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ECONOMIC EVALUATION ACROSS THE FOUR FACES OF PREVENTION: A CANADIAN PERSPECTIVE

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Executive Summary

In 1986, Louise Russell published her landmark book, "Is Prevention Better Than Cure?", in which she evaluated the health and economic benefits of preventive health care interventions and tested the validity of the common assumption that prevention saves money. While debunking the myth that prevention is invariably cost-saving, Russell insisted that prevention is only rightfully judged on whether it is a worthwhile investment in health, rather than on its cost-saving potential. Almost three decades later, the notion that "an ounce of prevention is worth a pound of cure" still grips the imagination of policymakers and members of the public.

We were commissioned by the Canadian Medical Association to review the economic evaluation evidence on prevention in the hope that such a review would assist health and health care priority setting in Canada.

Prevention Versus Cure?

In discussions of health policy and resource allocation, prevention is often pitted against cure and illness care. Prevention and illness care are not inherently competitive for resources. They serve different objectives and respond to different needs. In the quest for resources, prevention faces a difficult challenge in obtaining public and political support. In contrast to illness care, prevention has no identifiable beneficiaries and is usually characterized by immediate costs and delayed benefits.

Economic Evaluation and its Use in Priority Setting

It is widely argued that evidence of efficiency derived from economic evaluations should play an important role in health care priority setting and coverage decisions. Indeed, to our knowledge, every recently proposed priority-setting framework includes efficiency assessment as a crucial step. A limited number of jurisdictions require and use evidence of efficiency as part of coverage decision-making within public health care insurance programs. These examples are notable, however, precisely because they are exceptions. Overall, the use of economic evaluation evidence in priority setting lags far behind both the prescriptions of priority-setting frameworks and the expectations of many health policy makers and analysts.

A number of factors are likely responsible for this. Some stem from the fact that integration of economic evaluation evidence into decision-making is neither simple nor straightforward. But more fundamentally, most health care interventions have never been subject to an economic evaluation and the interventions that have been assessed tend to be those that are most easily studied (rather than those for which the need for such evidence is most pressing). Many more economic evaluations exist for clinical prevention interventions, for example, with more easily defined populations, interventions, and settings, and more easily measured outcomes, than for interventions drawn from the areas of health promotion, health protection or healthy public policies. To the extent that priority-setting exercises restrict consideration to interventions for which such evidence exists, only a limited and non-representative set of interventions can be considered. One hope, of course, is that in the long run demand by those setting priorities and making coverage decisions will bring forth a larger supply of such studies.

Economic Evaluation Evidence for Preventive Interventions

Deciding which topics to include in this review was a formidable task. While economic evaluation of preventive activities is not as frequent as for treatment, the volume of the prevention literature is vast. (Initial explorations of potentially relevant literature for this paper, for example, yielded over 5000 articles.) To guide our work, we identified 290 recommended prevention interventions and an additional 23 preventive interventions with potentially large population health impacts. We found no economic evaluations for 159 of the 290 recommended interventions (55 percent).

Our literature identified 672 economic evaluations of the remaining 154 preventive interventions. The majority (55 percent) evaluated clinical prevention interventions. The next largest group of evaluations assessed health protection interventions (31 percent), a significant proportion of which were universal or mandatory screening or immunization programs. Health promotion interventions represented 12 percent of the evaluations and healthy public policy interventions represented 2 percent.

The volume of relevant economic evaluations was far greater than we anticipated at the outset of the project. Accordingly, after categorizing available economic evaluations of recommended preventive interventions by type of intervention, the condition or issue targeted by the intervention, the study setting, and the availability and strength of effectiveness evidence, we summarized the results of economic evaluations of a sample of five diverse interventions that are not universally provided in Canada and for which a considerable body of economic evaluation evidence is available.

Synthesis of Economic Evaluation Evidence for Five Selected Preventive Interventions

- Varicella vaccination
- Colorectal cancer screening using fecal occult blood testing (FOBT)
- Needle exchange programs
- Community water fluoridation
- Day care or preschool programs

In summarizing and interpreting the results of economic evaluation evidence for these five syntheses, we addressed three questions:

- Does the intervention produce a net benefit from the societal perspective?
- Is the intervention cost-saving from the payer perspective?
- Where cost-benefit from a societal perspective has not been adequately assessed and the intervention is not cost-saving from the payer perspective, might the intervention nonetheless be a worthwhile investment in health (i.e., give value for money)?

For each intervention we found a high degree of consistency among economic evaluation studies, despite differences in methods and settings. In particular, we did not observe systematic differences in findings between economic evaluations set inside or outside of Canada.

All of the interventions we examined produce a net benefit to society. Needle exchange programs and water fluoridation are also cost-saving from a payer perspective. In both cases, there are sometimes multiple payers, which means that program costs may be born primarily by

one payer while another payer may be the principal beneficiary of cost-savings resulting from the intervention (e.g., reduced treatment costs). The remaining interventions—varicella vaccination, colorectal cancer screening with FOBT, and day care or preschool programs—while not cost-saving from the payer perspective (with the possible exception of preteen varicella vaccination), may still be sound investments in health. Decisions about whether to make those investments will appropriately depend on a variety of factors, some related to and others external to the economic evaluation evidence.

Next Steps

A large volume of unappraised and unsynthesized economic evaluation evidence is available for many preventive interventions. On the other hand, economic evaluation evidence is completely lacking for the majority of recommended preventive interventions.

If economic evaluation evidence on prevention is to be used to assist health and health care priority setting in Canada, the gaps that we have identified need to be filled. Critical activities include:

- Systematic reviews of effectiveness evidence for health promotion, health protection, and healthy public policy interventions
- Economic evaluations of individual preventive interventions for which economic evaluation evidence is currently lacking
- Systematic reviews of economic evaluation evidence for effective preventive interventions

These activities will require substantial resources. Significant work in this area has been and continues to be undertaken outside of Canada, particularly in the United States.

Application of Economic Evaluation Evidence to Policy Decision Making

Policy decision making that incorporates economic evaluation evidence cannot be reduced to rank ordering of programs by summary measures of efficiency and the mechanical application of thresholds to determine which programs will be implemented or continued. Even if such an approach were desirable, its feasibility is questionable given that economic evaluation evidence based on a common metric and common comparator is unlikely to be available across a full range of programs under consideration.

Decisions regarding public investments in health care programs are inevitably influenced by a variety of factors—some economic, some political, and some having to do with social values and preferences. These include:

- Differential timing of costs and benefits
- Opportunity costs
- Availability of required technology and human resources
- Program scope
- Nature of benefits
- Who benefits
- Who pays

Economic evaluation evidence can make a useful contribution to policy decision making. Given the dearth of economic evaluation evidence for preventive interventions, however, it is not

reasonable to make such formal evidence a pre-requisite for policy action. Requiring economic evidence as a mandatory input to decision making would, in the short term, delay the implementation of preventive programs with demonstrated large population health effects that had not yet been subjected to economic evaluation. Perhaps more importantly, in the long term such a requirement would discriminate against health promotion, health protection and healthy public policy interventions whose costs and consequences are often difficult to measure credibly because they are spread across multiple health and social domains. In spite of these challenges, we hope that this review demonstrates the value of increasing the use of economic evaluation methods to inform decision making for preventive interventions.

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1. Introduction

In 1986, Louise Russell published her landmark book, "Is Prevention Better Than Cure?", in which she evaluated the health and economic benefits of preventive health care interventions and tested the validity of the common assumption that prevention saves money. By examining vaccinations, screening tests, and lifestyle changes, she systematically demonstrated that prevention is rarely cost-saving. She highlighted the many factors that affect the economic impact of prevention: the size of the population that receives the preventive intervention, the size of the population that benefits from the preventive intervention, the frequency with which the preventive intervention is repeated, the magnitude and uncertainty of risks of the preventive intervention, the value that individuals place on the prevention benefits, how these values compare with other outcomes, and the time lag between costs and benefits. While debunking the myth that prevention is invariably cost-saving, Russell insisted that prevention is only rightfully judged on whether it is a worthwhile investment in health, much as acute care is judged, rather than on its cost-saving potential.

Almost three decades later, the notion that "an ounce of prevention is worth a pound of cure" still grips the imagination of policymakers and members of the public. For example, the final report of the Standing Senate Committee on Social Affairs, Science and Technology (Kirby Committee), *The Health of Canadians: The Federal Role,* included the claim that "there are enormous potential benefits to be derived from health and wellness promotion, disease and injury prevention, public health, and health protection and population health strategies, measured primarily in terms of improving the health of Canadians, *but also in terms of their long-term financial impact on the health care system*" (Kirby et al., 2002, quoted by Canadian Health Services Research Foundation, 2003; emphasis CHSRF's).

If the assumption that prevention saves money is not correct, economic evaluations of preventive interventions become important to identify preventive programs that are worthwhile investments, even if they do not produce net cost-savings.

2. Scope and Structure of the Paper

We were commissioned by the Canadian Medical Association to review the economic evaluation evidence on prevention in the hope that such a review would assist health and health care priority setting in Canada. This discussion paper assesses the state of the literature on the cost-effectiveness of a broad range of disease and injury prevention and health promotion interventions, using both peer-reviewed and grey literature (for example, government reports). We synthesized the economic evaluation evidence for five selected preventive interventions to illustrate how economic evaluation evidence might help in priority setting.

We begin this paper by discussing the characteristics of prevention—including the temptation to pit prevention against illness care—and the scope of prevention activities. This is followed by a short overview of economic evaluation, highlighting aspects that are particularly important for this paper, and a discussion of the use of economic evaluation in priority setting. The second half of this paper describes our methods and the results of our examination of the economic evaluation evidence for preventive interventions, including a detailed examination of the

evidence for five interventions that illustrate a range of approaches to prevention. The paper ends with a discussion of potential next steps and a consideration of factors affecting the application of economic evaluation evidence to policy decision making.

3. Prevention versus Cure?

In discussions of health policy and resource allocation, prevention is often pitted against cure and illness care. However, they serve different objectives and respond to different needs. Prevention aims to maintain health while illness care alleviates suffering and disability. Because they are means to different ends rather than means to the same end, prevention and illness care are not inherently directly competitive for resources. The common assumption that resources for prevention must come at the expense of illness care and vice versa rests on a shaky foundation.

Prevention faces a difficult challenge in obtaining public and political support. Unlike curative activities, prevention has no identifiable beneficiaries. Individuals do not obtain personal benefits in ways that are as easily recognized as they are for curative or illness care. We cannot distinguish with certainty those individuals who avoid disease or injury due to a preventive intervention from those who never would have developed the disease or been injured in the first place. The dearth of prevention poster children is compounded by the differential timing of costs and benefits. Unlike the simultaneous or closely occurring costs and benefits of curative care, preventive activities usually are characterized by immediate costs and delayed benefits (even if the benefits are measurable and identifiable). Curative interventions are also favored by the rule of rescue—that is, the imperative to save identifiable individuals from avoidable deaths above all other considerations (Jonsen, 1986).

4. The Four Faces of Prevention

To achieve a clear understanding of prevention, it is important to understand the spectrum of prevention activities. We find it helpful to conceptualize prevention as consisting of four approaches: clinical prevention, health promotion, health protection, and healthy public policy. Like the multiple faces of a crystal, each of these approaches presents a different view of the same object and shares common boundaries with other faces.

Clinical prevention interventions are one-on-one activities involving a health care provider and a recipient of care (patient or client). Clinical prevention services are provided to individuals who may accept or decline the service or recommended health action. Clinical prevention activities may be targeted at particular individuals (e.g., persons at high risk) or at all individuals presenting for clinical care. A physician counseling individual patients to quit smoking is an example of a clinical prevention activity.

Health promotion interventions encourage individual behaviours believed to produce positive health effects and discourage behaviours that produce negative health effects. Health promotion interventions frequently take the form of public information campaigns. While the decision to undertake the health action is ultimately up to the individual, delivery of health promotion programs is targeted at a group or population. A media-based, anti-smoking campaign is an example of a health promotion intervention; taxing tobacco products to reduce use is another.

Health protection interventions reduce health risks by changing the physical or social environment in which people live. The role of individual beneficiaries of health protection interventions is either passive or limited to compliance with laws or regulations. Health protection interventions are delivered at the organizational (e.g., hospital policy), local, provincial, national or international level. Prohibiting smoking in public places is an example of a health protection intervention.

As illustrated by the smoking examples, the same health-related behavior can be the object of clinical prevention, health promotion, and health protection activities. Hepatitis B vaccination provides another example. A clinician offering a high-risk patient a Hepatitis B vaccination is a clinical prevention intervention; provincial health insurance coverage of the costs of Hepatitis B vaccine is a health promotion intervention; and a policy of universal screening of pregnant women for Hepatitis B accompanied by Hepatitis B immune globulin and Hepatitis B vaccination for infants of infected mothers is an example of a health protection intervention.

The specific face of a preventive intervention depends on the design of the intervention. We categorize all one-on-one activities in clinical settings as clinical prevention, even if the activity has a health promotion flavor or a health protection effect (e.g., immunization for contagious disease). Universal or population focused programs are categorized as health promotion or health protection interventions.

Healthy public policy describes social or economic interventions that affect health but do not have health as the main policy objective. The determinants of health literature provides examples of policy interventions and social programs that have important ancillary health effects, such as restricting the placement of video gambling terminals, supportive housing, early childhood education, and the provision of income support.

We believe that the strength of our classification of prevention strategies lies in the close relationship between the categories of preventive activity and the relevant actors: individual clinicians in the case of clinical prevention; organizations (including governments and government agencies) in the case of health promotion and health protection; and governments in the case of healthy public policy. Other authors have taken a somewhat different approach. Rush and colleagues (2002) classified interventions by six types of health promotion activity (clinical preventive, develop personal skills, strengthen community actions, creating supportive environments, reorient health services, and building healthy public policy) and by five risk factors targeted by the intervention (biological, behavior, environment, social, economic). Ungar and Santos (2002) used four prevention-related categories (prevention, detection, health programs, and education) to classify pediatric economic evaluations. Teutsch & Harris (2003), in a theoretical discussion of types of prevention strategies, suggested four classification categories. Their first three categories—clinical, behavioural, and environmental prevention strategies—closely mirror our first three categories. Their fourth category—systemic prevention strategies, or activities that "change the fundamental community processes" (p. 7) such as changes to the health care system—does not easily map onto one of our faces of prevention. They describe no category corresponding to our healthy public policy face.

Assessing the state of economic evaluation evidence using the four faces of prevention as a framework is the main thrust of this paper. However, to set the stage, we briefly review economic evaluation principles and describe the use of economic evaluation in priority setting.

5. Overview of Economic Evaluation

An economic evaluation compares two or more interventions (programs) in terms of their respective benefits and costs. The goal of an economic evaluation is to measure the efficiency, or the value for money spent, of one intervention compared to another. An economic evaluation adopts one of three approaches: cost-effectiveness analysis, cost-utility analysis, or cost-benefit analysis. All three methods measure costs in the same way; the distinguishing feature of each is the way in which benefits are measured.

The costing principle in each case is to identify the opportunity cost associated with a program. The opportunity cost is the value of the benefits forgone by using scarce health care resources for the intervention of interest rather than for some other purpose. Measuring opportunity cost is very difficult. Under certain conditions the market prices of the resources approximate opportunity costs. But in reality there are a number of difficulties associated with assessing true opportunity cost, difficulties to which we will return below in our discussion of the use of economic-evaluation evidence in priority-setting.

The methods for assessing benefits are as follows. Cost-effectiveness analysis measures the benefits of an intervention in natural units associated with the primary outcome (e.g., cases prevented, life-years gained). Hence, study results are expressed in terms of the additional cost of achieving another unit of the benefit (e.g., the extra cost of preventing an additional case of a condition). The intervention with the lowest cost per additional outcome is the efficient outcome. Cost-utility analysis measures benefits in a common unit that strives to include both the quantity and quality of effects associated with an intervention, usually measured by the quality-adjusted life-year (QALY). Hence, a QALY takes into account both the increased average longevity resulting from an effective intervention and altered quality of life while alive. The efficient intervention is the one that has the lowest cost per additional QALY generated. Finally, cost-benefit analysis measures all benefits in dollar terms, so that the results are normally reported in terms of the net benefit of an intervention (benefits minus costs) or the ratio of benefits to costs.

These different ways of measuring benefits bring with them strengths and weaknesses. A main advantage of cost-effectiveness analysis is that measuring benefits in natural units simplifies the analysis and is often more intuitive for users of the study. Some key disadvantages include reduced comparability of efficiency assessments across interventions that produce different outcomes (e.g., flu vaccination versus water fluoridation) and the need to focus on a single outcome of an intervention even when an intervention generates a number of distinct benefits. Measuring outcomes in a common metric such as QALYs in cost-utility analysis greatly enhances the comparability of results across different types of interventions, including those that primarily affect quality of life as well as those that have a larger impact on the number of life-years gained. A key disadvantage is the considerable increase over CEA in the complexity of outcomes assessment. Cost-benefit analysis can incorporate the widest range of effects across

the widest range of interventions and programs (both inside and outside the health sector), but is often controversial because it requires that the value of the benefits be expressed in dollar terms.

There are a wide range of factors that determine the quality of an economic evaluation. One of the most important is the quality of the underlying evidence for the effectiveness of an intervention. Sound economic evaluation can only be built upon good evidence of the effectiveness of the intervention of interest. An ineffective intervention can never be efficient; it simply wastes resources. In addition, it is important to consider the relevance of the alternatives being compared in the evaluation, the comprehensiveness with which costs and effects are included, the methods for measuring and valuing such costs and effects, and the extent to which the robustness of the conclusions are assessed through sensitivity analysis. A more detailed treatment of all such issues can be found in standard texts on the subject (e.g., Drummond et al., 1997).

A number of challenges arise when using even high-quality economic evaluation evidence to guide health care priority setting or coverage decision-making. One set of challenges pertains to the generalizability of the costing component of an economic evaluation. As noted above, the conceptually ideal cost measure is the opportunity cost—what benefits are forgone by using the limited health care resources for the program of interest rather than another program? One way to think about this is to ask: if the budget is to remain fixed and one program is introduced or expanded, what program is to be eliminated or curtailed, and what benefits will be lost as a result? This is the true opportunity cost. This cost will vary from setting to setting (if the health care budget is increased, then the opportunity cost is simply borne outside the health care sector) and is often unknown to decision makers, though analysts increasingly encourage decision makers to consider this question explicitly (e.g., Donaldson, Currie, & Mitton, 2002; Gafni & Birch, 2003; Mitton et al., 2000; Mitton & Donaldson, 2003). A related costing issue that can affect generalizability is the fact that prices and the exact mix of resources used to produce a service can vary across settings, which can affect the efficiency of a service across jurisdictions. This can be a particular problem when considering international evidence.

These challenges do not invalidate the use of economic evaluation evidence as an important component of health care decision-making, but they do caution against simplistic approaches to such evidence, as evinced, for instance, by mechanistic construction of league tables which purport to provide a ranking of a wide variety of health care programs according to their efficiency (Drummond, Torrance, & Mason, 1993). The appropriate use of economic evaluation evidence requires detailed consideration of the quality of the evidence along with thoughtful assessment of threats to generalizability to one's setting and even, in some cases, re-calibration of study results to fit better the specific context of application (e.g., recalculate the cost-effectiveness substituting prices relevant to one's own setting for those from the study setting).

6. Economic Evaluation and its Use in Priority Setting

It is widely argued that evidence of efficiency derived from economic evaluations should play an important role in health care priority setting and coverage decisions (Hurley et al., 2000). Indeed, to our knowledge, every recently proposed priority-setting framework includes efficiency assessment as a crucial step. A limited number of jurisdictions require and use

evidence of efficiency as part of coverage decision-making within public health care insurance programs, most commonly for prescription drugs (e.g., Australia, Ontario, British Columbia) (Willison et al., 2001). The United Kingdom's (UK) National Institute for Clinical Excellence (NICE) conducts technology assessments, which include economic evaluations, in making binding recommendation to the National Health Service regarding coverage of health care technologies (National Institute for Clinical Excellence, 2001). Federal legislators in the US House of Representatives have put forward a bill requiring federal health research funding bodies to fund economic evaluations of costly, commonly used drugs (Moynihan, 2003).

These examples are notable, however, precisely because they are exceptions. Overall, the use of economic evaluation evidence in priority setting lags far behind both the prescriptions of priority-setting frameworks and the expectations of many health policy makers and analysts (Drummond, 2003; Jan, 2003). A number of factors are likely responsible for this. Some stem from the fact that integration of economic evaluation evidence into decision-making is neither simple nor straightforward (Jan, 2003), as was highlighted in the above discussion of the generalizability of economic evaluation evidence. But more fundamentally, most health care interventions have never been subject to an economic evaluation and the interventions that have been assessed tend to be those that are most easily studied (rather than those for which the need for such evidence is most pressing). Many more economic evaluations exist for clinical prevention interventions, for example, with more easily defined populations, interventions, and settings, and more easily measured outcomes, than for interventions drawn from the areas of health promotion, health protection or healthy public policies. To the extent that priority-setting exercises restrict consideration to interventions for which such evidence exists, only a limited and non-representative set of interventions can be considered. One hope, of course, is that in the long run demand by those setting priorities and making coverage decisions will bring forth a larger supply of such studies.

7. Economic Evaluation Evidence For Preventive Interventions

Deciding which topics to include in this review was a formidable task. While economic evaluations are not available to the same extent for preventive activities as for treatment (Ramsey, 2000), the scope of the preventive literature is vast and the topics are varied. (Initial explorations of potentially relevant literature for this paper, for example, yielded over 5000 articles.)

We used a two-pronged approach to select preventive interventions to include in this paper. First, we created lists of preventive activities that others recommended as important. In many cases, these recommended preventive activities were accompanied by separately documented evidence of effectiveness. Second, additional preventive interventions with potentially large population health impacts were identified through a review of Canadian-based prevention-oriented economic evaluations.

7A. Prong One: Preventive activities Recommended by Others

We used the work of preventive task forces to develop two lists of recommended preventive activities. The first list focuses on clinical prevention activities and consists of interventions assessed as having good or fair evidence of effectiveness by the Canadian Task Force on

Preventive Health Care (CTFPHC; A and B recommendations, respectively) (Table 1, first four columns). These interventions, along with other clinical preventive activities that were not ultimately recommended for action, were originally selected for study by CTFPHC because of the population burden of the condition and the feasibility of preventive activities (Canadian Task Force on the Periodic Health Examination, 1994).

The second list covers the remaining three faces of prevention—health promotion, health protection, and healthy public policy (Table 2, first four columns). For these types of intervention, we could find no Canadian list of recommended interventions. We therefore developed our own list, using a variety of sources. Topics identified by US Task Force on Community Preventive Services, a health promotion and health protection review group (which is distinct from the US Preventive Services Task Force, the US equivalent of CTFPHC), were used as a starting point. The US Task Force on Community Preventive Services identified 15 topics of importance based on existing targets in US health policy (e.g., Healthy People 2000), expert input, the burden of the condition, and the feasibility of prevention (Zaza et al., 2000). We supplemented the list from the US Task Force on Community Preventive Services with recommendations from Canadian health policy sources (provincial and federal government reports, including the Kirby Committee report and the Romanow Commission report) and conversations with Canadian experts (academics, public health personnel, and government representatives listed in Appendix A). While many of the interventions recommended by the US Task Force on Community Preventive Services were echoed by Canadian sources, the reverse was not true. Most notably, the US Task Force on Community Preventive Services recommended few traditional public health protection activities. We added interventions addressing workplace safety, food safety, water control, disease outbreak control, and environmental health based on recommendations from Canadian sources. We also added specific interventions to address topics that had been identified but not yet linked to interventions by the US Task Force on Community Preventive Services (alcohol abuse and improved pregnancy outcomes). The final list is intended to highlight health promotion, health protection, and healthy public policy interventions that should be considered for implementation.

In contrast to the clinical prevention list, there has been no systematic review of the effectiveness of many activities included on the promotion, protection, and policy list. We did not independently review effectiveness evidence but present effectiveness evidence when available from the US Task Force on Community Preventive Services (7 of their 15 topics have been reviewed for effectiveness to date; strength of effectiveness evidence is indicated by bracketed symbols in the possible interventions column of Table 2). Given the lack of synthesized effectiveness evidence, a systematic review of the effectiveness of health promotion, health protection, and healthy public policy interventions from a Canadian perspective could provide valuable information for decision making.

7B. Prong Two: Additional Preventive Interventions With Potentially Large Population Health Impacts

Rather than discard remaining potentially relevant evidence simply because the studied intervention was not identified on the above two lists, we created a third list from additional economic evaluations set in Canada that assessed preventive interventions with potentially large population health impacts (Figure 1). Preventive interventions were eligible for inclusion in this

list if they were identified in our literature search of economic evaluations (described below), were not included on the first two lists, and had not been assessed by the CTFPHC as having conflicting, insufficient or negative effectiveness evidence (C, I, and D or E recommendations, respectively). Economic evaluations of prostate cancer screening, for example, were not eligible for inclusion in this third list as prostate cancer screening was rated by the CTFPHC as having conflicting or negative effectiveness evidence (C or D recommendations).

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We evaluated each eligible intervention for a "potentially large population health impact" based on a combination of a large target population, important health effects, and a highly effective intervention, applying these criteria intuitively rather than quantifying "large," "important," and "highly effective". A quantitative assessment of the potential population health impacts of eligible interventions was not possible within the limits of available time and resources. The application of the criteria was generally straightforward, with the exception of defining the target population for screening programs. We treated the target population of screening programs to be the population with the disease or condition that would be identified through screening rather than the population that would be screened. A screening program only met the large target population criterion, therefore, if the population expected to have the disease or condition was large. Rare diseases or conditions, such as thalassemia (Ostrowsky, Lippman, & Scriver, 1985), would not meet this criterion. All economic evaluations with a Canadian setting were independently assessed for potentially large population health impacts by two members of the study team (LJG, BH). Disagreements were resolved by consensus.

7C. Economic Evaluation Evidence

We conducted a multi-source literature search for economic evaluations of prevention and promotion interventions, reviewing both peer-reviewed and grey literature from 1980 onward. Because of a concern about generalizability, we limited our search to economic evaluations set in Canada and other countries with similar health care systems and social structures—Australia, New Zealand, Europe, and the US.

For the peer-reviewed literature, we followed a search strategy suggested by Sassi and colleagues (2002) that was designed for systematic reviews of economic evaluations. Specifically, we used the search strategy that had the highest combination of correctly identifying economic evaluations and rejecting other articles ("LSE Selective Strategy C"). For studies set outside of Canada, we also employed their methodological quality filter of only including studies that reported incremental ratios; this reduced the number of our non-Canadian studies to manageable levels. We conducted this search in Medline only as Sassi and colleagues reported that other databases provide little additional yield. Our Medline search for economic evaluations was further restricted to studies published in 1980 or later and to studies with the following exploded MeSH headings: primary prevention, preventive health services, preventive medicine or public health.[1] We used a variety of approaches to find grey literature, relying predominantly on a variety of web-based searches and the reference lists of relevant articles.[2]

[1] The public health MeSH heading contains many disparate topics. We refined the explosion of the public health MeSH heading to exclude epidemiologic factors, epidemiologic measurements, and epidemiologic methods. Full details are available from the authors.

[2] Full details are available from the authors.

We supplemented our literature search with three additional sources: (1) a similar literature search conducted by Bonnie Rush and colleagues at the University of Calgary (2002); (2) the National Health Services Economic Evaluation Database[3] (NHS EED), an online database of reviews of published (both peer-reviewed and grey literature) economic evaluations (http://agatha.york.ac.uk/nhsdhp.htm); and (3) economic evaluations cited by the CTFPHC, the US Preventive Services Task Force, and the US Task Force on Community Preventive Services.

Our literature search yielded 1,372 publications reporting possible economic evaluations of prevention or promotion interventions (Figure 2). Four hundred and thirteen (413) of these articles were excluded for a variety of reasons, including not reporting on an economic evaluation (e.g., articles about economic evaluation methodology), not addressing a prevention or promotion topic, or being set in a country not on our inclusion list. Of the 959 publications reporting economic evaluations of prevention or promotion interventions, 126 of were set in Canada; 323 in Australia, New Zealand, and Europe; and 510 in the US. Using the title and abstract (or the paper itself when the title and abstract did not provide enough information), we classified the 959 publications as reporting economic evaluations of interventions listed in Table 1, Table 2 or neither. Three hundred and ninety eight (398) publications assessed interventions included in Table 1 and 284 assessed interventions included in Table 2. As there was overlap in the interventions listed in Tables 1 and 2 and some publications assessed interventions from more than one face of prevention, 138 publications were classified as addressing interventions listed in both Tables 1 and 2. Of the 415 publications reporting economic evaluations of interventions not included in Tables 1 or 2, 57 Canadian-based studies assessed interventions that were eligible for assessment of their potential population health impact. Twenty-three (23) of these studies evaluated interventions that we considered to have potentially large population health impacts (listed in Figure 1). In total, we classified 567 publications as addressing interventions included in Tables 1 or 2 or as Canadian studies of preventive interventions with a potentially large population health impact. These 567 publications reported 672 economic evaluations of preventive interventions on our lists (Tables 1 and 2 and Figure 1).

Not surprisingly, the majority of the 672 economic evaluations examined clinical prevention interventions (368 of 672, or 55 percent; Table 3). The next largest group of evaluations addressed health protection interventions (31 percent), a significant proportion of which were universal or mandatory screening or immunization programs. Health promotion interventions represented 12 percent of the evaluations and healthy public policy interventions represented 2 percent. These trends were consistent across the three country groupings.

Proportionately more interventions listed in the clinical prevention table (Table 1) were studied by at least one economic evaluation than the interventions listed in the health protection, health promotion, and healthy public policy table (Table 2). Table 1 lists 136 recommended interventions, 79 of which (58 percent) had at least one economic evaluation set in Canada or other included countries. Only 58 interventions out of 160 (36 percent) listed in Table 2 were accompanied by economic evidence. With respect to economic evaluations set in Canada, the

[3] We used the exploded MeSH headings of health promotion, health education, public health, public policy, environment, environmental health, risk management, mass screening, population surveillance, health status and health status indictors. We further searched for economic evaluations set in Canada with the NHS EED intervention classifications of primary prevention, secondary prevention or screening.

difference between the two tables narrows: 35 interventions listed in Table 1 (26 percent of recommended interventions) and 20 interventions listed in Table 2 (13 percent) have at least one economic evaluation set in Canada. We found no economic evaluations for 159 of the 290 interventions listed on Tables 1 and 2 (55 percent).[4]

Certain interventions have been more intensively studied than others (Table 4). Thirteen clinical prevention interventions have been studied in 10 or more economic evaluations. The interventions are varied but include a number of screening and vaccination interventions. Addressed conditions include heart disease, cancer, and infectious diseases. Six health protection interventions were studied in 10 or more economic evaluations. All of these health protection interventions were of universal or mandatory immunization programs targeted at specific groups, with the exception of community water fluoridation. No health promotion or healthy public policy interventions had 10 or more economic evaluations. The three most studied health promotion interventions were needle exchange programs (nine studies), community education campaigns to increase smoking cessation (nine studies), and community education campaigns to prevent sexually transmitted diseases (seven studies). Day care or preschool programs was the most-studied healthy public policy intervention (nine studies), followed by social skill development programs to reduce violent behaviour (five studies), and parenting classes to increase early childhood development opportunities (three studies).

8. Economic Evaluation Evidence for Five Preventive Interventions

Limited time and resources precluded a comprehensive evaluation and synthesis of economic evaluation evidence addressing the four faces of prevention. For illustrative purposes, we chose to focus on a sample of preventive interventions that cover the four faces of prevention, are the subject of a substantial body of economic evaluation evidence, some of which is set in Canada, and are not universally available in Canada. The selected interventions are:

1) Varicella vaccination for infants (clinical prevention; health protection if universal or mandatory);
2) Colorectal cancer screening using fecal occult blood testing for average risk adults over 50 years of age (clinical prevention);
3) Needle exchange programs (health promotion);
4) Community water fluoridation (health protection);
5) Day care or preschool programs (healthy public policy).

Our objective is to illustrate how critically appraised and synthesized economic evaluation can help to inform decision making.

Each study was reviewed by two members of our team using a published checklist for assessing economic evaluations (from Drummond et al., 1997). Disagreements were resolved by consensus. Detailed examination of each study allowed us to conclusively determine which articles should be included in our review. Articles that were not economic evaluations, did not

[4] Six interventions were listed on Tables 1 and 2 (day care and preschool programs, bicycle helmet laws, community water fluoridation, impaired driving laws, seat belt laws, and child safety seat laws) and were not double counted in the total of 290 interventions.

address the comparison of interest, or did not perform incremental comparisons were excluded. Where more than one article reported on the same study, we selected one article to represent the study and drew supplementary information from the duplicates as needed. We also added economic evaluations that we identified from the reference lists of reviewed articles.

Key results for the economic evaluation syntheses are summarized in accompanying tables. Currencies were converted to Canadian dollars for the same year using purchasing power parities (PPPs) published by the Organization of Economic Cooperation and Development.[5] Where the currency year was not reported, we assumed a currency year three years prior to the article publication date. All converted Canadian dollar amounts were then brought forward to 2003 Canadian dollars using the Health Care component of the Statistics Canada Consumer Price Index. We also computed relevant net benefits and benefit/cost and cost-effectiveness ratios where appropriate data were provided but the measures had not been calculated.

Each economic evaluation synthesis is preceded by a discussion of the status of the preventive intervention in Canada to provide context and insight into past policy decisions and future policy options.

8A. Varicella Vaccination for Infants

Varicella Vaccination in Canada

Varicella (chickenpox) is a common childhood disease with the possibility of severe complications. Uncomplicated cases of chickenpox in children in Canada result in $11.2 million direct health care costs and $98 million in caregiver productivity losses (1997/1998 dollars; Law et al., 1999a). Complicated cases of chickenpox in children add another $13.2 million to the total costs (the majority of which are direct health care costs) (Law et al., 1999b). The most common complications are bacterial infections of skin lesions, pneumonia, dehydration, encephalitis and hepatitis. Adolescents and adults usually have more severe disease and are at higher risk of complications than children. The varicella virus remains dormant in sensory nerve roots and in approximately 15 percent of the population is reactivated causing herpes zoster, a painful rash sometimes followed by persistent neuralgia. The frequency of herpes zoster increases with age.

Varicella vaccination was first licensed in Canada in 1998. The CTFPHC recommends routine varicella vaccination for 12 to 15 month old children and catch-up immunization for unvaccinated 1 to 12 year old children (A grade, Canadian Task Force on Preventive Health Care, 2001b). In May 1999, the National Varicella Consensus Conference recommended that varicella vaccination be publicly funded across Canada for young children (Health Canada, 1999). Prince Edward Island was the first jurisdiction to do so, implementing a universal vaccination program in 2000 for children 12 months of age combined with a catch-up program for children up to grade six (Sweet et al., 2003). To date, four additional provinces and territories cover the cost of varicella vaccination for all children at 12 months of age (Alberta, Nova Scotia, Northwest Territories, and Nunavut), with three of these provinces also implementing catch-up programs (Alberta, Nova Scotia, and Northwest Territories). New Brunswick has approved but not yet implemented a varicella vaccination program. Quebec has

[5] For the two studies reporting currencies in Spanish pesetas, we used the annual average exchange rate from the Bank of Canada. Using the OECD PPP values for Spain resulted in implausible values.

implemented a pilot program for susceptible health care workers and 10 year old children. Ontario recently began covering the cost of varicella vaccination for all babies born with HIV. Manitoba provides vaccination to persons at highest risk of infection or complications from varicella. British Columbia, Saskatchewan, Newfoundland and Labrador and the Yukon currently provide no coverage for varicella vaccination (Anonymous, 2003b; Canadian Paediatric Society, 2004; Immunization Monitoring Program Active, 2003; Sibbald, 2003). Varicella vaccine is costly in provinces without universal coverage for children (e.g., $75 in Saskatoon, Saskatchewan; $85 in Hamilton, Ontario). Universal coverage would also be expected to lower the cost of the vaccine (as was the case when Hepatitis B vaccination became widely available) and improve equity of access to vaccination.

Although the effectiveness of varicella virus vaccine in preventing varicella in children has been established in placebo-controlled randomized trials, the long term effects of large scale vaccination are unknown. Widespread vaccination of infants and young children will decrease the occurrence of natural infection among non-immunized children by reducing the circulation of wild varicella virus—a phenomenon referred to as "herd immunity". Unimmunized and unexposed children will remain susceptible to varicella infection during adolescence and adulthood and, when eventually exposed to wild varicella virus, will experience more serious illness than if they had become infected during childhood. Reduced circulation of wild varicella virus will reduce the boosting of immunity that occurs when previously immunized or infected individuals are subsequently exposed to wild varicella virus. This may result in waning immunity and an increased likelihood of either reactivation of dormant varicella virus, resulting in herpes zoster, or reinfection. Because broad-based implementation of infant vaccination could lead to an increased occurrence of more serious cases among adolescents and adults, a program of preteen varicella vaccination is sometimes recommended either as an alternative or as a supplement to infant vaccination (e.g., Canadian Task Force on Preventive Health Care, 2001b). Uncertainty about whether mass vaccination of children against varicella will result in a long term increase or decrease in the frequency of herpes zoster poses a challenge for the economic evaluation of varicella vaccination because of the considerable health care costs associated with herpes zoster.

The Economic Evaluation Evidence

The set of economic evaluations identified in our original literature search did not change based on our synthesis review (Figure 3). Ten economic evaluations of varicella vaccination met our inclusion criteria. The studies were published between 1985 and 2002. Study settings, methods and results are summarized in Tables 5A, 5B and 5C. Two studies were set in Canada (Brisson & Edmunds, 2002; Getsios et al., 2002); five in Australia, New Zealand or western Europe; and three in the United States. Six studies included both cost-benefit and cost-effectiveness analyses; three presented cost-benefit analyses only; and one evaluated cost-effectiveness only. All 10 studies conducted the evaluation from a health payer perspective; 8 studies included a societal perspective. All 10 studies evaluated infant varicella vaccination at the time of a routine vaccination (all but one specified the vaccination as measles, mumps and rubella). Five studies also evaluated infant vaccination with a catch-up program of preteen vaccination. Three of these also assessed stand-alone preteen varicella vaccination.

From a health payer perspective, the cost per life year gained of infant varicella vaccination varied from $27,000 to $94,000 (four studies). The benefit/cost ratio was 0.3 to 0.9 in five studies and was greater than 1 in a sixth study (Coudeville et al., 1999).[6] The cost per undiscounted case of varicella prevented varied from $3 to $55 (three studies) and the cost per discounted case prevented varied from $7 to $80 (three studies).[7] Three studies (two set in Canada) assessed infant vaccination combined with catch-up vaccination of preteens. Cost per life year gained varied from $13,000 to $88,000. In the two Canadian studies, cost-effectiveness of the combined program (at $58,000 and $88,000 per life year gained) was very similar to that of the infant only program. Two studies examined the incremental cost per case of varicella prevented through a combined program compared to an infant program only. Incremental costs were $445 per discounted case prevented in one study (Scuffham, Lowin, & Burgess, 2000) and $532 per undiscounted case prevented in the other (Lieu et al., 1994). In a study set in Germany (Beutels et al., 1996), preteen vaccination was cost-saving from a health payer perspective. In a Canadian study (Brisson & Edmunds, 2002), preteen vaccination cost $21,000 per life year gained—about half the cost per life year gained of either infant vaccination or infant vaccination with preteen catch-up vaccination. In a third study (Scuffham, Lowin, & Burgess, 2000), preteen vaccination cost $564 per case of varicella prevented.

From a societal perspective (which includes costs related to lost time from work), varicella vaccination was found to yield a net benefit in all studies. In the eight studies that assessed infant varicella vaccination from a societal perspective, benefit/cost ratios varied from 1.6 to 6.9. Infant vaccination with preteen catch-up and stand-alone preteen vaccination were estimated to produce a net benefit in three studies (two set in Canada) and two studies (one set in Canada), respectively.

In summary, varicella vaccination of infants and/or preteens is likely to produce a net societal benefit, but not be cost-saving from a health payer perspective. Whether any of the three approaches that have been evaluated represent a reasonable public investment is a matter of judgment, particularly because of the uncertainties about the long term effects of large scale varicella vaccination of infants. Vaccinating susceptible preteens protects against the risk of increased numbers of cases among adolescents and adults, which tend to be more severe and carry a higher risk of complications. While stand-alone preteen vaccination is at least as cost-effective as infant vaccination, with or without preteen catch-up, it would prevent many fewer cases of childhood varicella. All of the economic evaluations we reviewed ignore the pain and suffering associated with varicella and herpes zoster which are the main and, arguably, the most important effects of varicella infection. Death from varicella or its complications is rare, except among immunocompromised individuals.

[6] Methodologically, net benefit is frequently the preferred outcome measure in cost-benefit analysis. However, because we compare programs of vastly different size and scope, unless the net benefit is standardized to reflect program size, comparisons across interventions lose meaning. Because information for such standardization was frequently unavailable, we often rely on benefit/cost ratios to compare study results in the text. Both benefit/cost ratios and net benefits are included in the tables whenever possible.

[7] In economic evaluations, future costs and consequences are usually discounted to present value to reflect the fact that money or benefits that will be obtained at a future time are valued less than if they accrued immediately.

8B. Colorectal Cancer Screening Using Fecal Occult Blood Testing

Colorectal Cancer Screening in Canada

Colorectal cancer is the third most common cancer diagnosis in Canada and second most common cause of cancer death (lung cancer being first). An estimated 19,100 new cases of and 8,300 deaths from colorectal cancer are expected in 2004. Canadian colorectal cancer rates are among the highest in the world (National Cancer Institute of Canada, 2004).

The CTFPHC recommends colorectal cancer screening using fecal occult blood testing (FOBT) for average risk adults over 50 years of age (A grade, Canadian Task Force on Preventive Health Care, 2001a). However, current rates of colorectal cancer screening are low (Vinden, Schultz, & Rabeneck, 2004). From 1992 to 2001, the percentage of Ontarians between 50 and 74 years of age that received an FOBT varied from a low of 6.3 percent (in 1996) to a high of 10.0 percent (in 2001) (our calculations from Vinden, Schultz, & Rabeneck, 2004). The National Committee on Colorectal Cancer Screening, which was established by Health Canada in 1998, recommended a population-based colorectal cancer screening program (National Committee on Colorectal Cancer Screening, 2002). The Ontario Expert Panel on Colorectal Cancer Screening also made a similar recommendation (Ontario Expert Panel, 1999). Population-based colorectal cancer screening programs would be costly and require additional health human resources. The National Committee on Colorectal Cancer Screening estimates a biennial screening program with a 67 percent participation rate would require 500 additional family physicians for Ontario alone as well as almost 15 percent more confirmatory colonoscopies nationally (Coombs et al., 2002).

No provincial government has initiated a colorectal cancer screening program to date. Ontario started a pilot colorectal cancer screening program in early 2004; other provinces are considering pilots as well. The situation in other countries is similar—while some countries offer opportunistic screening, no country has implemented a population-based colorectal cancer screening program (Coombs et al., 2002; Rozen, Winawer, & Waye, 2002; Rozen & Pignone, 2003). A number of countries are conducting or have conducted pilot screening programs and educational campaigns to promote screening (Rozen, Winawer, & Waye, 2002).

The Economic Evaluation Evidence

Of the several possible approaches to colorectal cancer screening, only screening with fecal occult blood tests has been studied and found effective in randomized controlled trials. In three clinical trials conducted in Minnesota (Mandel et al., 1999), Denmark (Kronborg et al., 1996), and the UK (Hardcastle et al., 1996), biennial FOBT has been found to reduce colorectal cancer mortality by 21, 18 and 15 percent respectively over 18, 10 and 7.8 (median) years of follow-up. In the Minnesota trial, annual screening reduced colorectal cancer mortality by 33 percent over 18 years (Mandel et al., 1999). FOBT screening has not yet been shown to reduce all cause mortality (Budenholzer, 2003).

Because strong evidence is lacking regarding the effectiveness of other screening methods, in selecting economic evaluations of colorectal cancer screening for review, we included only studies that compared FOBT screening to usual care or no screening. Our original literature search identified 27 economic evaluations (Figure 3; 4 set in Canada; 10 in Australia, New

Zealand or western Europe; and 13 in the United States). On review of these articles, we excluded three review articles (Barry, 2002; Pignone et al., 2002; Provenzale, 2002) and four papers reporting on a study already represented by another included article (Gyrd-Hansen, 1997; McMahon et al., 2001; Neilson & Whynes, 1995; Winawer et al., 1997). We excluded another five articles as they did not address colorectal cancer screening with FOBT (McGrath, Ponich, & Gregor, 2002; Walker & Whynes, 1991) or did not compare FOBT with no screening (Castiglione et al., 1997; Manus et al., 1996; Rae & Cleator, 1994). We also identified five additional relevant articles from the reference lists of other articles. One of these additional articles supplemented a previously identified article (Gyrd-Hansen, 1998); the other four were new to our database (Eddy, 1990; Lieberman, 1995; UK CRC Screening Pilot Evaluation Team, 2003; Wagner, Herdman, & Wadhwa, 1991). This resulted in 19 economic evaluations for review (2 set in Canada; 6 in Australia, New Zealand or western Europe; and 11 in the United States).

To facilitate comparisons across studies, we included those that expressed cost-effectiveness as incremental costs per life year gained or per quality adjusted life year (QALY) gained and excluded those that reported cost-effectiveness as cost per cancer or adenoma detected (Weller et al., 1995) or cost per cancer death prevented (Lieberman, 1995; Sorrentino et al., 1999) Because costs of cancer treatment in the three published randomized controlled trials did not differ appreciably between the screened and unscreened arms (Helm et al., 2000; Tuck et al., 1989; Whynes et al., 1993), we included one study (Gyrd-Hansen, 1997; Gyrd-Hansen, 1998; Gyrd-Hansen, Sogaard, & Kronborg, 1998) that, rather than estimating treatment costs among screen-detected and clinically detected cases of colorectal cancer, assumed equivalent cancer treatment costs in screened and unscreened populations.

Sixteen economic evaluations of colorectal cancer screening with FOBT, published between 1980 and 2003, met our inclusion criteria (Tables 6A, 6B, and 6C). Two studies, one published in 2000 (Conseil d'Evaluation des Technologies de la Santè du Québec (CETS), 2000) and the other published in 2002 (Flanagan et al., 2002), were set in Canada; one in Australia; three in western Europe; and 10 in the US. Thirteen were cost-effectiveness evaluations, two used cost-utility analysis, and one was a cost-benefit analysis. All 16 studies assessed FOBT screening from a health payer perspective. One study also assessed cost-benefit from a societal perspective.

From a health payer perspective, estimates of the incremental cost-effectiveness of FOBT screening varied from $2,000 to $65,000 per life year gained across thirteen studies. The vast majority of cost-effectiveness estimates were less than $25,000 per life year gained. The single study in which the estimate of cost-effectiveness was greater than $35,000 deviated from the usual practice in economic evaluations of conducting a base case analysis using "best estimates" by selecting "conservative values… to produce cost-effectiveness ratios that were on the high side" (Wagner, Herdman, & Wadhwa, 1991). There was no systematic difference in cost-effectiveness estimates between the five studies that used randomized trial data as the basis for estimating the clinical impact of FOBT screening and the eight studies that based their clinical effectiveness estimates on observational data and simulation models. However, the range of cost-effectiveness estimates was somewhat narrower in the former than in the latter—$25,000 (from $3,000 to $28,000 per life year gained) versus $63,000 (from $2,000 to $65,000 per life

year gained). The two cost-utility evaluations provided estimates of cost per QALY gained that varied from $3,000 to $13,000. In the single cost-benefit study (Kristein, 1980), the benefit/cost ratio of FOBT screening was 0.81.

From a societal perspective, FOBT screening was estimated to produce a net benefit with benefit/cost ratios varying from 2.3 to 5.7, depending on the assumed time interval from screen-detectable to symptomatic cancer (Kristein, 1980).

In principle, cost-utility analysis might be seen to be more policy-relevant than cost-effectiveness evaluation. However, the effect of FOBT screening on quality of life remains uncertain. Whynes and colleagues (1994), in their analysis of data from the Nottingham trial of FOBT screening, found little difference in quality of life between screen-detected and symptomatic, clinically detected cancers. Further, stage of cancer progression was not closely related to quality of life outcome.

Based on the available data, FOBT screening of normal risk adults above the age of 50 years appears to be a reasonable investment by conventional standards and could be cost-saving from a societal perspective when the costs of lost time from work are taken into account. However, mobilizing the financial and human resources required to mount a mass, population-based FOBT colorectal cancer screening program would be a formidable challenge. The necessary public investment would require substantial reallocation of existing health or other public expenditures or an increase in tax revenue to meet the very considerable start-up and maintenance costs that would be associated with the program.

8C. Needle Exchange Programs

Needle Exchange Programs in Canada

Needle exchange programs (NEPs) were established in Vancouver, Montreal and Toronto by 1989. Although they now exist in substantial numbers, availability of NEPs in Canada is far from universal. Although no definitive data are available (Special Committee on Non-Medical Use of Drugs, 2002), current estimates of the number of NEPs vary from over 100 to over 200. Many large cities have NEPs. While some rural areas and smaller urban areas also have NEPs, programs in these communities frequently offer extremely limited availability (e.g., two hours per week). Few NEPs anywhere operate for extended hours. Funding for NEPs is insufficient and unstable according to many sources. No federal funding directly supports NEPs (Special Committee on Non-Medical Use of Drugs, 2002). The Ontario Ministry of Health and Long-Term Care mandates Boards of Health to provide NEPs. No other provinces or territories have similar guidelines. NEP supporters claim that few injection drug users have access to NEPs due to the geographical and institutional restrictions described above as well as limits on the number of syringes distributed and the lack of NEPs in prisons (e.g., Canadian HIV/AIDS Legal Network, 2002). In June 2003 the House of Commons Health Committee recommended that NEPs be established in federal prisons (Bueckert, 2003).

The Economic Evaluation Evidence

Our original literature search identified nine economic evaluations (Figure 3; two set in Canada, one in Australia and six in the United States). One article was excluded on closer examination because it was not an economic evaluation (Lurie & Drucker, 1997). An additional relevant

article was identified through the reference list of another paper (Lurie et al., 1998). This resulted in nine economic evaluations of needle exchange programs (two set in Canada, one in Australia and six in the United States). We excluded one study that did not relate costs to any health outcome, but presented cost-effectiveness as cost per syringe distributed (Lurie et al., 1998)

Of the eight included studies, two were set in Canada, one in Australia, and five in the United States. The study settings, methodologies and results are summarized in Tables 7A, 7B and 7C. Publication dates ranged from 1993 to 2002. Five studies employed cost-effectiveness analysis only, two used cost-benefit analysis only, and one included both cost-effectiveness and cost-benefit analyses. Six studies examined the costs and consequences of NEPs in relation to HIV infections. One study examined the costs and benefits of NEPs in preventing both HIV and Hepatitis C infections (Health Outcomes International Pty Ltd, National Centre for HIV Epidemiology and Clinical Research, & Drummond, 2002). The final study assessed the cost-effectiveness of NEPs in preventing Hepatitis C (Pollack, 2001). Each study used estimates of the effectiveness of NEPs in preventing HIV and Hepatitis C infections based on observational data and mathematical modeling. No randomized controlled trials of NEPs have been or are likely to be conducted. Similar estimates of effectiveness were obtained in all studies despite differences in data sources and modeling approaches. The evaluations were conducted from a variety of perspectives: needle exchange programs (four studies), payers (two studies), society (two studies), the public/voluntary sector (one study), government (one study) and intraveneous drug users (IDUs; one study).

From the program perspective, NEPs cost per HIV infection averted varied from $5,500 to $144,000 (in three studies), depending on the evaluation assumptions (both from Kahn, 1993) and at least $330,000 per Hepatitis C infection averted (Pollack, 2001). The single study that assessed cost-effectiveness from the societal perspective reported a cost of $38,000 per HIV infection averted if sterile syringes were available for 80 percent of injections and $45,000 per HIV infection averted at 100 percent coverage (Holtgrave et al., 1998). When the costs of HIV treatment were taken into account (estimated by one study as having a present value of almost $180,000 (Holtgrave et al., 1998)) in cost-benefit analyses, NEPs were universally cost-saving (four studies), whatever the perspective. One study reported a benefit/cost ratio of 4.7 from the payer perspective (Gold et al., 1997). Another study reported net benefits per participant of $10,500 from the public/voluntary sector perspective, $464,000 from IDUs' perspective, and $474,000 from the societal perspective (Reid, 2000). A third study reported net benefits of approximately $2 million over 10 years regardless of the combination of outcome (HIV only or HIV plus Hepatitis C) and perspective (government with or without IDUs) (Health Outcomes International Pty Ltd, National Centre for HIV Epidemiology and Clinical Research, & Drummond, 2002).

Results consistently indicated that health care costs averted through HIV prevention exceed program costs, often by a wide margin. Based on the available economic evaluation evidence, NEPs provide good value for money through the prevention of HIV infections.

8D. Community Water Fluoridation

Community Water Fluoridation in Canada

The Centers for Disease Control and Prevention in the United States recently named water fluoridation one of the "ten great public health achievements" of the last 100 years (Centers for Disease Control and Prevention, 1999b). Historically, the fluoridation of community water supplies decreased the incidence of dental caries by as much as 50 to 70 percent (Clark & Trahan, 1985). More recent data (~1980s onward) document decreases in caries rates and subsequent decreases in the effectiveness of water fluoridation. Differences in caries rates between fluoridated and non-fluoridated communities are now on the order of 25 percent (Clark & Trahan, 1985; Newbrun, 1989). This decrease is thought to result from the introduction of fluoridated toothpaste as well as the "halo effect" of children in non-fluoridated communities attending school in fluoridated communities and consuming processed foods and drinks manufactured with fluoridated water supplies (White, Antczak-Bouckoms, & Weinstein, 1989).

Health Canada estimates that about 40 percent of Canadians have fluoridated water (2002). Most large Canadian cities use water fluoridation; those without water fluoridation include Vancouver, Victoria, Montreal, and Regina. Provincial variation in water fluoridation coverage is large; in 2002, less than 5 percent of British Columbians had fluoridated water supplies compared with over 75 percent of Albertans (MacQueen, 2002).

The fluoridation of community water supplies is endorsed by Health Canada, the Canadian Public Health Association, the Canadian Dental Association, and the Canadian Medical Association. The CTFPHC and the US Task Force on Community Preventive Services recommend community water fluoridation to prevent dental caries (A recommendation, Lewis & Ismail, 1995; strong evidence, Task Force on Community Preventive Services, 2002).

Despite strong endorsements from varied sources, fluoridating community water supplies can be a contentious issue. There is a strong anti-fluoridation lobby and a number of smaller Canadian communities have voted to stop fluoridating their water supplies (e.g., West Elgin, Ontario in 2003; Colbalt, Ontario in 2001; Kamloops, British Columbia in 2001; and Whitehorse, Yukon Territory in 1998 (Jones & Fluoride Action Network, 2004))

The Economic Evaluation Evidence

Our original literature search identified 12 economic evaluations (Figure 3; one set in Canada; six in Australia, New Zealand or western Europe; and five in the United States). On review of these articles, we excluded three articles as they reported costs only (Garcia, 1989; Kailis et al., 1976; Ringelberg, Allen, & Brown, 1992). We found three additional relevant articles from the reference lists of other articles. One of these additional articles supplemented a previously identified article (Davies, 1973), the other two were new to our database (Carr, Dooland, & Roder, 1980; Manau et al., 1987). This resulted in 11 economic evaluations of water fluoridation (one set in Canada; seven in Australia, New Zealand or western Europe; and three in the United States).

We included all 11 economic evaluations of water fluoridation in our review (Tables 8A, 8B and 8C). Publication dates ranged from 1973 to 2001. A variety of economic approaches were used: six studies employed cost-benefit, two studies used cost-effectiveness, two studies employed

both cost-benefit and cost-effectiveness, and one study used cost-utility. Two studies conducted their evaluation from the societal perspective, one study employed both the societal and payer perspective, and the remainder employed some sort of payer perspective. Three of the payer perspectives were explicitly public payers, including the single Canadian study, which used the health care system as the public payer as the provincial government had gone on record that water fluoridation costs would be covered by the health care budget (O'Keefe, 1994).

The broad range of publication dates straddles both improvements in economic evaluation methodology and the decrease in water fluoridation effectiveness. Compared to the economic evaluations published in 1980 or earlier, the more recent economic evaluations are of much stronger quality. The one recent methodological exception is the article by Manau and colleagues (1987). Problems with this study include not assigning dollar values to all costs, including costs to children and adults and benefits only to children, and omitting other important pieces of information described below. As is appropriate, the four most recent studies use effectiveness data that reflect the decrease in caries reduction from fluoridation (Birch, 1990; Griffin, Jones, & Tomar, 2001; O'Keefe, 1994; Wright et al., 2001). A fifth study deals with the ramifications of lower caries rates in their discussion section (Niessen & Douglass, 1984).

The included studies constructed their models in a variety of ways, making comparisons amongst studies difficult. All but two studies conducted their analysis for a program length of 10 to 30 years, with the water fluoridation equipment assumed to last for 10 to 20 years (with the exception of Dowell (1976), where it is not clear whether capital costs were included). Two other studies reported their results solely for an average year of a water fluoridation program (Griffin, Jones, & Tomar, 2001; Manau et al., 1987). One of the studies that reported results for the length of the program also presented results for an average year (Niessen & Douglass, 1984). Discounting rates varied from 4 to 10 percent for nine of the studies. Two studies did not use discounting (Davies, 1973; Manau et al., 1987).

The effectiveness or benefit measure was affected by a variety of different assumptions, including the age distribution of the population, the length of fluoridation exposure, the time needed for maximum caries benefit, and the percentage of the population treated for caries. All of the studies included benefits for children, with the starting age of fluoridation benefits varying from 2.5 years (Davies, 1973) to 6 years (Griffin, Jones, & Tomar, 2001; Nelson & Swint, 1976) (median age = 4.5 years). One study did not specify the starting age for benefits (Manau et al., 1987). Two studies also included benefits for adults (Griffin, Jones, & Tomar, 2001; Wright et al., 2001). As water fluoridation is more effective with lifetime exposure, five studies assumed that their population would have lifetime exposure. Three studies decreased their effectiveness measure by the mobility of the population (Carr, Dooland, & Roder, 1980; Doessel, 1985; O'Keefe, 1994). Three studies did not specify anything about population mobility or lifetime exposure (Dowell, 1976; Griffin, Jones, & Tomar, 2001; Manau et al., 1987). The maximum caries benefit was assumed to start immediately in most of the economic evaluations. Two studies used a 10 year period to reach a maximum caries benefit (Nelson & Swint, 1976; Niessen & Douglass, 1984). Most of the studies that included treatment costs (more on this below) also assumed that all would receive caries treatment. In contrast, Doessel (1985) varied the willingness to pay for and have dental treatment from 0.9 to 0.5, applying this measure to the

treatment costs, and Niessen and Douglass (1984) included treatment costs in their cost-benefit analysis for only 50 percent of the population with caries.

In the four cost-effectiveness and one cost-utility analyses, savings in dental treatment were treated as (negative) program costs in two studies (O'Keefe, 1994; Wright et al., 2001) and as program consequences by the others. Conceptualizing dental treatment savings as program consequences means that the effectiveness measure represents expected treatment savings (perhaps among other effects like pain and suffering) and therefore the dollar value of treatment savings is not included in the cost calculations (or else the treatment savings would be double-counted). These two approaches produce different results. Subtracting treatment costs from water fluoridation costs results in a smaller numerator, which produces a smaller cost-effectiveness or cost-utility ratio (White, Antczak-Bouckoms, & Weinstein, 1989). The two cases where dental treatment savings are included as costs produce cost-saving results (one from the societal perspective (Wright et al., 2001); the other from the health care system perspective (O'Keefe, 1994)) because the treatment savings are larger than the water fluoridation costs. Although the three cost-effectiveness analyses that exclude dental treatment savings all produce positive cost-effectiveness ratios (all from the payer perspective), the values are small (< $3 per carious surface saved for two of the three studies (Manau et al., 1987; Niessen & Douglass, 1984), to a high of almost $91 per carious tooth reduced for one year in another study (Birch, 1990)).[8]

The eight studies that conducted cost-benefit analyses all reported strong cost-saving results, with cost-savings appearing to increase by community size (only four of the eight studies reported community size). Benefit/cost ratios were reported or calculable for five studies, all from the payer perspective. The ratios varied from a low of 1.1 (for a community of 1,000 persons) to a high of 49 (for a community of 300,000 persons) (both our calculations from Wright and colleagues (Wright et al., 2001)). The next highest reported benefit/cost ratio was 8.2 for a community of 7,000 persons (Niessen & Douglass, 1984). Net benefits were reported from the societal and payer perspective, with considerable overlap in results. With the exception of the study by Wright and colleagues (2001)—which reported the lowest and highest net benefits by far—net benefits from three studies varied from a low of $651,000 (societal perspective, worst case scenario from Doessel, 1985) to a high of $5.3 million (payer perspective, Nelson & Swint, 1976). Another two studies reported their cost-benefit results such that they were not comparable with other studies. Carr and colleagues (Carr, Dooland, & Roder, 1980) found that net benefits were first positive in the eighth year of a water fluoridation program from the payer perspective. In an evaluation from the societal perspective, Griffin and colleagues (2001) reported an annual net benefit per person of less than $24 in communities larger than 20,000 persons.

Variation in the magnitude of savings is hard to explain. Sensitivity analyses, undertaken in all but three studies (Davies, 1973; Manau et al., 1987; Nelson & Swint, 1976), found results to be generally robust with the exception of some extreme situations (e.g., very small communities). Economies of scale may have contributed to higher savings as a trend exists for the four studies that reported community size. In particular, the study by Wright and colleagues (Wright et al.,

[8] Birch (1990) argues that dentists will find other procedures to bill for to keep their income the same and so any treatment savings from caries averted will simply show up as another dental cost.

2001), with the largest (by far) benefit/cost ratio and net benefit, also reported the largest (by far) community size. Other evaluation features that tended to increase net benefits or cost-savings included incorporating caries reduction benefits for adults (Griffin, Jones, & Tomar, 2001; Wright et al., 2001), including populations with high caries rates (Birch, 1990; Wright et al., 2001), and modeling costs and benefits over a longer period of time (Niessen & Douglass, 1984; Wright et al., 2001). The time factor is important as water fluoridation is another example of a preventive intervention with high up-front costs and delayed benefits.

Despite the differences in design, effectiveness measures, and results, these 11 studies indicate that water fluoridation is a cost-saving intervention. All of the cost-benefit analyses, the single cost-utility analysis and one of the four cost-effectiveness analyses reported significant cost-savings and negative cost-utility or cost-effectiveness ratios. The remaining three cost-effectiveness analyses, all of which did not include savings in treatment costs, reported positive, but small, cost-effectiveness ratios. Our conclusions are similar to those reached by White and colleagues (White, Antczak-Bouckoms, & Weinstein, 1989) in an earlier review of economic evaluations of water fluoridation.

8E. Day Care and Preschool Programs

Day Care and Preschool Programs in Canada

Both the CTFPHC and the US Task Force on Community Preventive Services recommend day care or preschool programs for disadvantaged children (A recommendation, Lipman & Offord, 1994; strong evidence, Task Force on Community Preventive Services, 2003). The US Task Force further specifies that the program be publicly financed and "designed to increase social competence in children" (Anderson et al., 2003, p. 34).

Like health care services, day care and preschool programs fall under the jurisdiction of Canada's provinces and territories. Standards, regulations, and public funding for day care and preschool vary across the country. Day care and preschool in Canada is predominantly privately funded (Friendly, Beach, & Turiano, 2002), with Quebec as a notable exception. Since 1997, Quebec has been developing a universal publicly funded day care program for children under 5 years of age. The program was phased in gradually and, by 2000, all children under the age of 5 were eligible for a place in a childcare centre at a cost to the family of $5 per day. On January 1, 2004, the parental contribution was increased to $7 per day. Although almost 90,000 new childcare slots have been created since 1997 (Government of Quebec, 2003), the number of available spots represents only about half of the number of children under the age of 5 in Quebec (Lefebvre, 2004). This day care program does not specifically target disadvantaged children; in fact, children from low-income families are under-represented in the subsidized spaces (Lefebvre, 2004).

Data availability for day care and preschool participation varies across the country. No comprehensive source of data exists (Cleveland et al., 2003) and available national data are not specific to this age group. Friendly and colleagues (2002), for example, estimated that 12 percent of children 0 to 12 years of age had a regulated child care space in 2001. A comparable statistic was not available for 2003 as not all provinces provided updated information (Campaign 2000, 2003). Available information indicates that, although there has been a slight increase in the total number of regulated child care spaces for children 12 years and younger between 2001

and 2003, there has been an overall decrease in the number of spaces for preschoolers in regulated child care centres (Campaign 2000, 2003).

Public expenditures on regulated child care have increased from 2001 to 2003, resulting from recent federal/provincial/territorial agreements and the subsequent attention paid to this area (Campaign 2000, 2003). The Early Childhood Development agreement of September 2000 provides $2.2 billion in federal funds over five years to promote early childhood development. Child care is one area that has been funded under this agreement. The 2003 Multilateral Framework on Early Learning and Child Care provides a further $900 million in federal funds over five years to invest in regulated day care and preschool programs for children under six. Annual public reporting on services and child development and efforts to improve this reporting over time are built into both agreements.

The Economic Evaluation Evidence

We identified 10 articles in our original literature search (Figure 3; two set in Canada and seven in the United States). Five of these articles reported on the Perry Preschool Program in Ypsilanti, Michigan. We included the most recent evaluation—an age 27 follow-up of children previously involved the program (Barnett, 1993; Barnett, 1996)—and excluded the other Perry Preschool Program articles (age 10 assessment (Smith et al., 1997; Weber, Foster, & Weikart, 1978); age 19 assessment (Barnett, 1985); and a summary of the age 27 results (Weikart, 1998)). Two of the non-Perry Preschool Program articles were also excluded—one article was a review (Kellermann et al., 1998), and the other article measured costs but not benefits (Peters et al., 2000). We also identified an additional economic evaluation that was published subsequent to our original literature search (PricewaterhouseCoopers, 2003). This resulted in five economic evaluations of day care or preschool programs.

The five studies are summarized in Tables 9A, 9B & 9C. Publication dates ranged from 1993 to 2003. One study was set in Canada, one in the United Kingdom, and three in the United States. Four studies conducted cost-benefit analyses, which allowed for the simultaneous consideration of a variety of benefits. The remaining study employed cost-effectiveness analysis, measuring effectiveness as the number of serious crimes prevented. Four studies conducted their economic evaluation from the societal perspective. In one study, the authors estimated net benefits from a mixed public payer and societal perspective (by subtracting a parental contribution from the costs of the day care program) (Cleveland & Krashinsky, 1998). We calculated the net benefit from a societal perspective for this study by including the parental contribution. Additional perspectives employed in other studies included public payer, general public and program participants.

Day care and preschool interventions varied by program design, program length, and target population. Program comparators also varied. Two studies compared day care or preschool with no intervention while the other three used day care or preschool programs with partial participation as their comparator.

Program benefits that were measured included child developmental effects, increased labour force participation, decreased welfare payments, increased lifetime income, and decreased crime. No studies included direct health effects in their analyses, although two studies discussed the

connection between adverse health outcomes and low income, low education, and criminal activities (Barnett, 1996; Reynolds et al., 2002). One of these studies (Barnett, 1996) measured health effects in their randomized controlled trial of a preschool program for disadvantaged children (but did not include these measurements in the economic evaluation), finding no difference between the two groups in self-reported health status and illness. However, the experimental group was more likely to be hospitalized. This increased hospitalization result was hypothesized to result from the experimental groups being more likely to have health insurance through employment.

Two economic evaluations focused on the creation of a national day care program (one in Canada and the other in the UK). Both studies measured the labour force benefits of mothers being freed up to work and the developmental benefits of day care for children. The Canadian study measured developmental benefits by equating the additional cost incurred by higher-income families for high-quality day care as compared to informal neighbourhood care as a willingness-to-pay measure (Cleveland & Krashinsky, 1998). The UK study measured developmental benefits through the additional future income expected to accrue to children attending day care (an average increase of 2% across all children—the equivalent of a 10 percent increase in earning for disadvantaged children and a 0 percent increase in earnings for non-disadvantaged children) (PricewaterhouseCoopers, 2003). Both studies found a national day care program to be cost-saving from a societal perspective when compared with the status quo of some publicly funded day care. We calculated a net benefit of $4.2 billion dollars for an average year (benefit/cost ratio of 1.53) for the Canadian study while the UK study reported a net benefit of $1.0 billion dollars for an average year (benefit/cost ratio of 1.1). When examined from the public payer perspective, however, the UK study found that a national day care program had a net cost of $5.2 billion for an average year (benefit/cost ratio of 0.6). The UK results were highly sensitive to model assumptions, moving from a net societal benefit to a net societal cost when decreasing the expected female employment rate by 1 percent, for example. Sensitivity analyses were not conducted in the Canadian study.

The other three economic evaluations, all set in the US, evaluated programs of preschool plus home visitation for disadvantaged children. Two of the studies (the Perry Preschool program (Barnett, 1993) and the Chicago Child-Parent Center (Reynolds et al., 2002)) measured a variety of benefits including school success, future employment earnings (of the children rather than the parents), savings from welfare payments averted, and savings from prevented crime. The majority of the benefits were directly measured from experimental or quasi-experimental studies with long follow-up periods (20 years or more). These preschool programs were cost-saving from societal, general public and program participants' perspectives. Net benefits varied from a high of $145,000 per program participant (Perry Preschool program, societal perspective) to a low of $25,000 per program participant (Chicago Child-Parent Center, general public perspective). Benefit/cost ratios varied from 8.7 (Perry Preschool program, societal perspective) to 3.8 (Chicago Child-Parent Center, general public perspective). The lower net benefit results for the Chicago Child-Parent Center as compared to the Perry Preschool program are likely attributable to two factors: (1) a underestimation of the benefits attributable to the preschool program as some members of the control group were enrolled in another preschool program and all of the control group received full day kindergarten while the experimental group received a mixture of full day and half day kindergarten (and the design of the study was such that

kindergarten effects could not be analytically separated from preschool effects); and (2) an overestimation of the difference in costs between the control and experimental groups as the costs of the kindergarten program were not included.

The third US study—the only cost-effectiveness evaluation of the day care and preschool studies—addressed serious crime averted through various interventions at different life cycle stages. A program of day care and home visitation cost $127,000 per serious crime prevented when compared with no program (Greenwood et al., 1998). The authors describe their analysis as "exploratory."

Results from these five economic evaluations indicate that day care or preschool programs are cost-saving from the societal perspective. Stronger evidence exists for the net benefit of preschool programs for disadvantaged children as the cost-savings results hold across multiple perspectives and withstand sensitivity analyses. In contrast, an economic evaluation of a national day care program from the public payer perspective reported substantial net costs. Programs designed for disadvantaged children also had much larger benefit/cost ratios than programs designed for all children, suggesting that such programs for disadvantaged children are a better buy. The differences in study design, program implementation and range of included benefits make these conclusions tentative, however. The national day care programs set in Canada and the UK might have reported higher benefit/cost ratios if they had included crime averted as an explicit benefit, for example. Day care or preschool programs also suffer from differential timing effects—costs are up front while benefits take a much longer time to build. Large or universal day care or preschool programs come with substantial up front costs and the need for significant institutional capacity. Despite large up front costs and the possibility of large net costs, day care or preschool may still be considered a reasonable investment. Benefits from such programs are expected to be varied, significant, and accrue to both program participants and society.

8F. Synthesis of Evidence for the Selected Preventive Interventions

In summarizing and interpreting the results of economic evaluation evidence for these five syntheses, we addressed three questions:

1) Do the five interventions produce a net benefit for society?
2) Are the five interventions cost-saving from a payer perspective?
3) For interventions where cost-benefit from a societal perspective has not been adequately assessed and the interventions are not cost-saving from the payer perspective, might the interventions nonetheless be a worthwhile investment in health (i.e., give value for money)?

For each intervention we found a high degree of consistency among economic evaluation studies, despite differences in methods and settings. In particular, we did not observe systematic differences in findings between economic evaluations set inside or outside of Canada. As shown in Table 10, all of the interventions we examined produce a net benefit to society, although the body of evidence varied in size across interventions and was largest for varicella vaccination of infants. Needle exchange programs and water fluoridation are also cost-saving from a payer perspective. In both cases, there are sometimes multiple payers, which means that program costs may be born primarily by one payer while another payer may be the principal beneficiary of cost-savings resulting from the intervention (e.g., reduced treatment costs). The remaining

interventions—varicella vaccination, colorectal cancer screening with FOBT, and day care or preschool programs—while not cost-saving from the payer perspective (with the possible exception of preteen varicella vaccination), may still be sound investments in health. Decisions about whether to make those investments will appropriately depend on a variety of factors, some related to and others external to the economic evaluation evidence.

9. Discussion

A large volume of unappraised and unsynthesized economic evaluation evidence remain for other preventive interventions. Five hundred economic evaluations have been conducted for 126 additional preventive interventions listed on Tables 1 and 2. An additional 23 Canadian-based economic evaluations have been conducted for preventive interventions with a potentially large population health impact (see Figure 1). Reviewing and synthesizing this evidence would require substantial resources.

We found no economic evaluations, however, for the majority of recommended preventive interventions. Health promotion and healthy public policy interventions, in particular, are less likely to have economic evaluation evidence than clinical prevention and health protection interventions. This situation reflects others' findings of fewer economic evaluations for preventive interventions set in the community (Carande-Kulis et al., 2000; Ramsey, 2000), which may stem from the challenges of evaluating the effectiveness of community and public health interventions (Thomson et al., 2004). In addition, healthy public policy interventions do not always incorporate health outcomes in their evaluations, as we found for day care and preschool programs and others have found for income supplementation interventions (Connor, Rodgers, & Priest, 1999).

9A. Next Steps

If economic evaluation evidence on prevention is to be used to assist health and health care priority setting in Canada, the gaps that we have identified need to be filled. Critical activities include:

- Systematic reviews of effectiveness evidence for health promotion, health protection, and healthy public policy interventions;
- Economic evaluations of effective preventive interventions for which economic evaluation evidence is currently lacking;
- Systematic reviews of economic evaluation evidence for effective preventive interventions.

These activities will require substantial resources. Our paper can be used as a starting point but our list of economic evaluations should not be considered a definitive list. We designed our literature review to be comprehensive without conducting reviews specific to each of the 290 recommended preventive interventions. While we are confident that we have produced an accurate overall picture of trends in economic evaluation of preventive interventions, we do not claim to have identified all economic evaluations for each intervention. Future work should include searches specific for each recommended preventive intervention.

9B. What is Happening Elsewhere?
Significant work in this area has been and continues to be undertaken outside of Canada, particularly in the US. Efforts include:

- The Australian Department of Health and Aging commissioned a report titled "Returns on Investment in Public Health", which summarized government expenditures on and benefits from five public health programs (consisting of multiple interventions) designed to reduce tobacco consumption, reduce coronary heart disease, reduce HIV and AIDS, improve immunization, and improve road safety and reduce road trauma (Applied Economics, 2003).

- At the request of the US Congress in 1993, the US Centers for Disease Control and Prevention summarized economic evaluation evidence about their prevention activities. A second edition of the report, entitled "An Ounce of Prevention…What Are the Returns?", was produced in 1999 (Centers for Disease Control and Prevention, 1999a). The report summarizes US-based economic evaluation for 19 preventive activities divided into clinical, community, and policy areas of intervention. Preventive activities examined included breast cancer, colorectal cancer, childhood vaccine-preventable diseases, smoking, tuberculosis, bicycle-related head injuries, and dental caries. All 19 preventive activities were found to be either cost-saving or reasonable value for the money invested.

- Harvard University has constructed a comprehensive league table of cost-utility analyses of clinical interventions, available on the web (www.hsph.harvard.edu/cearegistry). They have recently announced expanding this registry to include non-health care interventions (i.e., "interventions that do not involve the direct provision of medical services") such as our health promotion, health protection, and healthy public policy faces (www.phsi.harvard.edu/value.php).

- The US Preventive Services Task Force has recently begun reviewing economic evaluation evidence alongside effectiveness evidence and will use both types of evidence in making their recommendations about clinical preventive services. They have explicitly ruled out rank ordering services based on economic evaluation evidence (Saha et al., 2001).

- The US Committee on Clinical Preventive Service Priorities was specifically designed to use the burden of disease prevented and cost-utility analysis to compare and rank the clinical preventive services recommended by the US Preventive Services Task Force (Coffield et al., 2001). Where cost-utility evidence was not available, the committee estimated their own (Maciosek et al., 2001). Their report identified services that have low delivery rates but should be of high priority including tobacco cessation counselling, screening adults for colorectal cancer, and screening young women for chlamydial infection (Coffield et al., 2001).

- In the largest effort of which we are aware, the US Task Force on Community Preventive Services was specifically developed to review effectiveness and economic evaluation

evidence for prevention. Having chosen 15 prevention topics (which we used as the starting point for our list of recommended health protection, health promotion, and healthy public policy interventions (Table 2)), they have reviewed effectiveness data for 7 of the 15 topics and economic evaluation data for 3 topics (vaccine-preventable diseases, reducing tobacco use, and reducing injury to motor vehicle occupants). This Task Force has also found economic evaluations to be lacking for many interventions. The group of 14 investigators, supported by 20 staff and consultations with experts, started their work in 1996.

At a minimum, the CTFPHC could follow the lead of the US Preventive Services Task Force and review economic evaluation evidence in making their recommendations. Health Canada's funding of the CTFPHC is currently under review and the future of the Task Force is uncertain. An editorial in the Canadian Medical Association Journal (Anonymous, 2003a) points out that the Canadian Coordinating Office for Health Technology Assessment (CCOHTA) has received additional funding and could evaluate some of the interventions covered by CTFPHC, although they caution that CCOHTA will be focused on marketable drugs and technologies and other aspects of prevention covered by CTFPHC will be lost. Ramsey (2000) points out a similar concern in a commentary on the US Task Force on Community Preventive Services. We add our voice to this concern. Allowing health technology assessment of more frequently studied interventions (e.g., drugs and technologies) to dominate the Canadian economic evaluation research agenda would further disadvantage health promotion, health protection, and healthy public policy interventions.

9C. Application of Economic Evaluation Evidence to Policy Decision Making

Policy decision making that incorporates economic evaluation evidence cannot be reduced to rank ordering of programs by summary measures of efficiency and the mechanical application of thresholds to determine which programs will be implemented or continued. Even if such an approach were desirable, its feasibility is questionable given that economic evaluation evidence based on a common metric and common comparator is unlikely to be available across a full range of programs under consideration.

Decisions regarding public investments in health care programs are inevitably influenced by a variety of factors—some economic, some political, and some having to do with social values and preferences. These include:

- **Differential timing of costs and benefits**
  Preventive interventions invariably require immediate investments, sometimes very large, while health benefits and savings accrue gradually over time. Among the interventions we examined, differential timing of costs and benefits was greatest for colorectal cancer screening, water fluoridation and day care or preschool programs and less for varicella vaccination and needle exchange programs. Discounting of costs and benefits is done to reflect such effects. However, the nature of such timing effects is complex. Within a broader political and social context even programs judged efficient under reasonable discount rates may not be undertaken due to the immediate nature of the costs and the distant nature of the benefits.

- **Opportunity costs**
  Investments in new preventive programs involve opportunity costs, that is, the need to forego other activities. From a public funder perspective, this means reducing expenditures in another program area (always a political challenge), borrowing, raising taxes (which implies reduced private consumption) or drawing on surpluses (rarely available). The true opportunity cost is specific to each situation and may deter funders from investing in efficient preventive programs.

- **Availability of required technology and human resources**
  Some preventive programs will require technological or human resources that are not immediately available. For example, it has been estimated by the National Committee on Colorectal Cancer Screening that 500 additional family physicians would be needed in the province of Ontario to implement a universal biennial screening program for persons 50 to 74 years of age (Coombs et al., 2002). Similarly, implementation of a universal day care or preschool program would be hamstrung by a lack of appropriately trained child care workers.

- **Program scope**
  The magnitude of the initial investment and associated opportunity costs to implement a preventive program is dependent to a large extent on the program's scope. As a result, programs with similar cost-effectiveness or benefit/cost ratios may require very different levels of investment. All other things equal, broadly-based programs (e.g., screening average risk adults over 50 years of age for colorectal cancer) will require a much larger investment than a narrowly targeted program (e.g., screening of individuals with a family history of colorectal cancer), and result in larger population health benefits. In some circumstances, a program targeted to high risk individuals or groups may be preferred because of manageable up front costs.

- **Nature of benefits**
  One program may be preferred over another because of the nature of the benefits it provides. For example, a preventive intervention whose main effect is to increase years of life may be preferred over an equally efficient intervention that primarily reduces pain and suffering.

- **Who benefits**
  Decisions about investments in preventive programs may be influenced by who is expected to benefit. Programs directed toward the general population may garner greater political and public support than those that are more narrowly targeted. Interventions that target children may be preferred over those aimed at older persons.

- **Who pays**
  Some programs involve multiple payers. For example, the costs of water fluoridation may be born publicly while the costs of treatment averted for dental caries accrue privately (as most dental care is privately financed). In such instances, programs that are cost-saving from a combined payer perspective may increase costs to the public payer and thus be less attractive as a publicly-funded program.

Economic evaluation evidence can make a useful contribution to policy decision making. Given the dearth of economic evaluation evidence for preventive interventions, however, it is not reasonable to make such formal evidence a pre-requisite for policy action. Requiring economic evidence as a mandatory input to decision making would, in the short term, delay the implementation of preventive programs with demonstrated large population health effects that had not yet been subjected to economic evaluation. Perhaps more importantly, in the long term such a requirement would discriminate against health promotion, health protection and healthy public policy interventions whose costs and consequences are often difficult to measure credibly because they are spread across multiple health and social domains. In spite of these challenges, we hope that this review demonstrates the value of increasing the use of economic evaluation methods to inform decision making for preventive interventions.

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Table 1: Canadian Task Force on Preventive Health Care (CTFPHC) A and B Recommendations

Condition	Population	Maneuver*	CTFPHC Effectiveness Evidence	Number of Economic Evaluations†		
				Canada	Aust/NZ/ Europe	USA
Prenatal and Perinatal Preventive Care						
Perinatal morbidity and mortality	Pregnant women	Single prenatal ultrasound in the second trimester	B		1	
Low birth weight/cognitive ability of child	Pregnant women who smoke	Smoking cessation interventions	A		1	8
Fetal alcohol syndrome	Pregnant women	Screening for alcohol consumption	B			
	Pregnant women who consume alcohol	Counselling for reducing alcohol consumption	B			
Neural tube defects	Women capable of becoming pregnant	Folic acid supplementation	A			2
	Pregnant women	Maternal serum alphafetoprotein measurement followed by ultrasound and amniocentesis if elevated	B	2	1	1
Down syndrome	High-risk pregnant women	Amniocentesis or CVS and counselling	B	1	4	4
	Pregnant women < 35 years of age	Triple screening and counselling	B		8	5
Bacteruria in pregnancy	Pregnant women	Urine culture	A			1

* Most maneuvers in this table are classified as clinical prevention activities. Maneuvers that are otherwise classified are indicated by the following codes: (i) = healthy public policy, (ii) = health protection (for child when intervention applied to pregnant women or women who could become pregnant), (iii) = health promotion, and (iv) = health protection if mandatory for population.

† An "X" in the Canada column indicates that neither the Canadian Task Force on Preventive Health Care (CTFPHC) nor the McMaster team could find any economic evaluations meeting inclusion criteria for the intervention described in the row. Similarly, an "X" in the USA column indicates that neither the US Preventive Services Task Force nor the McMaster team could find any economic evaluations meeting inclusion criteria for the intervention described in the row. The year of the published statement by the respective task force indicating no economic evidence is provided with the "X."

Table 1: Canadian Task Force on Preventive Health Care (CTFPHC) A and B Recommendations (cont'd)

Condition	Population	Maneuver*	CTFPHC Effectiveness Evidence	Number of Economic Evaluations†		
				Canada	Aust/NZ/ Europe	USA
Prenatal and Perinatal Care (continued)						
D (Rh) Sensitization	Pregnant women	D (Rh) antibody screening; For women who are antibody negative, repeat screening followed by immunoglobin (D Ig) administration after delivery of D positive infant	A	2		1
	Pregnant women who are antibody negative	Antepartum D Ig administration	B	2	3	2
	Women undergoing induced abortion or amniocentesis	D (Rh) antibody screening; For women who are antibody negative, immunoglobin (D Ig) administration after induced abortion or amniocentesis	B	1		
Congenital rubella syndrome	Non-pregnant women of child-bearing age	Screen and vaccinate or universal vaccination	B		1	2
	Pregnant women	Screen, counsel, and vaccinate post-partum if indicated	B	X (1994)		
Preeclampsia	Pregnant women	Blood pressure measurement	B			
Ophthalmia neonatorum	Newborns	Ocular prophylaxis	A			
Group B Streptococcal	Pregnant women	Universal screening for GBS colonization and intrapartum chemoprophylaxis to colonized women	B		2	6

* Most maneuvers in this table are classified as clinical prevention activities. Maneuvers that are otherwise classified are indicated by the following codes: (i) = healthy public policy, (ii) = health protection (for child when intervention applied to pregnant women or women who could become pregnant), (iii) = health promotion, and (iv) = health protection if mandatory for population.

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Table 1: Canadian Task Force on Preventive Health Care (CTFPHC) A and B Recommendations (cont'd)

Condition	Population	Maneuver*	CTFPHC Effectiveness Evidence	Number of Economic Evaluations†		
				Canada	Aust/NZ/ Europe	USA
Pediatric Preventive Care						
Phenylketonuria	Newborns	Serum phenylalanine screening	A			3
Congenital hypothyroidism	Neonates	Thyroid-stimulating hormone (TSH) test	A			
Cystic fibrosis	Siblings of children with CF	DNA analysis for carrier status	B			
		Sweat test, immunoreactive trypsin and "BM meconium" test	B			
Hemoglobinopathies	Families with positive carrier status	Prenatal screening and counselling	B			
	High-risk pregnant women	Screening for carrier status	B	1		
	High-risk neonates	Hemoglobin electrophoresis	A			3
Gastrointestinal and respiratory infection in the newborn	Pregnant women and women in peripartum period	Counselling on breast feeding	A			X (2003)
		Peripartum interventions to increase frequency of breast feeding	A			X (2003)
Iron deficiency anemia	Pregnant women and women in peripartum period	Counselling on breast feeding	B			
	Infants	Iron fortified formula, cereal or supplementation	B			
	High-risk infants	Routine hemoglobin	B			
	Disadvantaged children	Routine hemoglobin	B			
Night-time crying	Parents of infants distressed by crying	Anticipatory guidance on systematic ignoring	A			

* Most maneuvers in this table are classified as clinical prevention activities. Maneuvers that are otherwise classified are indicated by the following codes: (i) = healthy public policy, (ii) = health protection (for child when intervention applied to pregnant women or women who could become pregnant), (iii) = health promotion, and (iv) = health protection if mandatory for population.

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Table 1: Canadian Task Force on Preventive Health Care (CTFPHC) A and B Recommendations (cont'd)

Condition	Population	Maneuver*	CTFPHC Effectiveness Evidence	Number of Economic Evaluations†		
				Canada	Aust/NZ/ Europe	USA
Pediatric Preventive Care (continued)						
Amblyopia	Infants	Eye exam	A			
Hearing impairment	Infants	Hearing assessment using parental questioning and clap test	A	1		2
Delayed mental development	Parents of infants	Enquiries about developmental milestones	B			1
Disorders of physical growth	Infants	Serial height, weight, head circumference measurement	B			
Developmental dysplasia of the hip (DDH)	Newborns with clinically detected DDH	Supervised period of observation	A			
	Normal-risk infants	Repeated serial clinical examination by trained examiners	B	1	1	1
Lead exposure	High-risk children	Blood lead screening	B			5
Vision problems	Preschool children	Visual acuity testing	B			
Child maltreatment	First-time mothers of low socioeconomic status, single parents or teenaged parents	Home visitation by nurses during perinatal period through infancy	A			2
All-cause morbidity and mortality	Disadvantaged children	Day care or preschool programs (i)	A	2		7

* Most maneuvers in this table are classified as clinical prevention activities. Maneuvers that are otherwise classified are indicated by the following codes: (i) = healthy public policy, (ii) = health protection (for child when intervention applied to pregnant women or women who could become pregnant), (iii) = health promotion, and (iv) = health protection if mandatory for population.

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Table 1: Canadian Task Force on Preventive Health Care (CTFPHC) A and B Recommendations (cont'd)

Condition	Population	Maneuver*	CTFPHC Effectiveness Evidence	Number of Economic Evaluations†		
				Canada	Aust/NZ/ Europe	USA
Pediatric Preventive Care (continued)						
Household and recreational injury	Families with infants or children	Legislation requiring window and stair guards (ii)	B			
	Parents of infants	Counselling to reduce home risk factors	A	1	1	1
	Parents of children older than infants	Counselling to reduce home risk factors	B	1	1	1
	General population	Legislation requiring private and public pools to conform to safety standards (ii)	B			
	Parents of young children	Public health education on not leaving child unattended in bathtub (iii)	B			
	General population	Legislation requiring smoke detectors and non-flammable sleepwear for children (ii); public health education about hot water thermostat settings (iii)	B			
	Parents of young children	Counselling on smoke detectors and hot water thermostat settings	B	1	1	1
	General population	Legislation requiring child-resistant packaging for chemicals and therapeutic drugs (ii)	A			
	Parents of young children	Counselling on prevention of poisoning and the provision of ipecac and poison control centre phone number stickers	B	1	1	1
	Children	Legislation requiring children to wear bicycle helmets (ii)	B		4	2

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Table 1: Canadian Task Force on Preventive Health Care (CTFPHC) A and B Recommendations (cont'd)

Condition	Population	Maneuver*	CTFPHC Effectiveness Evidence	Number of Economic Evaluations†		
				Canada	Aust/NZ/Europe	USA
Immunization of Children and Adults						
Immunizable infectious disease	Infants and children	Immunization with diphtheria-pertussis-tetanus (DPT) and polio vaccines (iv)	A	3	4	4
		Immunization with Hemophilus influenzae type b (Hib) conjugate vaccine (iv)	A	1	7	4
		Immunization with measles-mumps-rubella (MMR) vaccine (iv)	A	1	1	2
Pneumococcal pneumonia	Immunocompetent patients ≥55 years in institutions	Single dose of 23-valent pneumococcal vaccine	A	1		1
	Persons with sickle cell anemia and those having undergone splenectomy	Single dose of 23-valent pneumococcal vaccine	A			
Hepatitis B	Infants, children and adolescents	Immunization (iv)	A	4	12	4
Varicella vaccine	12-15 month children	Immunization with varicella vaccine (iv)	A	2	5	3
	1-12 year old children	Catch-up immunization with varicella vaccine (iv)	A	2	3	2
	Susceptible adolescents and adults	Immunization with varicella vaccine	B		1	7

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Table 1: Canadian Task Force on Preventive Health Care (CTFPHC) A and B Recommendations (cont'd)

Condition	Population	Maneuver*	CTFPHC Effectiveness Evidence	Number of Economic Evaluations†		
				Canada	Aust/NZ/ Europe	USA
Preventive Dental Care						
Dental caries	General population	Community fluoridation (ii)	A	1	6	5
	General population	Daily fluoride supplements where water fluoride levels are less than optimal	A			
	General population	Brushing teeth with fluoride toothpaste	A			
	High-risk population	Annual or biannual professional application of topical fluorides	A			2
	High-risk children	Fissure sealants	A	1	5	3
Gingivitis	General population	Brushing teeth	B			
	Persons with severe gingivitis	Use of Listerine oral rinse	B			
Periodontal disease	General population	Tooth scaling and prophylaxis	B			
	Adult population	Flossing teeth	A			
	Smokers	Recommend smoking cessation	B			
Disorders of the Genitourinary Tract						
Progressive renal disease	Adults with insulin dependent diabetes mellitus	Urine dipstick	A		2	
Prevention of Psychosocial Illness and Disease of Lifestyle						
Suicide	High-risk population	Medical treatment for diagnosed depression	A			
		Medical treatment for reduction in suicidal ideation	B			
	Physicians	Physician education, risk recognition and therapy	B			

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Condition	Population	Maneuver*	CTFPHC Effectiveness Evidence	Number of Economic Evaluations†		
				Canada	Aust/NZ/Europe	USA
Prevention of Psychosocial Illness and Disease of Lifestyle (continued)						
Adverse consequences, children of alcoholics	Children and adolescents	Administer Children of Alcoholics Screening Test (CAST) to identify children and adolescents at risk of adverse consequences	B			
Problem drinking	General population	Case finding and counselling	B		3	3
Tobacco-caused disease	Children and adolescents	Counselling to prevent smoking initiation	B			
	Smokers	Counselling, smoking cessation, or offer nicotine replacement therapy	A		14	20
		Referral to validated cessation program	B			1
Motor vehicle related injury	General population	Legislation controlling drinking and driving (ii)	A		1	1
		Counselling on avoidance of drinking and driving	B			
		Legislation requiring seatbelt use (ii)	A		1	
		Legislation requiring child restraint use (ii)	A		1	
		Counselling on seatbelt and child restraint use	B			1
		Legislation requiring safety helmet use for motorcycles or all-terrain vehicles (ii)	B		1	1
Household and recreational injury	General population	Legislation on avoidance of alcohol with water recreation (ii)	B			
		Legislation requiring bicycle helmet use (ii)	B		4	1

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Condition	Population	Maneuver*	CTFPHC Effectiveness Evidence	Number of Economic Evaluations†		
				Canada	Aust/NZ/ Europe	USA
Prevention of Psychosocial Illness and Disease of Lifestyle (continued)						
Unwanted pregnancies and sexually transmitted diseases in adolescents	Adolescents (and parents where appropriate)	Discussion of sexual development, prevention of sexually transmitted diseases, and prevention of unwanted pregnancy	B		1	1
	Sexually active adolescents	Counselling on sexual activity and contraceptive methods	B		1	1
		Recommendation of use of oral contraceptives and condoms	B			
All-cause mortality and morbidity	General population	Counselling about engaging in moderate physical activity	B		2	6
Domestic violence	Women who have spent at least one night in a domestic violence shelter	Referral to post-shelter advocacy counselling	B	X (2001)		
Metabolic/Nutritional Disorders						
Obesity	Obese adults with obesity-related disease	BMI measurement	B		4	4
		Weight-reduction therapy	B		4	5
Diet-related illness	Adult population	Counselling on adverse nutritional habits	B		4	5
Osteoporotic fractures (and side effects)	Perimenopausal women	Counselling on hormone replacement therapy	B		4	

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Condition	Population	Maneuver*	CTFPHC Effectiveness Evidence	Number of Economic Evaluations†		
				Canada	Aust/NZ/ Europe	USA
Circulatory Disorders						
Hypertension	Adult population	Blood pressure measurement	B	1	5	4
	Adult, specific subgroups	Pharmacologic treatment	A	1	5	1
Coronary heart disease	Males 30-69 years	General dietary advice on fat and cholesterol	B		5	3
	Males 30-59 years with elevated cholesterol or LDL-C	Diet/drug treatment	B	4	22	8
Stroke	Patients with clinical cardiac disease and no pre-existing indication for anticoagulation	Echocardiography: Transthoracic (TTE) or transesophageal (TEE) for detection of intracardiac masses	B			1
	Patients with stroke and intracardiac thrombus	Anticoagulation (warfarin) for intracardiac thrombus to prevent systemic emboli	B			
	Patients with paroxysmal atrial fibrillation	Anticoagulation if atrial fibrillation detected after stroke	B			
Other Infectious Diseases						
HIV/AIDS	High-risk populations	Voluntary HIV antibody screening	A		1	8
	Infants of HIV positive women	Voluntary HIV antibody screening	B			1
Gonorrhea	High-risk groups	Gram stain/culture cervical or urethral smear	A			1
	General population	Counselling and educational materials	B			

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Condition	Population	Maneuver*	CTFPHC Effectiveness Evidence	Number of Economic Evaluations†		
				Canada	Aust/NZ/ Europe	USA
Other Infectious Diseases (continued)						
Chlamydial infection	Pregnant women	Screening during first prenatal visit	B			
	High-risk women	Annual screening	B	2	7	15
Influenza	High-risk sub-groups, health care providers and elderly	Immunization, annual	B	1	4	4
	High-risk sub-groups, elderly	Outreach vaccination reminder strategies by health care providers	A	1	1	3
	High-risk or unvaccinated individuals exposed to index case	Amantadine chemoprophylaxis	A			
Tuberculosis	High-risk groups	Mantoux tuberculin skin test	A	1	1	4
		INH prophylaxis	B		1	2
	Household contacts and skin test converters	INH prophylaxis	A			1
Neoplasms						
Lung cancer	Smokers	Dietary advice on green leafy vegetables and fruit	B			
Breast cancer	Women aged 50-69 years	Mammography and clinical exam every 1-2 years	A	2	13	2
	High-risk women	Counselling on benefits and risks of using tamoxifen to reduce likelihood of breast cancer	B			2

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Condition	Population	Maneuver*	CTFPHC Effectiveness Evidence	Number of Economic Evaluations†		
				Canada	Aust/NZ/Europe	USA
Neoplasms (continued)						
Colorectal cancer	Average risk adults > 50 years of age	Multiphase screening with the Hemoccult test	A	4	10	13
		Sigmoidoscopy	B	1	3	12
	High-risk adults with familial adenomatous polyposis (FAP)	Flexible sigmoidoscopy beginning at puberty	B	2		
		Genetic testing	B	2		
	High-risk adults with hereditary nonpolyposis colon cancer (HNPCC)	Colonoscopy	B		1	
Oral cancer mortality	Smokers	Smoking cessation counselling	A			
Skin cancer	General population	Counselling on avoidance of sun exposure and use of protective clothing	B			
	Persons with first degree relative with melanoma	Total body skin examination	B		1	1
Pancreatic cancer	Smokers	Smoking cessation counselling	B			
Cervical cancer	Sexually-active women	Papanicolaou smear	B		8	5
Conditions Affecting Primarily the Elderly						
Cognitive impairment	Elderly	Assessment and follow-up based upon caregiver or informant description of decline	A			
		Assessment based upon individual's complaint of memory loss	B			

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Condition	Population	Maneuver*	CTFPHC Effectiveness Evidence	Number of Economic Evaluations†		
				Canada	Aust/NZ/ Europe	USA
Conditions Affecting Primarily the Elderly (continued)						
Falls/injury	Elderly	Multidisciplinary post-fall assessment	A		2	2
		Legislation on use of safety aids in hazardous areas such as stairs, bathtubs (ii)	B			
Diminished visual acuity	Elderly	Screening using Snellen sight card	B			
Diabetic retinopathy	Diabetics	Funduscopy or retinal photography	B	2	1	5
Hearing impairment	General population	Noise control and hearing protection	A			
	Elderly	Enquiry, whispered voice test or audioscope	B			

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Table 2: Health Promotion, Health Protection, and Health Public Policy Recommended Activities
Note: Recommended clinical prevention interventions have been excluded from the table - see Table 1.

Issue	Goals/Objectives	Possible Interventions*	Prevention Face			Number of Economic Evaluations†		
			Health promotion	Health protection	Healthy Public Policy	Canada	Aust/NZ/ Europe	USA
Changing Health Risk Behaviors								
Tobacco Product Use	Reduce initiation of tobacco use	Increasing price for tobacco products (++)	✓				1	**1**
		Community education campaigns (++)	✓					1
		School-based anti-smoking education programs	✓			1	1	2
	Increase or improve cessation	Increasing price for tobacco products (++)	✓				1	**2**
		Subsidizing cessation aids or programs (+)	✓					2
		Community education campaigns (++)	✓				6	3
		Smoking cessation contests (?)	✓				1	5
		School-based cessation education programs	✓					1
	Reduce exposure to environmental tobacco smoke	Smoking bans and restrictions (++)		✓			2	2
		Community education campaigns to reduce exposure to environmental tobacco smoke in the home (?)	✓					
Alcohol abuse	Prevention of alcohol abuse and misuse	Increasing price for alcohol products	✓				1	
		Legal drinking age		✓				
		School-based alcohol education programs	✓					
		Community education campaigns	✓					

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			Health promotion	Health protection	Healthy Public Policy	Canada	Aust/NZ/ Europe	USA
Changing Health Risk Behaviors (continued)								
Other Addictive Drug Use	Reduce initiation	School-based anti-drug programs	✓					1
		Community education campaigns	✓					
		Anti-drug legislation		✓				
	Increase cessation	School-based anti-drug programs	✓					1
		Community education campaigns	✓					
		Anti-drug legislation		✓				
Physical Activity	Increase physical activity	School-based physical education (++)	✓					**X** (2001)
		Classroom information provision (?)	✓					
		Community education campaigns (++)	✓				1	**1**
		Providing social support in community settings (e.g., setting up walking group at workplace) (++)	✓			1		**2**
		Point-of-decision prompts (signs suggesting the use of stairs rather than elevators) (+)	✓					**X** (2001)
		Creating or improving access to places for physical activity (++)	✓			1	1	2
		Zoning regulations for urban design that facilitates physical activity			✓			

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				Health promotion	Health protection	Healthy Public Policy	Canada	Aust/NZ/ Europe	USA
Changing Health Risk Behaviors (continued)									
Sexual behavior	Prevent HIV and other sexually transmitted diseases	Community education campaigns		✓				1	6
	Prevent unintended pregnancies	School-based sexual education		✓					1
		Community youth development programs				✓			
		Strengthening family, social networks and other support systems				✓			
		Community education campaigns		✓			1		
Nutrition	Improve diets and reduce incidence of obesity	School-based nutrition programs		✓					
		Community education programs		✓				1	1
		Controlling food and beverage advertising to children			✓				
		Legislation requiring nutrition information on labels			✓				
Addressing Specific Health Conditions									
Vaccine preventable diseases	Enhance access to vaccination services	Vaccination programs in schools and other community settings (?)	DPT/polio	✓				2	4
			Hep B	✓			2		1
			MMR	✓				3	3
		Reducing or eliminating out-of-pocket costs for vaccines (++)	Hib	✓				1	
			influenza	✓					1
			MMR	✓				1	

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Issue	Goals/Objectives	Possible Interventions*		Prevention Face			Number of Economic Evaluations†		
				Health promotion	Health protection	Healthy Public Policy	Canada	Aust/NZ/ Europe	USA
Addressing Specific Health Conditions (continued)									
Vaccine preventable diseases (continued)	Increase community demand for vaccines	Community education program (?)	Hib	✓				1	
			Influenza	✓					1
			MMR	✓				1	1
		Multicomponent community interventions with education (++)	DPT/polio	✓					3
			Hep B	✓					1
			Hib	✓					3
			MMR	✓					3
		Vaccination requirements for child care or school attendance (++)	DPT/polio		✓		1		
Breast cancer	Improve the use of breast cancer screening	Community education campaigns (+)		✓					1
		Incentive programs for clients in conjunction with reminders (+)		✓					
		Incentive programs for clients who refer friends		✓					
	Improved informed decision making about cancer screening	Community education campaigns		✓					

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			Health promotion	Health protection	Healthy Public Policy	Canada	Aust/NZ/ Europe	USA
Addressing Specific Health Conditions (continued)								
Cervical cancer	Improve the use of cervical cancer screening	Community education campaigns (+)	✓					
		Incentive programs for clients in conjunction with reminders (+)	✓					
		Incentive programs for clients who refer friends	✓					
	Improved informed decision making about cancer screening	Community education campaigns	✓					
Colorectal cancer	Improve the use of colorectal cancer screening	Community education campaigns (?)	✓					
		Incentive programs for clients in conjunction with reminders	✓					
		Incentive programs for clients who refer friends (?)	✓					
	Improve informed decision making about cancer screening	Community education campaigns	✓					
Skin cancer	Improve sun-protective behaviors to reduce skin cancer incidence	Educational interventions in schools (+)	✓					
		Educational interventions in recreational/tourism settings (+)	✓					
		Community education campaigns (?)	✓				2	

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			Health promotion	Health protection	Healthy Public Policy	Canada	Aust/NZ/ Europe	USA
Addressing Specific Health Conditions (continued)								
Diabetes	Behavior change for persons with diabetes	Diabetes self-management education in community settings (?)	✓					
		Community education campaigns	✓					
	Glycemic control for persons with diabetes	Diabetes self-management education in community settings (+)	✓					**X** (2001)
		Community education campaigns	✓					
	Improved long-term clinical and economic outcomes for persons with diabetes	Diabetes self-management education in community settings (?)	✓					
		Community education campaigns	✓					
	Improved quality of life for persons with diabetes	Diabetes self-management education in community settings (?)	✓					
		Community education campaigns	✓					
Mental Health	*Prevention of depression*	Self-help/mutual support groups	✓					
		Family support/parenting skills groups	✓					
		Community education campaigns	✓					
		Increased mental health insurance coverage	✓					
	Prevention of relapse/ recurrence of depression	Self-help/mutual support groups	✓					
		Family support/parenting skills groups	✓					
		Community education campaigns	✓					
		Increased mental health insurance coverage	✓					

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				Health promotion	Health protection	Healthy Public Policy	Canada	Aust/NZ/ Europe	USA
Addressing Specific Health Conditions (continued)									
Improved pregnancy outcomes	Preconception preparation for women and men (with an emphasis on healthy lifestyles)	School-based sexual health education		✓					
		Workplace education programs		✓					
		Community education campaigns		✓					
	Improved prenatal care	Community prenatal nutrition programs		✓			1		1
		Community education programs encouraging early and regular prenatal care		✓					
	Reduce disease transmission from mother to infant	Mandatory or universal screening for disease with effective prophylaxis for infant	CMV		✓				1
			D(Rh)		✓		3	3	2
			GrpB Strep		✓			2	6
			Hepatitis B		✓		2	5	2
			Herpes simplex		✓				1
			HIV		✓		1	1	3
			Rubella		✓			1	2
			Syphillis		✓			1	
			Toxoplasmosis		✓			2	
			Varicella		✓				3
	Improved postnatal care	Community support programs for mothers at risk		✓				2	

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Note: Recommended clinical prevention interventions have been excluded from the table - see Table 1.

Issue	Goals/Objectives	Possible Interventions*	Prevention Face			Number of Economic Evaluations†		
			Health promotion	Health protection	Healthy Public Policy	Canada	Aust/NZ/ Europe	USA
Addressing Specific Health Conditions (continued)								
Oral health	Prevent caries	Community water fluoridation (++)		✓		1	6	5
		Community dental sealant delivery programs (?)	✓				2	2
		Increased insurance coverage of dental care	✓					
		School-based education programs	✓					
	Prevent and control oral and pharyngeal cancers	Education programs of risk factors	✓					
		Education programs of signs and symptoms of oral and pharyngeal cancers	✓					
		Community cancer screening programs (?)	✓					
	Prevent or control craniofacial injury in contact sports	Educational campaigns promoting the use of helmets, facemasks, and mouthguards (?)	✓					
		Policies requiring safety equipment in sports		✓				
Motor vehicle occupant injury	Reducing alcohol impaired driving	Impaired driving laws (++)		✓			1	**1**
		Minimum legal drinking age (++)		✓				**X** (2001)
		Lower impaired driving levels for young or inexperienced drivers (+)		✓				1
		Sobriety checkpoints (++)		✓			2	3
		Intervention training programs for servers of alcoholic beverages (+)		✓				**2**
		Community education campaigns	✓					1

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† An "X" in the USA column indicates that neither the US Task Force on Community Preventive Services nor the McMaster team could find any economic evaluations meeting inclusion criteria for the intervention described in the row. The year of the published statement by the US Task Force on Community Preventive Services indicating no economic evidence is provided with the "X."

Table 2: Health Promotion, Health Protection, and Health Public Policy Recommended Activities (cont'd)

Note: Recommended clinical prevention interventions have been excluded from the table - see Table 1.

Issue	Goals/Objectives	Possible Interventions*	Prevention Face			Number of Economic Evaluations†		
			Health promotion	Health protection	Healthy Public Policy	Canada	Aust/NZ/ Europe	USA
Addressing Specific Health Conditions (continued)								
Motor vehicle occupant injury (continued)	Increase child safety seat use	Child safety seat laws (++)		✓				**X** (2001)
		Child safety seat distribution and education programs (++)	✓				1	
		Community education campaigns combined with enforcement (+)	✓	✓				**X** (2001)
		Incentive and education programs (+)	✓					**X** (2001)
	Increase seat belt use	Seat belt laws (++)		✓				**X** (2001)
		Community education campaigns	✓					
Injuries due to violence	Reduce violent behaviour	Community policing programs			✓			
		Community organizing projects			✓			
		Anti-hate crime programs			✓			
		Anti-hate crime legislation			✓			
		Social skill development programs			✓			5
Other injuries	Reduce the rate of fall-related injuries in the elderly	Legislation on use of safety aids in hazardous areas such as stairs, bathtubs		✓				

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Table 2: Health Promotion, Health Protection, and Health Public Policy Recommended Activities (cont'd)

Note: Recommended clinical prevention interventions have been excluded from the table - see Table 1.

Issue	Goals/Objectives	Possible Interventions*	Prevention Face			Number of Economic Evaluations†		
			Health promotion	Health protection	Healthy Public Policy	Canada	Aust/NZ/ Europe	USA
Addressing Specific Health Conditions (continued)								
Other injuries (continued)	Eliminate drowning in waters used for specified recreation purposes	Pool fencing laws		✓				
		Government inspections of public pools		✓				
		Community education campaigns	✓					
	Reduce cycling injuries	School-based education programs	✓					1
		Community education campaigns	✓					1
		Bicycle helmet use laws		✓			4	2
		Bicycle helmet subsidies	✓			1	1	1
	Workplace safety	Workplace safety legislation		✓				
		Guidelines for permissible chemical levels		✓				1
		Government inspections of workplaces		✓				
Addressing the Environment								
Social Environment	Early childhood development opportunities	Day care or preschool (++)			✓	2		7
		Parenting classes			✓	1		2
		Funding for expansion of community preschool programs			✓			
		Development of high-quality foster childcare systems			✓			
		Programs to support young mothers			✓			

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Table 2: Health Promotion, Health Protection, and Health Public Policy Recommended Activities (cont'd)

Note: Recommended clinical prevention interventions have been excluded from the table - see Table 1.

Issue	Goals/Objectives	Possible Interventions*	Prevention Face			Number of Economic Evaluations†		
			Health promotion	Health protection	Healthy Public Policy	Canada	Aust/NZ/ Europe	USA
Addressing the Environment (continued)								
Social Environment (continued)	Affordable family housing in safe neighborhoods	Rental vouchers allowing choice in residential location (+)			✓			
		Mixed-income housing developments (?)			✓			
		Legislative support for subsidized housing			✓			
		Building codes requiring developers to apportion low-cost units in new developments			✓			
		Habitat for Humanity			✓			
	Culturally competent health care systems	Cultural diversity training for healthcare providers (?)		✓				
		Culturally accommodating setting for delivery of health services (?)		✓				
		Provider interpreter services and linguistically proficient staff (?)		✓				
		Developing culturally appropriate health education materials (?)		✓				
		Multicultural healthcare staff recruitment and retention programs (?)		✓				
	Access to higher education	Reducing costs of higher education (e.g., increased scholarships, decreased tuition)			✓			
	Income redistribution	Redistributive tax policies			✓			
		Child benefits for low income families			✓			

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Table 2: Health Promotion, Health Protection, and Health Public Policy Recommended Activities (cont'd)

Note: Recommended clinical prevention interventions have been excluded from the table - see Table 1.

Issue	Goals/Objectives	Possible Interventions*		Prevention Face			Number of Economic Evaluations†		
				Health promotion	Health protection	Healthy Public Policy	Canada	Aust/NZ/ Europe	USA
Addressing the Environment (continued)									
Physical environment	Reduce incidence and transmission of infectious diseases through screening[1]	Screening programs in health care settings (e.g., hospitals, nursing homes)	Hepatitis A		✓			1	
			HIV		✓			1	6
			TB		✓		1		
			Staph infection		✓		1		
			varicella		✓			1	3
		Screening immigrants	HIV		✓		1		
			TB		✓		2		
		Community wide screening programs, universal	Hepatitis A		✓				1
			Hepatitis C		✓			1	
		Community wide screening programs, targeted groups	Hepatitis A		✓			2	1
			Hepatitis C		✓			1	
			HIV		✓			1	5
			TB		✓		1		
			Varicella		✓				3
	Reduce incidence and transmission of infectious diseases through immunization[2]	Mandatory vaccination before school entry	DPT/polio		✓		1		
		Community wide vaccination programs, universal	Hepatitis A		✓			1	1
			Hepatitis B		✓			1	1
			Meningococcal		✓		1		

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Table 2: Health Promotion, Health Protection, and Health Public Policy Recommended Activities (cont'd)

Note: Recommended clinical prevention interventions have been excluded from the table - see Table 1.

Issue	Goals/Objectives	Possible Interventions*		Prevention Face			Number of Economic Evaluations†		
				Health promotion	Health protection	Healthy Public Policy	Canada	Aust/NZ/ Europe	USA
Addressing the Environment (continued)									
Physical Environment (continued)	Reduce incidence and transmission of infectious diseases through immunization[2] (continued)	Community wide vaccination programs, targeted groups	Adenovirus		✓				2
			DPT/polio		✓		3	4	3
			Hepatitis A		✓			8	5
			Hepatitis B		✓		3	12	7
			Hib		✓		1	7	4
			HPV		✓				1
			Influenza		✓		1	3	4
			Measles		✓				2
			Meningococcal		✓			4	1
			MMR		✓		1	1	2
			Pneumococcal		✓		1		2
			Rotavirus		✓			1	2
			TB		✓				1
			Varicella		✓		2	5	7
	Reduce incidence and transmission of infectious diseases through immunization[2]	Vaccination of staff in health care and day care settings	Hepatitis A		✓			2	1
			Hepatitis B		✓				1
			Influenza		✓			1	
			Varicella		✓			1	3
		Vaccination of nursing home residents			✓				
		Subsidizing vaccination costs		✓					

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Table 2: Health Promotion, Health Protection, and Health Public Policy Recommended Activities (cont'd)

Note: Recommended clinical prevention interventions have been excluded from the table - see Table 1.

Issue	Goals/Objectives	Possible Interventions*	Prevention Face			Number of Economic Evaluations†		
			Health promotion	Health protection	Healthy Public Policy	Canada	Aust/NZ/ Europe	USA
Addressing the Environment (continued)								
Physical Environment (continued)	Reduce incidence and transmission of infectious diseases through other strategies	Needle exchange programs	✓			2	1	6
		Government inspections of health care, day care, and personal care (e.g., hairdressers, aesthetic clinics, tattoo studios) settings		✓				
		Community education campaigns	✓					
		School based education campaigns	✓					
		Education programs for health care and day care staff		✓				
	Reduce the incidence of food-borne illness	Government inspections of food premises		✓				1
		Community education campaigns	✓					
		Food handler training programs		✓				1
	Prevent the occurrence of rabies in humans	Confining animals suspected of carrying rabies		✓				
		Pet rabies vaccination laws		✓				
	Reduce incidence of water-borne illnesses	Government inspections of drinking water systems		✓				1
		Government inspections of bathing beaches		✓				
	Reduce adverse health effects from clinical treatment	Government regulation of drugs		✓				
		Government regulation of medical devices		✓				
	Reduce pollution	Environmental health assessments		✓				
		Pollution-control laws		✓		1		2

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† An "X" in the USA column indicates that neither the US Task Force on Community Preventive Services nor the McMaster team could find any economic evaluations meeting inclusion criteria for the intervention described in the row. The year of the published statement by the US Task Force on Community Preventive Services indicating no economic evidence is provided with the "X."

Table 2: Health Promotion, Health Protection, and Health Public Policy Recommended Activities (cont'd)

Note: Recommended clinical prevention interventions have been excluded from the table - see Table 1.

1. Infectious disease screening strategies that were reviewed by the Canadian Task Force on Preventive Health Care (CTPHC) and not given ratings of good or fair evidence of effectiveness (A and B recommendations) are not included here. This includes HIV screening of the general population (i.e., not high-risk); HIV screening of pregnant women that are not in a high-risk group; gonorrhea screening of the general population (i.e., not high-risk); chlamydial screening of the general population (i.e., not high-risk); tuberculosis screening of the general population (i.e., not high-risk), and HPV screening.

2. Infectious disease immunization strategies that were reviewed by the Canadian Task Force on Preventive Health Care (CTPHC) and not given ratings of good or fair evidence of effectiveness (A and B recommendations) are not included here. This includes the use of influenza vaccine for persons less than 65 years of age and who are not in a high-risk group or are health care providers; and 23-valent pneumococcal vaccine in children, immunocompromised patients, and immunocompetent patients aged 55 years or older living independently.

Table 3: Included Economic Evaluations Classified by Four Faces of Prevention

	Evaluation Setting						Total	
	Canada		Australia/New Zealand/Europe		USA			
	Number	(Percent)	Number	(Percent)	Number	(Percent)	Number	(Percent)
Clinical prevention	58	(57)	141	(60)	169	(50)	368	(55)
Health promotion	13	(13)	18	(8)	50	(15)	81	(12)
Health protection	27	(27)	76	(32)	105	(31)	208	(31)
Healthy public policy	3	(3)	0	(0)	12	(4)	15	(2)
Total	101		235		336		672*	

* The total is greater than the 567 included economic evaluations as some studies examined interventions from more than one face of prevention

Table 4: Preventive Interventions with the Highest Number of Economic Evaluations

Prevention Face	Intervention	Number of Economic Evaluations	
		All Settings	Canada
Clinical prevention	Drug treatment for elevated cholesterol	34	4
	Counselling smokers to stop smoking or offering nicotine replacement therapy	34	0
	Colorectal cancer screening of average risk adults with FOBT screening	27	4
	Screening of high-risk women for Chlamydia	24	2
	Hepatitis B immunization for infants, children and adolescents	20	4
	Mammography screening for breast cancer	17	2
	Colorectal cancer screening of average risk adults with sigmoidoscopy	16	1
	Cervical cancer screening using the Pap smear in sexually-active women	13	0
	Triple screening for Down syndrome	13	0
	Immunizing infants and children with Hib vaccine	12	1
	Immunizing infants and children with DPT and polio vaccines	11	3
	Immunizing 12-15 month children with varicella vaccine	10	2
	Blood pressure measurement	10	1
Health promotion	Needle exchange programs	9	2
	Community education campaigns to increase smoking cessation	9	0
	Community education campaigns to prevent sexually transmitted diseases	7	0
Health protection	Universal or mandatory immunization programs, specific groups, Hepatitis B	22	3
	Universal or mandatory immunization programs, specific groups, varicella	14	2
	Universal or mandatory immunization programs, specific groups, Hepatitis A	13	0
	Community water fluoridation	12	1
	Universal or mandatory immunization programs, specific groups, Hib	12	1
	Universal or mandatory immunization programs, specific groups, DPT and polio	10	3
Healthy public policy	Day care or preschool programs	9	2
	Social skill development programs to reduce violent behaviour	5	0
	Parenting classes to increase early childhood development opportunities	3	1

Table 5A: Varicella Vaccination – Canada

Author(s), Year of publication	Brisson & Edmunds, 2002	Getsios et al., 2002
Study location, Study Period	Canada	Canada
Analytic method(s)	Cost-effectiveness Cost-benefit	Cost-effectiveness Cost-benefit
Analytic perspective(s)	Health payer Societal	Health payer Societal
Intervention	1. Vaccination at 1 year of age at time of MMR vaccination (infant strategy) 2. Same as 1 plus catch-up vaccination of children 5 to 11 years of age for first 5 years (catch-up strategy) 3. Vaccination at 12 years of age (preteen strategy)	1. Vaccination at 1 year of age at time of MMR vaccination (infant strategy) 2. Same as 1 plus catch-up program for susceptible 12 year olds (based on recall) for first 11 years (catch-up strategy)
Comparator	No vaccination	No vaccination
Source of effectiveness estimates	Randomized controlled trials	Randomized controlled trials
Discount rate	3%	3%
Base Case Features* - population - length of follow-up - program length - vaccination coverage - base year and currency	 General population 30 years 30 years 90% infants, 80% children 1997-98 Canadian dollars	 11 cohorts of children susceptible to varicella 70 years 11 years 80% 1998 Canadian dollars
Results (in 2003 Canadian dollars)†	Health payer perspective (cost per life year gained): • Base case Infant $50,636 Catch-up $57,875 Preteen $21,058	Health payer perspective (cost per life year gained): • Infant vaccination $94,059 • With catch-up $88,357 • Incremental cost-effectiveness of adding catch-up $46,654

* In any of the base case features, a ? in front of a value indicates our best estimate of the value from the published paper and a ? on its own indicates no value was provided in the published paper.

† When the base year for the original currency was missing, we assumed a base year of three years prior to the study publication date.

‡ Our calculations based on data provided in the published article.

Table 5A: Varicella Vaccination – Canada (cont'd)

Author(s), Year of publication	Brisson & Edmunds, 2002	Getsios et al., 2002
Results (in 2003 Canadian dollars)†	• Including breakthrough (modified varicella in immunized individuals) Infant $53,358 Catch-up $62,365 Preteen $23,482 • Including breakthrough and impact on incidence of zoster Infant $46,024 to $134,475 Catch-up $53,250 to $170,662 Preteen $23,315 to $24,862 Societal perspective: • Benefit/cost ratio Infant 5.24 Catch-up 4.90 Preteen 4.44 • Net benefits Infant $1,901 million Catch-up $2,191 million Preteen $276 million	Societal perspective (net benefits): • Infant $42.6 million • Catch-up $45.5 million
Sensitivity analysis	Findings sensitive only to cost of vaccination and only from health payer perspective	Results sensitive only to cost of vaccination and only from a health payer perspective
Strengths	Modelled effects of herd immunity, potential effects of breakthrough varicella and potential effects on incidence of zoster	Modelled waning of immunity
Limitations		Did not account for herd immunity or potential effects on incidence of zoster

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‡ Our calculations based on data provided in the published article.

Table 5B: Varicella Vaccination – Australia, New Zealand or Europe

Author(s), Year of publication	Beutels et al., 1996	Coudeville et al., 1999	Diez Domingo et al., 1999
Study location, Study Period	Germany	France	Spain (Valencia)
Analytic method(s)	Cost-effectiveness Cost-benefit	Cost-benefit	Cost-benefit
Analytic perspective(s)	Health payer Societal	Health payer	Health payer Societal
Intervention	1. Vaccination at 12 to 18 months of age at time of MMR vaccination (infants) 2. Vaccination of susceptible 12 year olds (negative history of varicella) (preteens) 3. 1 plus 2 (for 11 years) (infants plus catch-up)	Vaccination at age 9 months to 6 years at time of MMR vaccination	Universal vaccination at 15 months of age at time of MMR vaccination
Comparator	No vaccination	No vaccination	No vaccination
Source of effectiveness estimates	Randomized controlled trials	Expert panel results from a previously published study	Randomized controlled trials
Discount rate	5%	5%	5%
Base Case Features*			
- population	Annual birth cohorts of healthy children	Simulated population of France aged 75 years or less	Hypothetical cohort of children born in Valencia
- length of follow-up	70 years	30 years	20 years
- program length	?	30 years	20 years
- vaccination coverage	70%	80%	95%
- base year and currency	1995 Deutsche marks	1995 France francs	1994 Spanish pesetas

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† When the base year for the original currency was missing, we assumed a base year of three years prior to the study publication date.
‡ Our calculations based on data provided in the published article.

Table 5B: Varicella Vaccination – Australia, New Zealand or Europe (cont'd)

Results (in 2003 Canadian dollars)†	Health payer perspective (cost per life year gained): • Infants $32,131 • Preteens – $71,262 (cost-saving) • Infants plus catch-up $13,244 Societal perspective Benefit/cost ratio: • Infants 4.6 • Preteens 6.02 • Infants plus catch-up 4.72 Net benefits per annual birth cohort: • Infants $224.0 million • Preteens $29.2 million • Infants plus catch-up $253.1 million	Net reduction in health care costs of $2,551 million over the first 30 years of a vaccination program	Health payer perspective: • Benefit/cost ratio = 0.54 Societal perspective: • Benefit/cost ratio = 1.61 • Net benefit $11.4 million ($31.49 per child vaccinated)
Sensitivity analysis	Preteen vaccination no longer cost-saving from a health payer perspective in the absence of treatment with acyclovir or at low specificity (40%) of varicella recall Infant vaccination becomes cost-saving from a health payer perspective if vaccine cost is reduced by one-third	Findings robust to plausible alternative values	Findings robust to plausible alternative values of vaccine efficacy and coverage and discount rate. Program is no longer cost-saving from a societal perspective at a vaccine cost greater than $72.07 per dose
Strengths	Included costs of acyclovir prescriptions (5% of children less than 14 years; all children 14 years or older)		
Limitations	Did not account for herd immunity or potential effects on incidence of zoster	Indirect costs (lost time from work) were measured but not assigned a monetary value, precluding cost-benefit analysis from a societal perspective. Did not account for potential effects on incidence of zoster	Did not account for herd immunity or potential effects on incidence of zoster

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† When the base year for the original currency was missing, we assumed a base year of three years prior to the study publication date.
‡ Our calculations based on data provided in the published article.

Table 5B: Varicella Vaccination – Australia, New Zealand or Europe (cont'd)

Author(s), Year of publication	Scuffham et al., 1999	Scuffham et al., 2000
Study location, Study Period	New Zealand	Australia
Analytic method(s)	Cost-effectiveness Cost-benefit	Cost-effectiveness
Analytic perspective(s)	Health payer Societal	Health payer
Intervention	Vaccination of 15 months old children at time of MMR vaccination	1. Vaccination at 1 year of age at time of MMR vaccination 2. Vaccination at 12 years of age if no history of varicella 3. 1 plus catch-up vaccination of 12 year olds for first 11 years
Comparator	Status quo (user pay)	No vaccination for programs 1 and 2 Program 1 for program 3
Source of effectiveness estimates	Randomized controlled trials	Randomized controlled trials
Discount rate	5%	5%
Base Case Features* - population - length of follow-up - program length - vaccination coverage - base year and currency	 Hypothetical annual cohorts of 15 month old children 30 years after introduction of the program 30 years Vaccination program 80%; usual care 10% 1997 New Zealand dollars	 Initial cohort of children 0 to 12 years of age and 29 successive birth cohorts 30 years 30 years Infants 80%; preteens 50 to 75% (higher value for states with a school- based vaccination program) 1996-97 Australian dollars

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† When the base year for the original currency was missing, we assumed a base year of three years prior to the study publication date.
‡ Our calculations based on data provided in the published article.

Table 5B: Varicella Vaccination – Australia, New Zealand or Europe (cont'd)

Author(s), Year of publication	Scuffham et al., 1999	Scuffham et al., 2000
Results (in 2003 Canadian dollars)†	Health payer perspective: • Benefit/cost ratio = 0.67 • Cost per case prevented = $80.08 Societal perspective: • Benefit/cost ratio = 2.79 • Net benefit of $44.64 per child vaccinated • Net annual benefits = $900,024	Cost per case prevented: • Infant program $68 • Preteen program $564 • Infant program with catch-up (vs. infant program only) $445
Sensitivity analysis	From a societal perspective, the program ceases to be cost-saving only when the number of days of work lost per case falls to one (base case 3) From a health payer perspective the findings are sensitive only to vaccine cost and discount rate	Findings somewhat sensitive to vaccine cost, discount rate and accuracy of preteens' recall of varicella
Strengths		
Limitations	Did not account for herd immunity and potential effects on incidence of zoster	Did not account for herd immunity, age shifts in incidence with infant vaccination or potential effects on incidence of zoster

* In any of the base case features, a ? in front of a value indicates our best estimate of the value from the published paper and a ? on its own indicates no value was provided in the published paper.
† When the base year for the original currency was missing, we assumed a base year of three years prior to the study publication date.
‡ Our calculations based on data provided in the published article.

Table 5C: Varicella Vaccination – United States

Author(s), Year of publication	Preblud et al., 1985, 1986	Huse et al., 1994	Lieu et al., 1994
Study location, Study Period	United States	United States	United States
Analytic method(s)	Cost-benefit	Cost-benefit Cost-effectiveness	Cost-effectiveness Cost-benefit
Analytic perspective(s)	Health payer Societal	Health payer Societal	Health payer Societal
Intervention	Vaccination at 15 months of age at time of MMR vaccination	Vaccination at 15 months of age at time of MMR vaccination	1. Vaccination of children less than 6 years of age (infant program) 2. Same as 1 plus catch-up program for 12 year olds (based on recall) for 11 years beginning after the first year
Comparator	No vaccination	No vaccination	1. No vaccination for intervention 1 2. Intervention 1 for intervention 2
Source of effectiveness estimates	Single randomized controlled trial and observational studies	Single randomized controlled trial	Randomized controlled trials and an expert panel
Discount rate	5% (costs only)	5%	5%
Base Case Features*			
- population	**Hypothetical birth cohort**	Hypothetical cohort of children aged 15 months	Children less than 6 years of age
- length of follow-up	Cohort followed to 30th birthday	25 years	30 years from initiation of the program 30 years
- program length	Vaccination of single cohort	Vaccination of single cohort	97% of children less than 6 years by the sixth year; 100% for catch-up program for susceptible 12 year olds
- vaccination coverage	90%	100%	1990 US dollars
- base year and currency	1984 US dollars	1991 US dollars	

* In any of the base case features, a ? in front of a value indicates our best estimate of the value from the published paper and a ? on its own indicates no value was provided in the published paper.
† When the base year for the original currency was missing, we assumed a base year of three years prior to the study publication date.
‡ Our calculations based on data provided in the published article.

Table 5C: Varicella Vaccination – United States (cont'd)

Author(s), Year of publication	Preblud et al., 1985, 1986	Huse et al., 1994	Lieu et al., 1994
Results (in 2003 Canadian dollars)†	Health payer perspective: Benefit/cost ratio = 0.3 Cost per undiscounted case prevented = $28.11‡ Societal perspective: Benefit/cost ratio = 6.9 Net benefits = $595 million	Health payer perspective: Cost per undiscounted case prevented = $55.08‡ Benefit/cost ratio = 0.35‡ Societal perspective: Benefit/cost ratio = 2.38‡ Net benefits = $10.6 million ($105.81 per child vaccinated)	Health payer perspective: • Infant program Cost per undiscounted case prevented = $3.54 Cost per discounted case prevented = $7.09 Cost per life year gained = $26,998 Benefit/cost ratio = 0.9 • Catch-up program Incremental cost per undiscounted case prevented = $532 Societal perspective (infant program): Benefit/cost ratio = 5.4 Net benefits = $648 million
Sensitivity analysis	Program remained cost saving from a societal perspective in worst case scenario (benefit/cost ratio = 2.2)	Findings robust to plausible alternative values of vaccine efficacy, number of doses of vaccine (one vs. two), costs of treating varicella, costs of work loss and discount rate	Findings sensitive to vaccine cost
Strengths			Modelled shifts in age distribution of varicella as infant vaccination rates increase
Limitations	Did not account for herd immunity or potential effects on incidence of zoster Did not include foregone wages of working age patients (but included those of caregivers of children with varicella)	Sensitivity to cost of vaccine not assessed. Non-prescription drug costs not included Assumed no use of acyclovir Did not account for herd immunity and potential effects on incidence of zoster Assumed no deaths from varicella	Did not account for potential effects on incidence of zoster Unclear whether timing of varicella vaccination of infants/preschoolers coincides with MMR vaccination

* In any of the base case features, a ? in front of a value indicates our best estimate of the value from the published paper and a ? on its own indicates no value was provided in the published paper.

† When the base year for the original currency was missing, we assumed a base year of three years prior to the study publication date.

‡ Our calculations based on data provided in the published article.

Table 6A: Fecal Occult Blood Test (FOBT) Screening for Colorectal Cancer – Canada

Author(s), Year of publication	Conseil d'évaluation des technologies de la santé du Québec (CETS), 2000[1]	Flanagan et al., 2002
Study location	Canada (Quebec)	Canada
Analytic method(s)	Cost-effectiveness	Cost-effectiveness
Analytic perspective(s)	Health payer	Health payer
Intervention	Biennial FOBT screening of average risk, asymptomatic 50 to 79 year olds	Biennial FOBT screening of 50 to 79 year olds
Comparator	Usual care	Usual care
Source of effectiveness estimates	Meta-analysis of 2 randomized controlled trials	Randomized controlled trials
Discount rate	Unclear whether future costs and consequences were discounted	5%
Base Case Features* - population - length of follow-up - program length - compliance rate for FOBT - FOBT - base year and currency	 **Average risk 50 to 79 year olds** Not specified Not specified Not specified Non-rehydrated "guaiac-type" ? Canadian dollars	 50 to 74 year olds with no history of colorectal cancer 10 years 25 years (from age 50 to74 years) Initial screening 67%; re-screening 93% Non-rehydrated Hemoccult II ? Canadian dollars
Results (in 2003 Canadian dollars)†	Cost per life year gained = $6,724	Cost per life year gained = $12,957
Sensitivity analysis	Not done	Findings robust to plausible alternative values of participation in initial screening, screening costs and discount rate
Strengths		
Limitations	Program startup and administrative costs not accounted for Costs of cancer treatment appear not to have been estimated	

[1] Based on an English summary of a report in French of "preliminary" findings.

* In any of the base case features, a ? in front of a value indicates our best estimate of the value from the published paper and a ? on its own indicates no value was provided in the published paper.

† When the base year for the original currency was missing, we assumed a base year of three years prior to the study publication date.

‡ Our calculations based on data provided in the published article.

Table 6B: Fecal Occult Blood Test (FOBT) Screening for Colorectal Cancer – Australia, New Zealand or Europe

Author(s), Year of publication	Salkeld et al., 1996	Gyrd-Hansen, 1997, 1998a, 1998b	Whynes et al., 1998
Study location	Australia	Denmark (Funen)	England
Analytic method(s)	Cost-effectiveness	Cost-effectiveness	Cost-utility
Analytic perspective(s)	Health payer	Health payer	Health payer (UK National Health Service)
Intervention	Annual FOBT screening of 50 to 80 year olds	FOBT screening of 50 to 74 year olds at 1, 1.5 or 2 year intervals	Biennial FOBT screening of 50 to 74 year olds
Comparator	Usual care	No screening	Usual care
Source of effectiveness estimates	Single randomized controlled trial (Mandel, 1993)	Single randomized controlled trial	Single randomized controlled trial
Discount rate	5%	5%	6%
Base Case Features*			
- population	Hypothetical cohort aged 50 to 80 years	General population aged 50 to 74 years	1. Participants in Nottingham trial (aged 50 to 74 years) 2. Hypothetical cohort of 50 to 74 year olds with the UK's demographic structure
- length of follow-up	Lifetime 30 years (annual screening to age 80)	36 years from program initiation 36 years	1. Mean of 8 years 2. Lifetime 1. Up to 6 screening invitations
- program length	Not specified		2. Up to 13 screening invitations
- compliance rate for FOBT		Initial screening 67.3%; re-screening 93.5%	1. As in Nottingham trial 2. Initial screening 70%, decreasing by 10% in each subsequent round
- FOBT	Hemoccult II	Non-rehydrated Hemoccult II	Non-rehydrated Hemoccult II
- base year and currency	1994 Australian dollars	1993 Danish kroner	1995 British pounds

* In any of the base case features, a ? in front of a value indicates our best estimate of the value from the published paper and a ? on its own indicates no value was provided in the published paper.

† When the base year for the original currency was missing, we assumed a base year of three years prior to the study publication date.

‡ Our calculations based on data provided in the published article.

Table 6B: Fecal Occult Blood Test (FOBT) Screening for Colorectal Cancer – Australia, New Zealand or Europe (cont'd)

Author(s), Year of publication	Salkeld et al., 1996	Gyrd-Hansen, 1997, 1998a, 1998b	Whynes et al., 1998
Results (in 2003 Canadian dollars)†	Cost per life year gained = $26,625	Cost per life year gained: Biennial, age 65-74 $2,875 Biennial, age 60-74 $2,976 Biennial, age 55-74 $3,179 Every 1.5 years, age 55-74 $3,416 Annual, age 55-74 $3,890 Annual, age 50-74 $4,397	Cost per quality-adjusted life year (QALY): • Based on Nottingham trial results males $12,992 females $11,315 • UK population distribution, lifetime costs and consequences compliance as in Nottingham trial Males $4,678 Females $3,133 UK population distribution, lifetime costs and consequences, initial compliance 10%, declining by 10% in each subsequent round Males $5,099 Females $3,853
Sensitivity analysis	Results somewhat sensitive to mortality reduction due to screening (cost per life year gained could vary from $13,706 to $73,254 based on the 95% confidence interval for mortality in screened group in Mandel 1993)	Above results robust to plausible alternative values of cost of FOBT, cost of colonoscopy, and mortality reduction with screening. Cost-effectiveness estimates unaffected when adenoma removal is assumed not to prevent cancer	Results sensitive only to lower discount rate (3% discount rate results in 40-50% lower cost-effectiveness ratio), and fall in FOBT specificity (10% lower specificity results in a doubling of the cost-effectiveness ratio)
Strengths			
Limitations		Did not include treatment costs	

* In any of the base case features, a ? in front of a value indicates our best estimate of the value from the published paper and a ? on its own indicates no value was provided in the published paper.
† When the base year for the original currency was missing, we assumed a base year of three years prior to the study publication date.
‡ Our calculations based on data provided in the published article.

Table 6B: Fecal Occult Blood Test (FOBT) Screening for Colorectal Cancer – Australia, New Zealand or Europe (cont'd)

Author(s), Year of publication	UK CRC Screening Pilot Evaluation Team, 2003
Study location	United Kingdom
Analytic method(s)	Cost-utility
Analytic perspective(s)	Health payer (UK National Health Service)
Intervention	Biennial FOBT screening of 50 to 75 year olds
Comparator	Usual care
Source of effectiveness estimates	Single randomized controlled trial (Nottingham)
Discount rate	Costs 6%, QALYS 1.5%
Base Case Features* - population - length of follow-up - program length - compliance rate for FOBT - FOBT - base year and currency	 Hypothetical cohort of 50 or 60 year old males To age 80 15 or 25 years (to 75 years of age for either cohort) 60% Non-rehydrated Hemoccult II 2002 British pounds
Results (in 2003 Canadian dollars)†	50 year old cohort = $5,116 per QALY gained 60 year old cohort = $12,787 per QALY gained
Sensitivity analysis	Results robust to plausible alternative values of compliance with FOBT and follow-up colonoscopy, costs of colorectal cancer treatment, and cost of colonoscopy
Strengths	
Limitations	

* In any of the base case features, a ? in front of a value indicates our best estimate of the value from the published paper and a ? on its own indicates no value was provided in the published paper.
† When the base year for the original currency was missing, we assumed a base year of three years prior to the study publication date.
‡ Our calculations based on data provided in the published article.

Table 6C: Fecal Occult Blood Test (FOBT) Screening for Colorectal Cancer – United States

Author(s), Year of publication	Kristein, 1980	Allison & Feldman, 1985	Eddy, 1990
Study location	United States	United States	United States
Analytic method(s)	Cost-benefit	Cost-effectiveness	Cost-effectiveness
Analytic perspective(s)	Societal Health payer	Health payer	Health payer
Intervention	One time FOBT screening offered to persons over 55 years of age	FOBT screening of health plan members 45 years of age or older who made appointments for "multiphasic examinations"	Annual FOBT screening of average risk 50 to 75 year olds
Comparator	Usual care	Usual care	No screening
Source of effectiveness estimates	Observational data	Observational data	Observational data and expert opinion
Discount rate	10%	No discounting	5%
Base Case Features*			
- population	Hypothetical cohort over 55 years of age	Health plan members 45 years or older	Average risk 50 year olds
- length of follow-up	Lifetime	Lifetime for survival; 5 years for costs	Lifetime
- program length	One time FOBT screening	One time screening	25 years (age 50 to 75 years)
- compliance rate for FOBT	75%	70%	?100%
- FOBT	Not specified	Non-rehydrated Hemoccult II	Rehydrated Hemoccult II
- base year and currency	1978 US dollars	1980 US dollars	?1987 US dollars

Table 6C: Fecal Occult Blood Test (FOBT) Screening for Colorectal Cancer – United States (cont'd)

Author(s), Year of publication	Kristein, 1980	Allison & Feldman, 1985	Eddy, 1990
Results (in 2003 Canadian dollars)†	Benefit/cost ratio • Societal perspective 5 year lead time 5.7 10 year lead time 3.6 15 year lead time 2.3 (Lead time = average time interval from screen-detectable to symptomatic disease) • Health payer perspective (cancer treatment costs not discounted) 0.81 Net benefits • Societal perspective 5 year lead time $11.3 million 10 year lead time $7.1 million 15 year lead time $4.6 million	Cost per life year gained = $2,374	**Men = $16,411 per life year gained** Women = $19,898 per life year gained
Sensitivity analysis	Results somewhat sensitive to reduced (30%) compliance and increased test sensitivity	Not done	Results somewhat sensitive to the proportion of invasive cancers that arise from adenomas
Strengths			
Limitations			

Table 6C: Fecal Occult Blood Test (FOBT) Screening for Colorectal Cancer – United States (cont'd)

Author(s), Year of publication	Wagner et al., 1991	Wagner et al., 1996	Frazier et al., 2000
Study location	United States	United States	United States
Analytic method(s)	Cost-effectiveness	Cost-effectiveness	Cost-effectiveness
Analytic perspective(s)	Health payer	Health payer	Health payer
Intervention	Annual FOBT screening of 65-85 year olds	Annual FOBT screening of average risk 50-85 year olds	Annual FOBT screening beginning at age 50 years
Comparator	No screening	No screening	No screening
Source of effectiveness estimates	Observational data	Observational data	Observational data
Discount rate	5%	5%	5% and 3%
Base Case Features*			
- population	**Hypothetical cohort of 65 year olds**	Hypothetical cohort of 50 year olds	Hypothetical cohort of 50 year olds at average risk of colorectal cancer
- length of follow-up	Lifetime	Lifetime	Lifetime
- program length	Annual screening 20 years (age 65 to 85); follow-up of adenomas for rest of life	35 years (annual screening to age 85)	35 years (annual screening to age 85)
- compliance rate for FOBT	100%	?100%	100% and 60%
- FOBT	?Non-rehydrated	Rehydrated Hemoccult II	Non-rehydrated
- base year and currency	1988 US dollars	?1995 US dollars	1998 US dollars

Table 6C: Fecal Occult Blood Test (FOBT) Screening for Colorectal Cancer – United States (cont'd)

Author(s), Year of publication	Wagner et al., 1991	Wagner et al., 1996	Frazier et al., 2000
Results (in 2003 Canadian dollars)[†]	**Cost per life year gained = $65,400**	Cost per life year gained: • 5 year polyp dwelling time $19,360 • 10 year polyp dwelling time $14,121 (Dwelling time = average time for a precancerous adenoma to become cancerous)	Cost per life year gained: • 100% compliance, 5% discount rate $34,387 • 60% compliance, 3% discount rate $16,753
Sensitivity analysis	Results insensitive to relative and absolute costs of early versus late cancer treatment and to reduced FOBT sensitivity. Cost per life year gained increases to $95,135 if polyp to cancer progression time is assumed to be 3 rather than 6 years (base case)	Findings robust to plausible alternative values of FOBT sensitivity and specificity, percent of cancers arising from polyps, cost of FOBT and cost of treating cancer	Not done
Strengths			
Limitations	"Conservative values were deliberately selected in order to produce cost-effectiveness ratios that were on the high side."		

Table 6C: Fecal Occult Blood Test (FOBT) Screening for Colorectal Cancer – United States (cont'd)

Author(s), Year of publication	Helm et al., 2000	Khandker et al., 2000	Sonnenberg et al., 2000
Study location	United States	United States	United States
Analytic method(s)	Cost-effectiveness	Cost-effectiveness	Cost-effectiveness
Analytic perspective(s)	Health payer	Health payer	Health payer
Intervention	1. Annual FOBT screening of 50-80 year olds 2. Biennial FOBT screening of 45-75 year olds	Annual FOBT screening of average risk 50-85 year olds	Annual FOBT screening of general population beginning at 50 years of age
Comparator	Usual care	No screening	No screening
Source of effectiveness estimates	Randomized controlled trials	Observational data	Observational data
Discount rate	3%	3%	3%
Base Case Features*			
- population	1. Hypothetical cohort of 50 to 80 year olds 2. Hypothetical cohort of 45 to 75 year olds	**Hypothetical cohort of 50 to 85 year olds "without predisposing factors"**	Hypothetical cohort of 50 year olds
- length of follow-up	10 years for clinical costs and consequences; lifetime for survival	To age 85	Lifetime
- program length	10 years	35 years (annual screening to age 85)	Single cohort offered annual screening until death
- compliance rate for FOBT	60 to 67%	100%	100%
- FOBT	1. Mixture of rehydrated and non-rehydrated 2. Non-rehydrated	Not specified	?Non-rehydrated
- base year and currency	1997 US dollars	1994 US dollars	? US dollars

Table 6C: Fecal Occult Blood Test (FOBT) Screening for Colorectal Cancer – United States (cont'd)

Author(s), Year of publication	Helm et al., 2000	Khandker et al., 2000	Sonnenberg et al., 2000
Results (in 2003 Canadian dollars)[†]	Cost per life year gained: • Based on Minnesota trial results (50 to 80 year olds, mixture of rehydrated and unrehydrated FOBT, 60% compliance) $28,192 • Based on Funen (Denmark) trial results (45 to 75 year olds, 67% compliance) $3,713 • Based on Nottingham (UK) trial results (45 to 74 year olds, 60% compliance) $3,438	Cost per life year gained = $20,608	Cost per life year gained: 100% compliance with initial and subsequent FOBT screening and with follow-up colonoscopy of FOBT positives = $13,346 90% compliance with annual screening, 100% compliance with follow-up colonoscopy = $20,337 100% compliance with annual screening, 75% compliance with follow-up colonoscopy = $19,351
Sensitivity analysis	Results not sensitive to costs of diagnostic procedure	Results reported to be sensitive to low (23%) compliance, but cost-effectiveness ratio not specified	Findings robust to plausible alternative values of FOBT sensitivity and specificity and screening frequency (1, 2, 3 yearly)
Strengths			
Limitations			

Table 6C: Fecal Occult Blood Test (FOBT) Screening for Colorectal Cancer – United States (cont'd)

Author(s), Year of publication	Vijan et al., 2001
Study location	United States
Analytic method(s)	Cost-effectiveness
Analytic perspective(s)	Health payer
Intervention	Annual FOBT screening beginning at age 50 years
Comparator	No screening
Source of effectiveness estimates	Observational data
Discount rate	3%
Base Case Features* - population - length of follow-up - program length - compliance rate for FOBT - FOBT - base year and currency	 Persons 50 years of age and older Lifetime Age 50 until death 100% Not specified 1999 US dollars
Results (in 2003 Canadian dollars)†	Cost per life year gained: • 100% compliance $7,166‡ • 75% compliance $10,050‡ • 50% compliance $9,786‡ • 25% compliance $20,692‡
Sensitivity analysis	Not done
Strengths	
Limitations	

Table 7A: Needle Exchange Programs – Canada

Author(s), Year of publication	Gold et al., 1997	Jacobs et al., 1999
Study location	Canada (Hamilton, Ontario)	Canada (Edmonton, Alberta)
Analytic method(s)	Cost-benefit	Cost-effectiveness
Analytic perspective(s)	Payers	Program
Intervention	Needle exchange program	Needle exchange program
Comparator	No program	No program
Source of effectiveness estimates	Observational data	Observational data and mathematical modeling
Discount rate	5%	Not applicable (one year time frame)
Base Case Features*		
- population	IDUs[1]	IDUs
- length of follow-up	Lifetime for direct costs of HIV treatment	1 year
- program length	5 years	1 year
- clinical outcomes	HIV and complications	HIV
- base year and currency	1995 Canadian dollars	?1997 Canadian dollars
Results (in 2003 Canadian dollars)†	**Benefit/cost ratio = 4.7** Net savings = $1.7 million	Cost per HIV infection averted for 1 year = $10,378
Sensitivity analysis	Findings robust through plausible range of HIV incidence, number of program users and discount rate	Findings robust to plausible alternative values of HIV prevalence, number of sharing partners per needle and the extent of needle sharing in the absence of the program
Strengths	Included non-market costs for time contributed by volunteers	Included non-market costs of volunteer or donated service
Limitations		

[1]IDUs = Intravenous drug users

Table 7B: Needle Exchange Programs – Australia, New Zealand or Europe

Author(s), Year of publication	Health Outcomes International et al., 2002
Study location	Australia
Analytic method(s)	Cost-benefit
Analytic perspective(s)	Government Payers (government and IDUs)
Intervention	Needle exchange program
Comparator	No program
Source of effectiveness estimates	Observational data and regression modeling
Discount rate	5%
Base Case Features*	
- population	IDUs
- length of follow-up	Lifetime for direct costs of HIV and Hepatitis C treatment
- program length	10 years (1991-2000)
- clinical outcomes	HIV, Hepatitis C and complications
- base year and currency	2000 Australian dollars

Table 7B: Needle Exchange Programs – Australia, New Zealand or Europe (cont'd)

Author(s), Year of publication	Health Outcomes International et al., 2002
Results (in 2003 Canadian dollars)†	Net benefit over 10 years: • HIV Government = $2,041 million Government + "consumers" = $2,027 million • HIV + Hepatitis C Government = $2,153 million Government + "consumers" = $2,138 million
Sensitivity analysis	Finding robust to plausible alternative values of program costs and effectiveness, HIV treatment costs and discount rate
Strengths	
Limitations	Excluded non-market costs of volunteers and other unpaid values

Table 7C: Needle Exchange Programs – United States

Author(s), Year of publication	Kahn, 1993	Holtgrave et al., 1998	Reid, 2000
Study location	United States	United States	United States (various locations)
Analytic method(s)	Cost-effectiveness	Cost-effectiveness Cost-benefit	Cost-benefit
Analytic perspective(s)	Program	Societal	IDUs Public/voluntary sector Societal
Intervention	Needle exchange program (four hypothetical program/context combinations)	Needle exchange program	Needle exchange program
Comparator	No program (does not assume absence of other sources of sterile needles)	Status quo (current levels of sterile syringe use)	No program
Source of effectiveness estimates	3 mathematical models based on alternative sets of observational data	Observational data and mathematical modeling	Observational data
Discount rate	No discounting	3%	Unclear whether future costs and consequences were discounted
Base Case Features* - population - length of follow-up - program length - clinical outcomes - base year and currency	 IDUs 1-5 years 1 year HIV ?1993 US dollars	 IDUs **Lifetime for direct costs of HIV treatment** 1 year HIV and complications 1996 US dollars	 IDUs **Lifetime for direct costs of HIV treatment and value of lives saved** ?1 year HIV and complications ?1997 US dollars

Table 7C: Needle Exchange Programs – United States (cont'd)

Author(s), Year of publication	Kahn, 1993	Holtgrave et al., 1998	Reid, 2000
Results (in 2003 Canadian dollars)[†]	Cost per HIV infection averted = $5,522 to $143,990 depending on program design, context and mathematical model For a needle exchange program run by a community-based organization with high needle exchange volume, moderate cost per needle exchanged, limited counseling and referral, high HIV prevalence and incidence, and a mean of 3 needle sharing episodes, cost per HIV infection averted varied from $5,522 to $17,563 depending on the model used	Cost per HIV infection averted: • At 80% coverage $37,780 • At 100% coverage $45,336 Cost-benefit: Given an estimated present value of HIV treatment of $143,460, program would produce a net benefit to society at any level of coverage	Net benefits per participant: • IDUs $463,508 • Public/voluntary sector $10,548 • Societal $474,055
Sensitivity analysis	Not done	Findings robust to plausible alternative values of coverage, % of syringes obtained from pharmacies vs. Needle exchange programs, program costs and HIV incidence among IDUs	Not done
Strengths	2 of the 3 models included effects on sexual transmission of HIV by IDUs		
Limitations			Data on costs and consequences drawn from other published studies (i.e., not estimated in present study)

Table 7C: Needle Exchange Programs – United States (cont'd)

Author(s), Year of publication	Laufer, 2001	Pollack, 2001
Study location	United States (New York State)	United States
Analytic method(s)	Cost-effectiveness	Cost-effectiveness
Analytic perspective(s)	Program	?Program
Intervention	Needle exchange program	Needle exchange program
Comparator	No program	No program
Source of effectiveness estimates	Observational data and mathematical modeling	Observational data and mathematical modeling
Discount rate	Not applicable (one year time frame)	Unclear whether future costs and consequences were discounted
Base Case Features* - population - length of follow-up - program length - clinical outcomes - base year and currency	 IDUs 1 year 1 year HIV ?1996 US dollars	 IDUs Time to steady state incidence and prevalence of Hepatitis C (3 to 26 years depending on assumed transmission or infectivity rates) Hepatitis C ? US dollars

Table 7C: Needle Exchange Programs – United States (cont'd)

Author(s), Year of publication	Laufer, 2001	Pollack, 2001
Results (in 2003 Canadian dollars)[†]	Cost per HIV infection averted = $26,004	Cost per Hepatitis C infection averted = $330,648 to > $1,322,594 at steady state prevalence
Sensitivity analysis	Findings robust to plausible alternative values of the number of shared injections per IDU per year and HIV incidence among IDUs	Findings robust to plausible alternative values of the frequency of needle sharing, infectivity (transmission), and exit rate of IDUs from the population of active drug injectors
Strengths	Included non-market costs of in-kind and donated services	
Limitations		Used average daily program costs per client from another study with no details provided

Table 8A: Water Fluoridation - Canada

Author(s), Year of publication	O'Keefe, 1994
Study Location	Canada (Montreal, Quebec)
Analytic method(s)	Cost-utility
Analytic perspective(s)	Health care system
Intervention	Community water fluoridation and current child dental program
Comparator	Current child dental program (with no community water fluoridation)
Source of effectiveness estimates	Observational data
Discount rate	5%
Base Case Features*	
- population	Hypothetical children born during the fluoridation program in the part of Montreal that receives its water supply from the City of Montreal (88% of population of Montreal)
- length of follow-up	15 years
- program length	15 years
- percent of caries treated	100%
- incorporated population mobility	Percentage of non-lifetime residents is 3 percent among one-year-olds rising to 50 percent among 15-year-olds
- time needed for maximum caries reduction	Immediate
- age at start of fluoridation benefits	4 years
- base year and currency	1993 Canadian dollars

Table 8A: Water Fluoridation - Canada (cont'd)

Author(s), Year of publication	O'Keefe, 1994
Results (in 2003 Canadian dollars)[†]	–$20.64 per Quality Adjusted Tooth Year (QATY) (cost-saving)
Sensitivity analysis	One-way sensitivity analyses of discount rate, cost of information campaign, and cost of children's dental program. Negative cost per QATY (cost-saving) of fluoridation holds for all but most extreme scenarios
Strengths	Included the costs of an information campaign at beginning of fluoridation program
Limitations	

Table 8B: Water Fluoridation – Australia, New Zealand or Europe

Author(s), Year of publication	Davies, 1973	Dowell, 1976	Carr et al., 1980
Study Location	New Zealand (Hastings)	United Kingdom (England)	Australia
Analytic method(s)	Cost-benefit	Cost-benefit	Cost-benefit
Analytic perspective(s)	Public payer	Payer	Public payer
Intervention	Community water fluoridation	Community water fluoridation	Community water fluoridation
Comparator	No community fluoridation	No community water fluoridation	No community water fluoridation
Source of effectiveness estimates	Observational data	Observational data	Observational data
Discount rate	No discounting	10%	7%
Base Case Features*			
- population	Children in Hastings aged 2.5 to 16 years after 10 years of fluoridation program; population size = 37,000	Hypothetical children ≤ 12 years of age when fluoridation program began plus children born during the fluoridation program; based on the age structure of England in 1974	Children 0 to 2 years when fluoridation commenced
- length of follow-up	10 years	30 years	10 years
- program length	10 years	30 years	10 years
- percent of caries treated	100%	100%	100%
- population mobility	All children in continuous residence	Not specified	30% with discontinuous exposure (based on survey data)
- time needed for maximum caries reduction	Immediate	Immediate	Immediate
- age at start of fluoridation benefits	2.5 years	3 years	5 years
- base year and currency	1965 New Zealand dollars	1974 British pounds	1971 Australian dollars

Table 8B: Water Fluoridation – Australia, New Zealand or Europe (cont'd)

Author(s), Year of publication	Davies, 1973	Dowell, 1976	Carr et al., 1980
Results (in 2003 Canadian dollars)[†]	Benefit/cost ratio = 6.6	Benefit/cost ratio = 2.5 when fluoridation costs $1.64 per person	At 7% discount rate, net benefits first positive in year 8 at $263,959
Sensitivity analysis	Not done	Calculated the annual cost of fluoridation where benefits equal costs for different program lengths – a cost of $1.64 per person requires the program to run for 10 years before the break even point	Takes longer time to achieve positive net benefits with change in discount rate to 10% and using lower treatment savings estimates; worst case scenario is positive net benefits first achieved 12 years after start of program
Strengths			Used actual fluoridation equipment and treatment costs rather than estimates or projections
Limitations	Fees were used instead of costs for caries treatment Costs spread to entire population but benefits only to children	Assumes adults will have same water fluoridation effectiveness rates as children Cannot tell if capital costs included Does not provide a base estimate for water fluoridation costs Used lifetime fluoridation effectiveness rates on persons with non-lifetime exposure to fluoridation, likely resulting in an overestimation of benefits	Cannot tell how calculated positive net present value Does not calculate results over entire program

Table 8B: Water Fluoridation – Australia, New Zealand or Europe (continued)

Author(s), Year of publication	Doessel, 1985	Manau et al., 1987	Birch, 1990
Study location	Australia (Townsville)	Spain (Catalonia)	United Kingdom
Analytic method(s)	Cost-benefit	Cost-effectiveness	Cost-effectiveness
Analytic perspective(s)	Societal	Payer	Payer
Intervention	Community water fluoridation	Community water fluoridation	Community water fluoridation
Comparator	Naturally occurring low fluoridation community water	No community water fluoridation	No community water fluoridation
Source of effectiveness estimates	Observational data	Observational data	Observational data
Discount rate	10%	No discounting	5% and 10%
Base Case Features*			
- population	Children aged 5-14 in Townsville from 1966 to 2000 (later data projected)	Hypothetical children (age not specified)	Children ages 4 to 14 years with lifetime exposure to fluoridated water in three hypothetical communities of different sizes
- length of follow-up	15 years	Costs spread over 20 years, benefits over 1 year	14 years
- program length	15 years	Not specified	14 years
- percent of caries treated	Varied willingness to have and pay for dental treatment from 0.9 to 0.5	Not applicable (treatment costs not included)	Not applicable (treatment costs not included)
- incorporated population mobility	Incorporated population mobility (method specified elsewhere)	Not specified	Lifetime exposure specified
- time needed for maximum caries reduction	Immediate	Immediate	Immediate
- age at start of fluoridation benefits	5 years	Not specified	4 years
- base year and currency	1965-66 Australian dollars	1986 Spanish pesetas	?1988 British pounds

Table 8B: Water Fluoridation – Australia, New Zealand or Europe (cont'd)

Author(s), Year of publication	Doessel, 1985	Manau et al., 1987	Birch, 1990
Results (in 2003 Canadian dollars)[†]	Net benefits: Best case scenario = $2.6 million Worst case scenario = $651,348	$0.88 per DMFS saved in an average year	Reduction in dmft/DMFT costs over 4 times as much in a low caries area than in a high caries area of the same size Specific results vary from $5.37 per dmft/DMFT for one year (area with high caries incidence, 600,000 population, 5% discount rate) to $90.74 per dmft/DMFT for one year (area with low caries incidence, 60,000 population, 10% discount rate)
Sensitivity analysis	Varied discounting from 0 to 100%, willingness to have and pay for dental treatment from 0.9 to 0.5, and used an upper and lower estimate of dental fees for cost estimations Results extremely robust; negative net present value only occurs in extreme situations (mainly very high discount rates)	Not done	Main results were conducted for a variety of scenarios; both population size of community and caries incidence were important influences on the results
Strengths	Validated their projected cross-sectional effectiveness data with longitudinal data from elsewhere in Australia		Conservative assumptions likely understated cost-effectiveness
Limitations	Fees were used instead of costs for caries treatment	Spread capital costs over time but benefits only reported for 1 year Costs spread to entire population but benefits only to children Ignored some lab costs & facility costs that are provided free rather than adjusting to market values	

Table 8B: Water Fluoridation – Australia, New Zealand or Europe (cont'd)

Author(s), Year of publication	Wright et al., 2001
Study location	New Zealand
Analytic method(s)	Cost-benefit Cost-effectiveness
Analytic perspective(s)	Payer for cost-benefit Societal for cost-effectiveness
Intervention	Community water fluoridation
Comparator	No community water fluoridation
Source of effectiveness estimates	Observational data
Discount rate	5%
Base Case Features*	
- population	Hypothetical population aged 4 to 45 years based on the 2000 New Zealand age and ethnic structure (15% aboriginal)
- length of follow-up	30 years
- program length	30 years
- percent of caries treated	100%
- incorporated population mobility	Assumed out-migration exactly counterbalanced by in-migration
- time needed for maximum caries reduction	Immediate
- age at start of fluoridation benefits	4 years
- base year and currency	1999 Australian dollars

Table 8B: Water Fluoridation – Australia, New Zealand or Europe (cont'd)

Author(s), Year of publication	Wright et al., 2001
Results (in 2003 Canadian dollars)†	Community of 1,000 persons Benefit/cost ratio = 1.1‡ Net benefit = $15,806 Community of 300,000 persons Benefit/cost ratio = 49‡ Net benefit = $43,192,102 Cost-effectiveness ratios were not calculated for base cases since all were cost-saving
Sensitivity analysis	Cost-saving results remain across all sensitivity analyses of 100% aboriginal communities (with much higher caries rates), 10% discount rate, and number of fluoride injection sites, excepting some instances for communities of 1,000 people or less. Where fluoridation was not cost-saving, cost-effectiveness ratios were calculated. Results varied from $27 per averted decayed surface (1,000 people, 10% discount rate) to $340 per averted decayed surface (1,000 people, 5 injection sites)
Strengths	Uses recent data reflecting overall decline in caries rates Conservative assumptions likely understated net benefits
Limitations	Fees were used instead of costs for caries treatment

Table 8C: Water Fluoridation – United States

Author(s), Year of publication	Nelson & Swint, 1976	Niessen & Douglass, 1984	Griffin et al., 2001
Study location	United States (Houston, Texas)	United States	United States
Analytic method(s)	Cost-benefit	Cost-effectiveness Cost-benefit	Cost-benefit
Analytic perspective(s)	Payer	Payer	Societal
Intervention	Community water fluoridation	Community water fluoridation	Community water fluoridation
Comparator	No community water fluoridation ("virtually no fluoride" in water)	No water fluoridation (water contains 0.1ppm naturally occurring fluoride)	No community water fluoridation
Source of effectiveness estimates	Observational data	Observational data	Multiple sources: clinical trials, community trials, survey data
Discount rate	10%	5%	4%
Base Case Features*			
- population	Children ages 6 to 13 years in Houston that are served by Lake Houston water (approximately 40% of the children in Houston)	Hypothetical children in grades kindergarten through 12; population size = 7,000	Hypothetical population aged 6 to 65 years based on the 1995 US population age structure
- length of follow-up	20 years	20 years	15 years for fluoridation costs; treatment cost projections to age 65; average year for water fluoridation effectiveness
- program length	20 years	20 years	Estimated for an average year once program running
- percent of caries treated	100%	50% for CBA Not applicable for CEA (treatment costs not included)	100%
- incorporated population mobility	All children in continuous residence	All children in continuous residence	Not specified
- time needed for maximum caries reduction	10 years	10 years	Immediate
- age at start of fluoridation benefits	6 years	5 years	6 years
- base year and currency	1975 US dollars	1983 US dollars	1995 US dollars

Table 8C: Water Fluoridation – United States (cont'd)

Author(s), Year of publication	Nelson & Swint, 1976	Niessen & Douglass, 1984	Griffin et al., 2001
Results (in 2003 Canadian dollars)[†]	Net benefit = $5.3 million Benefit-cost ratio = 1.51	Steady state year (i.e., after maximum caries reduction reached): Benefit/cost ratio = 11.55 Cost–effectiveness ratio = $2.10 per carious surface prevented Over 20 years: Net benefits = $1,314,189 Benefit/cost ratio = 8.22 Cost-effectiveness ratio = $2.94 per carious surface prevented	Annual net benefit per person = $22.74 in communities with fewer than 5,000 persons; $23.18 in communities with more than 20,000 persons
Sensitivity analysis	Not done	Net benefits still large for community water fluoridation under 10% discount rate	Results "extremely robust" to changes in discount rate, treatment costs, effectiveness of water fluoridation, caries increment, and community size
Strengths	Conservative assumptions likely understated net benefit	Conservative assumptions likely understated net benefits and cost-effectiveness	Included costs to replace fillings and opportunity costs for those getting treatment Used recent caries increment data with lower rates
Limitations	Applied effectiveness evidence to the caries rate of a small sample of children in Catholic school in Houston, some of whom had fluoridated water supplies Fees were used instead of costs for caries treatment	Fees were used instead of costs for caries treatment Used older data for annual caries increment -- more recent lower annual caries increment rate means that benefits are overestimated Claims effectiveness measure is number of carious surfaces prevented but effectiveness estimate comes from a review of evidence for number of carious teeth prevented, a less sensitive measure	Fees were used instead of costs for caries treatment

Table 9A: Day Care or Preschool Programs - Canada

Author(s), Year of publication	Cleveland & Krashinsky, 1998
Study location	Canada
Analytic method(s)	Cost-benefit
Analytic perspective(s)	Societal Mixed public payer and societal
Intervention	Hypothetical national program of "relatively high quality licensed child care to all children aged 2 to 5 years with employed parents plus enriched nursery school for children cared primarily at home"
Comparator	Status quo (no national day care program but some public expenditures on day care)
Source of effectiveness estimates	Some experimental studies, some observational
Discount rate	Not applicable (one year time frame)
Base Case Features*	
- population	Children 2 to 5 years of age
- length of follow-up	To age 65
- program length	4 years
- benefits measured	Child development benefits and labour force benefits
- base year and currency	?[1] Canadian dollars

Table 9A: Day Care or Preschool Programs - Canada (cont'd)

Author(s), Year of publication	Cleveland & Krashinsky, 1998
Results (in 2003 Canadian dollars)[†]	Societal perspective: Annual net benefit = $4.2 billion[‡] Benefit/cost ratio = 1.53[‡] Mixed public payer and societal perspective: Annual net benefit = $6.1 billion Benefit/cost ratio = 2
Sensitivity analysis	Not done
Strengths	Benefits divided analytically into benefits to children and benefits of employment to parents
Limitations	Measured benefits from societal perspective and costs from public payer perspective

[1]No base year is stated for the costs of the child care program.
The child development benefits are based on 1993 figures.
The labour force benefits are based on 1990 figures.

Table 9B: Day Care or Preschool Programs – Australia, New Zealand or Europe

Author(s), Year of publication	PricewaterhouseCoopers, 2003
Study location	United Kingdom
Analytic method(s)	Cost-benefit
Analytic perspective(s)	Societal Public payer
Intervention	Hypothetical national program of day care for all children ages 1 to 4 years for 8 hours a day
Comparator	Status quo (national day care program of 2.5 hours a day for all 4 year olds and some 3 year olds)
Source of effectiveness estimates	Overview of other studies (at least some of which were experimental)
Discount rate	3.5% for first 30 years, 3% thereafter
Base Case Features*	
- population	Children 1 to 4 years of age
- length of follow-up	1 year and 65 years
- program length	4 years
- benefits measured	Labour force benefits (to women + children once in labour market) and reduced welfare payments
- base year and currency	2003 UK pounds

Table 9B: Day Care or Preschool Programs – Australia, New Zealand or Europe (cont'd)

Author(s), Year of publication	PricewaterhouseCoopers, 2003
Results (in 2003 Canadian dollars)[†]	Societal perspective: Net benefit in an average year = $1.0 billion Benefit/cost ratio = 1.1[‡] Net benefit over 65 years = $74 billion Public payer perspective: Net benefit in an average year = – $5.2 billion (net cost) Benefit/cost ratio = 0.6[‡] Net benefit over 65 years = – $178 billion (net cost)
Sensitivity analysis	Highly sensitive to model assumptions, particularly effect on female employment; 1% decrease and increase in effect on female employment from baseline value results in a net societal benefit varying from –$2.1 billion (net cost) to $3.6 billion over one year and from –$11 billion (net cost) to $162 billion over 65 years
Strengths	Outline six key issues for refinement of their analysis to guide policy
Limitations	

Table 9C: Day Care or Preschool Programs – United States

Author(s), Year of publication	Barnett, 1993, 1996	Greenwood et al., 1998	Reynolds et al., 2002
Study location	United States (Ypsilanti, Michigan)	United States	United States (Chicago, Illinois)
Analytic method(s)	Cost-benefit	Cost-effectiveness	Cost-benefit
Analytic perspective(s)	Societal General public (taxpayers) Program participants	Societal	Societal General public (taxpayers and crime victims) Program participants
Intervention	Perry Preschool Program (2.5 hour classes on weekdays and weekly 90-minute home visits from October to May) for 3 and 4 year olds	Hypothetical program of full-time day care and education from ages 2 through 5 and weekly home visits starting by third trimester of pregnancy and continuing to child's second year	Chicago Child-Parent Center program, including preschool, full-day or part-day kindergarten, and family support services from age 3 onwards
Comparator	No preschool	No day care/home visit program	Typical early childhood programs in low-income neighborhoods (15 percent attended Head Start preschool and the remaining children were in home care) plus all-day kindergarten
Source of effectiveness estimates	Randomized controlled trial	Experimental studies of similar programs	Quasi-experimental study with matching of participants
Discount rate	3%	4%	3%
Base Case Features*			
- population	African-American children of low socioeconomic status born between 1958 and 1962 (ages 3 and 4 during preschool program)	Hypothetical cohort of children of young, poor, single mothers	Low income children born in 1980 (ages 3 and 4 years during preschool program)
- length of follow-up	25 years (and some lifetime projection of benefits)	30 years	20 years (and some lifetime projection of benefits)
- program length	1 to 2 years depending on age of entry	5 years	1 to 2 years of preschool (followed by 1 year of kindergarten)
- benefits measured	Child care costs, school success, employment earnings, crime & delinquency, and welfare costs	Juvenile crime, ages 14 to 17 years, and adult crime, ages 18 to 30 years	Costs of remedial schooling, crime, child welfare system, employment earnings and tax revenues
- base year and currency	1992 US dollars	? 1995 US dollars	1998 US dollars

* In any of the base case features, a ? in front of a value indicates our best estimate of the value from the published paper and a ? on its own indicates no value was provided in the published paper.

Table 9C: Day Care or Preschool Programs – United States (cont'd)

Author(s), Year of publication	Barnett, 1993, 1996	Greenwood et al., 1998	Reynolds et al., 2002
Results (in 2003 Canadian dollars)†	Societal perspective: Net benefit per program participant = $145,267 Benefit/cost ratio = 8.74‡ General public perspective: Net benefit per program participant = $115,545 Benefit/cost ratio = 7.16‡ Program participants perspective: Net benefit per program participant = $29,721 (Benefit/cost ratio not calculable as no program cost for participants)	$126,921 per serious crime prevented	Societal perspective: Net benefit per program participant = $54,315 Benefit/cost ratio = 7.14 General public perspective: Net benefit per program participant = $25,234 Benefit/cost ratio = 3.85 Program participants: Net benefit per program participant = $29,081 (Benefit/cost ratio not calculable as no program cost to participants)
Sensitivity analysis	Positive net benefit results highly robust to one-way sensitivity analyses of discount rates and various benefits Less conservative assumptions for post age 27 projections for crime costs, welfare costs, and earnings result in small increases in net benefit	Not done	Results robust to change in discount rates
Strengths	Children followed for 25 years therefore the majority of the benefits are directly measured rather than projected data	Decreased program effectiveness estimates by projecting effectiveness lost due to scale up of small pilot studies to a population program and expected decay of early program effects	Children followed for 20 years therefore the majority of the benefits are directly measured rather than projected data
Limitations		Authors describe report as "exploratory" and did "not attempt an exhaustive appraisal" of costs	Did not include costs of kindergarten program – including such costs would have increased the net benefit as all in control group had full day kindergarten program

† When the base year for the original currency was missing, we assumed a base year of three years prior to the study publication date.
‡ Our calculations based on data provided in the published article.

Table 10: Synthesis of Evidence for the Selected Preventive Interventions

Preventive Intervention	Societal Perspective (number of studies)	Payer Perspective (number of studies)
Varicella vaccination, infants	Net benefit (8)	• $27,000 to $94,000 per life year gained (4) • $3 to $80 per case prevented (5) • Benefit/cost ratio = 0.3 to 0.9 (5) • Cost-saving (1)
Varicella vaccination, infants plus catch-up	Net benefit (3)	• $13,000 to $88,000 per life year gained (3) • $445 to $532 per case prevented (compared to infant vaccination) (2)
Varicella vaccination, preteen only	Net benefit (2)	• $21,000 per life year gained (1) • – $71,000 per life year gained (1) • $564 per case prevented (1)
Colorectal cancer screening with FOBT	Net benefit (1)	• $2,000 to $65,000 per life year gained (13) • $3,000 to $13,000 per QALY gained (2) • Benefit/cost ratio = 0.81 (1)
Needle exchange programs	Net benefit (2)	Cost-saving (2)
Water fluoridation	Net benefit (3)	Cost-saving (7)
Day care or preschool programs, all children	Net benefit (2)	• Benefit/cost ratio = 0.6 (1)
Day care or preschool programs, disadvantaged children	Net benefit (2)	[not evaluated]

Figure 1: Canadian-Based Economic Evaluations With Potentially Large Population Health Impacts

Clinical Prevention

- Anderson DR, O'Brien B, Nagpal S, Goeree R, Wells P, Kearon C, Flowerdew G, Robinson KS, and Gross M (1998) *Economic Evaluation Comparing Low Molecular Weight Heparin With Other Modalities for the Prevention of Deep Vein Thrombosis and Pulmonary Embolism Following Total Hip or Knee Arthroplasty*. Ottawa, Ontario: Canadian Coordinating Office for Health Technology Assessment.
- Balen RM, Marra CA, Zed PJ, Cohen M, and Frighetto L (1999) Cost-effectiveness analysis of enoxaparin versus unfractionated heparin for acute coronary syndromes: a Canadian hospital perspective. *PharmacoEconomics* 16: 533-542.
- Dougherty GE, Soderstrom L, and Schiffrin A (1998) An economic evaluation of home care for children with newly diagnosed diabetes: results from a randomized controlled trial. *Medical Care* 36: 586-98.
- Grover SA, Coupal L, Zowall H, Alexander CM, Weiss TW, and Gomes DR (2001) How cost-effective is the treatment of dyslipidemia in patients with diabetes but without cardiovascular disease? *Diabetes Care* 24: 45-50.
- Hull RD, Raskob GE, Pineo GF, Feldstein W, Rosenbloom D, Gafni A, Feinglass J, Trowbridge AA, Elliott G, Lerner RG, and Brant R (1997) Subcutaneous low-molecular-weight heparin vs warfarin for prophylaxis of deep vein thrombosis after hip or knee implantation. *Archives of Internal Medicine* 157: 298-303.
- Kiberd BA, and Jindal KK (1998) Routine treatment of insulin-dependent diabetic patients with ACE inhibitors to prevent renal failure: an economic evaluation. *American Journal of Kidney Diseases* 31: 49-54.
- Kiberd BA, and Jindal KK (1995) Screening to prevent renal failure in insulin dependent diabetic patients: an economic evaluation. *BMJ* 311: 1595-1599.
- Lee SK, Normand C, McMillan D, Ohlsson A, Vincer M, and Lyons C (2001) Evidence for changing guidelines for routine screening for retinopathy of prematurity. *Archives of Pediatrics & Adolescent Medicine* 155: 387-395.
- Lowensteyn I, Coupal L, Zowall H, and Grover SA (2000) The cost-effectiveness of exercise training for the primary and secondary prevention of cardiovascular disease. *Journal of Cardiopulmonary Rehabilitation* 20: 147-155.
- Lytwyn A, Sellors JW, Mahony JB, Daya D, Chapman W, Ellis N, Roth P, Lorincz AT, and Gafni A (2000) Comparison of human papillomavirus DNA testing and repeat Papanicolaou test in women with low-grade cervical cytologic abnormalities: a randomized trial. HPV Effectiveness in Lowgrade Paps (HELP) Study No. 1 Group. *Canadian Medical Association Journal* 163: 701-7.
- Maetzel A, Ferraz MB, and Bombardier C (1998) The cost-effectiveness of misoprostol in preventing serious gastrointestinal events associated with the use of nonsteroidal anti inflammatory drugs. *Arthritis & Rheumatism* 41: 16-25.
- McCusker J, Jacobs P, Dendukuri N, Latimer E, Tousignant P, and Verdon J (2003) Cost-effectiveness of a brief two-stage emergency department intervention for high-risk elders: results of a quasi-randomized controlled trial. *Annals of Emergency Medicine* 41: 45-56.

(*continued*)

Figure 1: Canadian-Based Economic Evaluations With Potentially Large Population Health Impacts (continued)

Clinical Prevention (continued)

- O'Brien B, Anderson DR, and Goeree R (1994) Cost-effectiveness of enoxaparin versus warfarin prophylaxis against deep-vein thrombosis after total hip replacement. *Canadian Medical Association Journal* 150: 1083-1090.
- O'Brien BJ, Connolly SJ, Goeree R, Blackhouse G, Willan A, Yee R, and Gent M (2001) Cost-effectiveness of the implantable cardioverter-defibrillator: results from the Canadian Implantable Defibrillator Study (CIDS). *Circulation* 103: 1416-1421.
- Riviere M, Wang S, Leclerc C, Fitzsimon C, and Tretiak R (1997) Cost-effectiveness of simvastatin in the secondary prevention of coronary artery disease in Canada. *Canadian Medical Association Journal* 156: 991-997.
- Robertson KA, and Kayhko K (2001) Cost analysis of an intensive home follow-up program for first-time post-myocardial infarction patients and their families. *Dynamics* 12: 25-31.
- Rosner AJ, Grima DT, Torrance GW, Bradley C, Adachi JD, Sebaldt R, and Willison DJ (1998) Cost effectiveness of multi-therapy treatment strategies in the prevention of vertebral fractures in postmenopausal women with osteoporosis. *PharmacoEconomics* 14: 559-573.
- Trussell J, Wiebe E, Shochet T, and Guilbert E (2001) Cost savings from emergency contraceptive pills in Canada. *Obstetrics and Gynecology* 97: 789-793.
- Yuan L, and Robinson G (1994) Hepatitis B vaccination and screening for markers at a sexually transmitted disease clinic for men. *Canadian Journal of Public Health.* 85: 338-41.

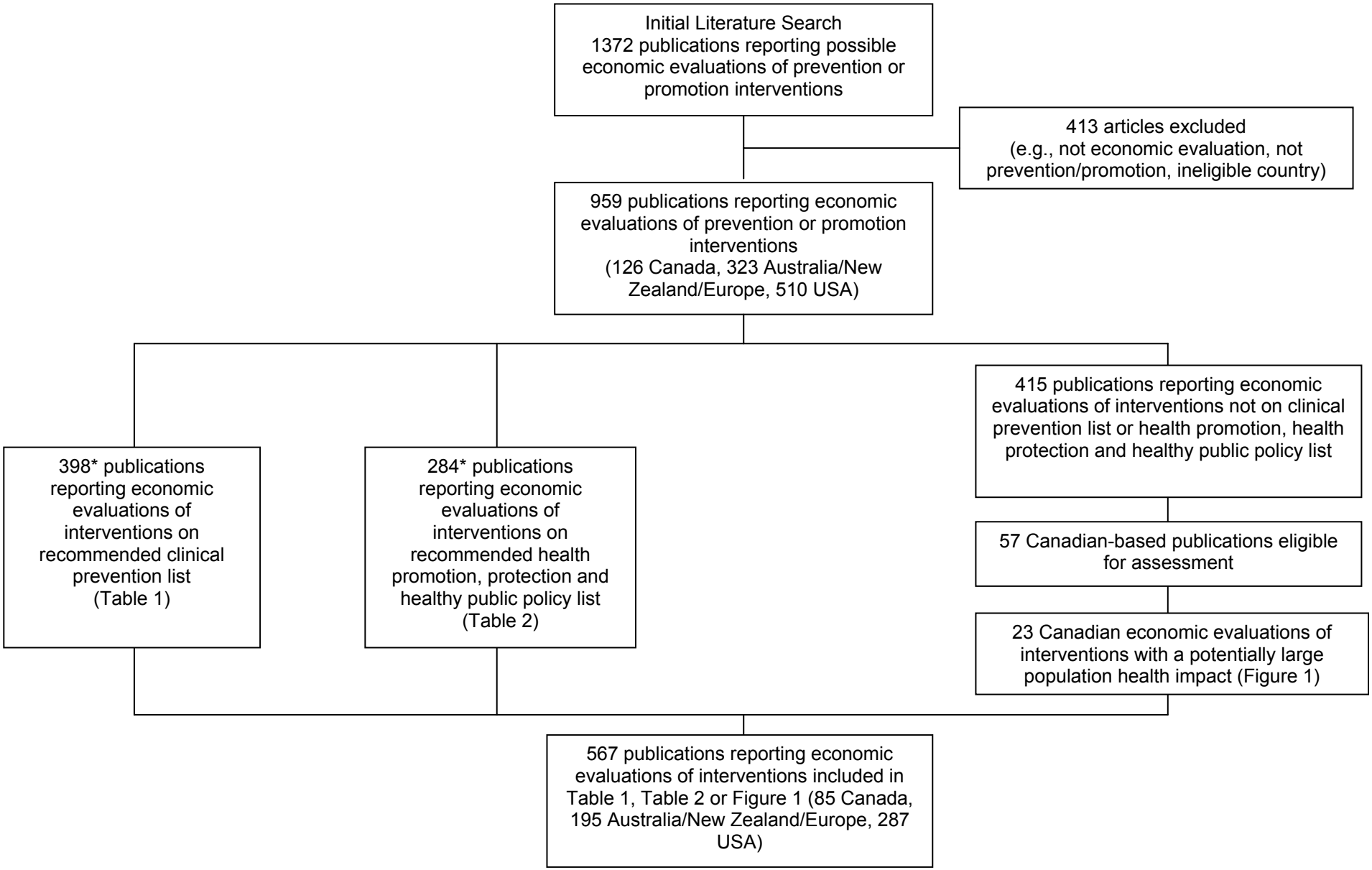
Health Promotion

- Adams PC, Gregor JC, Kertesz AE, and Valberg LS (1995) Screening blood donors for hereditary hemochromatosis: decision analysis model based on a 30-year database. *Gastroenterology* 109: 177-188.
- Adams PC, and Valberg LS (1999) Screening blood donors for hereditary hemochromatosis: decision analysis model comparing genotyping to phenotyping. *American Journal of Gastroenterology* 94: 1593-1600.
- Lowensteyn I, Coupal L, Zowall H, and Grover SA (2000) The cost-effectiveness of exercise training for the primary and secondary prevention of cardiovascular disease. *Journal of Cardiopulmonary Rehabilitation* 20: 147-155.
- Rampton J, Leach T, Therrien SA, Bota GW, and Rowe BH (1997) Head, neck, and facial injuries in ice hockey: the effect of protective equipment. *Clinical Journal of Sport Medicine* 7: 162-167.

Health Protection

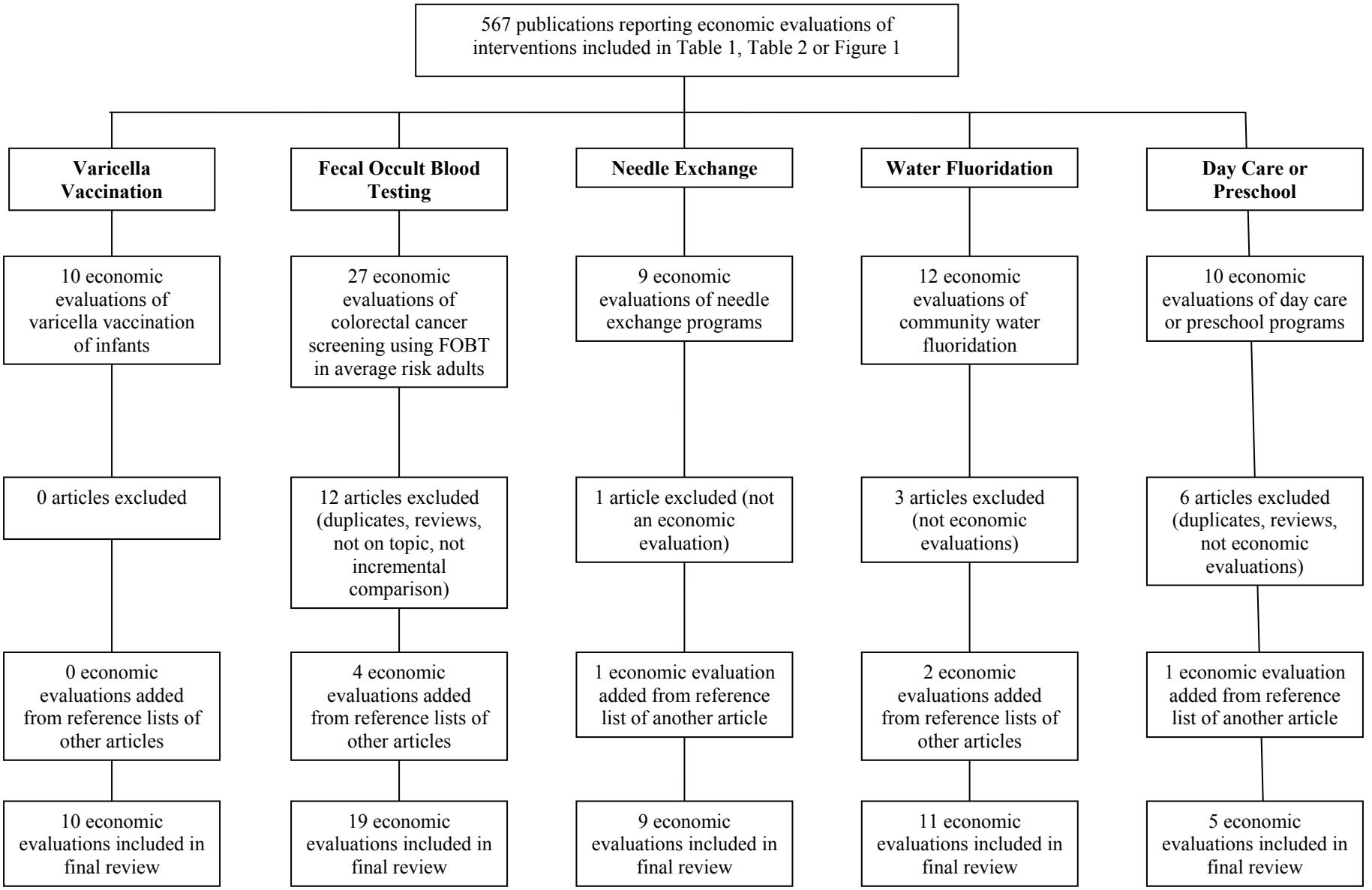
- Yassi A, Mcgill ML, and Khokhar JB (1995) Efficacy and cost-effectiveness of a needleless intravenous access system. *American Journal of Infection Control* 23: 57-64.

Figure 2: Literature Search



*138 publications reported economic evaluations of interventions that were on both the recommended clinical prevention list (Table 1) and the recommended health promotion, protection and healthy public policy list (Table 2) (e.g., community water fluoridation, universal vaccination programs).

Figure 3: Review of Economic Evaluations for Five Preventive Interventions



Appendix A: Experts Consulted For Topics to Include on the Recommended Health Promotion, Health Protection and Healthy Public Policy Interventions List

Lisa Ashley, Public Health and Long-Term Care Branch, City of Ottawa

Halina Cyr, Assistant Director, Office of Demand Reduction, Drug Strategy and Controlled Substances Programme, Health Environments and Consumer Safety Branch, Health Canada

Maureen Dobbins, Assistant Professor, School of Nursing, McMaster University

Philippa Holowaty, Senior Epidemiologist, Social & Public Health Services Department, City of Hamilton, and Assistant Professor, Department of Clinical Epidemiology and Biostatistics, McMaster University

Suzanne Jackson, Coordinator, Canadian Consortium for Health Promotion Research, and Director, Centre for Health Promotion, University of Toronto

Heather McColm, Health Resources Centre, Canadian Public Health Association

Sandra Micucci, Project Coordinator, Effective Public Health Practice Project, Public Health Research, Education and Development Program, City of Hamilton

Blaize Mumford, Policy Analyst, Policy Development Unit, HIV/AIDS Policy, Coordination and Programs Division, Centre for Infectious Disease Prevention and Control, Population and Public Health Branch, Health Canada

Barb Powell, Public Health and Community Services, City of Hamilton

Dennis Raphael, Associate Professor, School of Health Policy and Management, York University

Harry Shannon, Director, Program in Occupational Health and Environmental Medicine, and Professor, Department of Clinical Epidemiology and Biostatistics, McMaster University

Alan Shiell, Professor, Department of Community Health Sciences and the Centre for Health and Policy Studies, University of Calgary