sales volume expected from universal coverage. This would occur as a function of the purchasing power that comes from creating an effective single-payer for the medicines on the essential medicines list. As off invoice rebates are extensively used in the comparator countries, we had to estimate brand name price changes based on differences in list prices and published average rebates reported by manufacturers for sales in the United States.[9-11] Whether through changes in list prices, increases in the size and scope of confidential rebates, or both, our base case assumption is that the prices of brand-name Essential medicines would fall by 15%, with reductions of 20% (best case) and 10% (worst case) used in sensitivity analyses. Such price declines would be more than offset by the assumed increases sales volumes for the manufacturers of the essential medicines (see direct and indirect increases in covered medicines above).

We corroborated the above assumptions concerning brand-name price reductions with information about the weighted-average net prices from the US Department of Veterans Affairs. From the US Department of Veterans Affairs, we obtained a weighted-average of relative prices for 16 brand-name

drugs that accounted for 91% of Canadian expenditures on all of the essential medicines available only from brand-name manufacturers in Canada. Net of manufacturer rebates, the weighted-average price of those brand-name drugs was 43% below Canadian list prices using exchange rate conversions and 49% below Canadian list prices using purchasing power parities.

To put the net-of-rebate US prices in perspective requires assumptions about private and public drug plan price negotiations in Canada. Private drug plans and uninsured Canadians finance 57% of the essential medicines studied here. To date, private drug plans in Canada have seldom negotiated price rebates with manufacturers; indeed, some private drug plans pay prices in excess of official list prices in Canada.[18] We therefore assume private drug plans pay prices no better than official list prices in Canada. In contrast, public drug plans in Canada do negotiate rebates for some brand-name medicines and increasingly do so through collaborative negotiations.[19] If one assumes that drug plans in Canada currently secure rebates equal to the level achieved by the single-payer system for the US Department of Veterans Affairs, then net brand-name prices in Canada would decline by 30% if those rebates negotiated by public plans were applied to all related purchases in Canada (specifically, average net prices would fall from 81% of list prices to 57% of list prices under such assumptions). If, alternatively, the limited negotiation powers of Canada's patchwork of public drug plans results in more modest average price rebates, such as average discounts of 20%, the potential net price reductions for brand-name drugs stemming from having a single-payer system for essential medicines in Canada could be as high as 40%, even after accounting for current rebates obtained by public drug plans. Both scenarios imply greater potential brand-name drug price savings from a universal public drug plan than we modelled in the economic analyses presented above.

We assumed no change in the price of brand-name versions of the essential medicines that were available in generic form, as it was assumed that only generic forms will be covered unless not tolerated by a patient.

**Co-payments and dispensing fees:** Because universal drug plans worldwide typically exempt vulnerable populations from user-charges, we assumed that 30% of the volume of the prescriptions for essential medicines in each province would be filled by individuals exempted from any charges for those prescriptions (e.g., social assistance recipients, the elderly, and/or children). We assumed that the remaining population would pay a co-payment equal to an $11 dispensing fee per prescription or less, should pharmacies compete by lowing fees to attract customers.

We do not account for potential savings to patients from shopping at pharmacies with lower dispensing fees. All of our economic scenarios therefore include a total of over $6 billion in pharmacy dispensing fees, equivalent to more than $210,000 per pharmacist practicing in the community setting in Canada.[20]

**Existing drug plans:** We assumed there would be no other changes to existing public or private drug plans in Canada. Thus, we assumed that existing public drug plans for various beneficiary groups – e.g., the elderly, social assistance recipients, and/or those with catastrophic annual drug expenditures – would continue to cover all other medicines on their existing formularies even if those medicines are not on the essential medicines list. The public cost of such continued coverage through existing public drug plans is accounted for in all scenarios of our economic models.

**Indirect savings:** We did not account for indirect savings to governments stemming from reduced cost of private insurance for public sector employees, which previous analyses suggest would be equal to approximately 20% of the total private sector savings in the economic models.[12] Further, we did not account for health system savings stemming from reduced financial barriers to drugs on the essential medicines list.

# References


1. Morgan SG, Smolina K, Mooney D, et al. *The Canadian Rx Atlas, 3rd Edition.* Vancouver: UBC Centre for Health Services and Policy Research;2013.
2. World Health Organization Collaborating Centre for Drug Statistics Methodology. Anatomical Therapeutic Chemical Code Classification index with Defined Daily Doses. 2014; http://www.whocc.no/atcddd/. Accessed 4 Feb, 2014.
3. Morgan SG. Sources of variation in provincial drug spending. *CMAJ: Canadian Medical Association Journal.* 2004;170:329-30.
4. Morgan SG. Drug spending in Canada: recent trends and causes. *Medical Care.* 2004;42:635-42.
5. Contoyannis P, Hurley J, Grootendorst P, Jeon SH, Tamblyn R. Estimating the price elasticity of expenditure for prescription drugs in the presence of non-linear price schedules: An illustration from Quebec, Canada. *Health Economics.* 2005;14:909-23.
6. Morgan SG, Gillian H, Greyson D. Comparing tiered formularies and reference pricing policies: A systematic review. *Open Medicine.* 2009;3.
7. Morgan SG, Hanley G, McMahon M, Barer ML. Influencing Drug Prices through Formulary-Based Policies: Lessons from New Zealand. *Healthcare Policy.* 2007;3:121-40.
8. Beall RF, Nickerson JW, Attaran A. Pan-Canadian overpricing of medicines: a 6-country study of cost control for generic medicines. *Open Medicine.* 2014;8:e130.
9. Langreth R, Keller M, Cannon C. Decoding Big Pharma's Secret Drug Pricing Practices. *Bloomberg.* June 29, 2016.
10. PMPRB. *Patented Medicine Prices Review Board: Annual Report 2014.* Ottawa: Patented Medicine Prices Review Board; November 2015.
11. Sawhney R, Gordian M, Behnke N. *Pharma: The Market Access Dilemma.* New York: Bain & Company, Inc.;2016.
12. Morgan SG, Law M, Daw JR, Abraham L, Martin D. Estimated cost of universal public coverage of prescription drugs in Canada. *Canadian Medical Association Journal.* 2015;187:491-7.
13. Booth GL, Bishara P, Lipscombe LL, et al. Universal Drug Coverage and Socioeconomic Disparities in Major Diabetes Outcomes. *Diabetes Care.* 2012;35:2257-64.
14. Goldman DP, Joyce GF, Zheng Y. Prescription Drug Cost Sharing: Associations With Medication and Medical Utilization and Spending and Health. *JAMA.* 2007;298:61-9.
15. Kesselheim AS, Huybrechts KF, Choudhry NK, et al. Prescription drug insurance coverage and patient health outcomes: a systematic review. *Am J Public Health.* 2015;105:e17-30.
16. Tamblyn R, Laprise R, Hanley JA, et al. Adverse events associated with prescription drug cost-sharing among poor and elderly persons. *JAMA.* 2001;285:421-9.
17. Angus Reid Institute. *Prescription drug access and affordability an issue for nearly a quarter of all Canadian households.* Vancouver: Angus Reid Institute;2015.
18. Lexchin J. Drug Pricing in Canada. In: Babar Z-U-D, ed. *Pharmaceutical Prices in the 21st Century*. Cham: Springer International Publishing; 2015:25-41.
19. Morgan S, Friesen M, Thomson P, Daw J. Use of product listing agreement by Canadian provincial drug benefit plans. *Healthcare Policy.* 2013;In Print.
20. Canadian Pharmacists Association. Pharmacists in Canada. 2016; https://www.pharmacists.ca/pharmacy-in-canada/pharmacists-in-canada/. Accessed Nov 2, 2016.