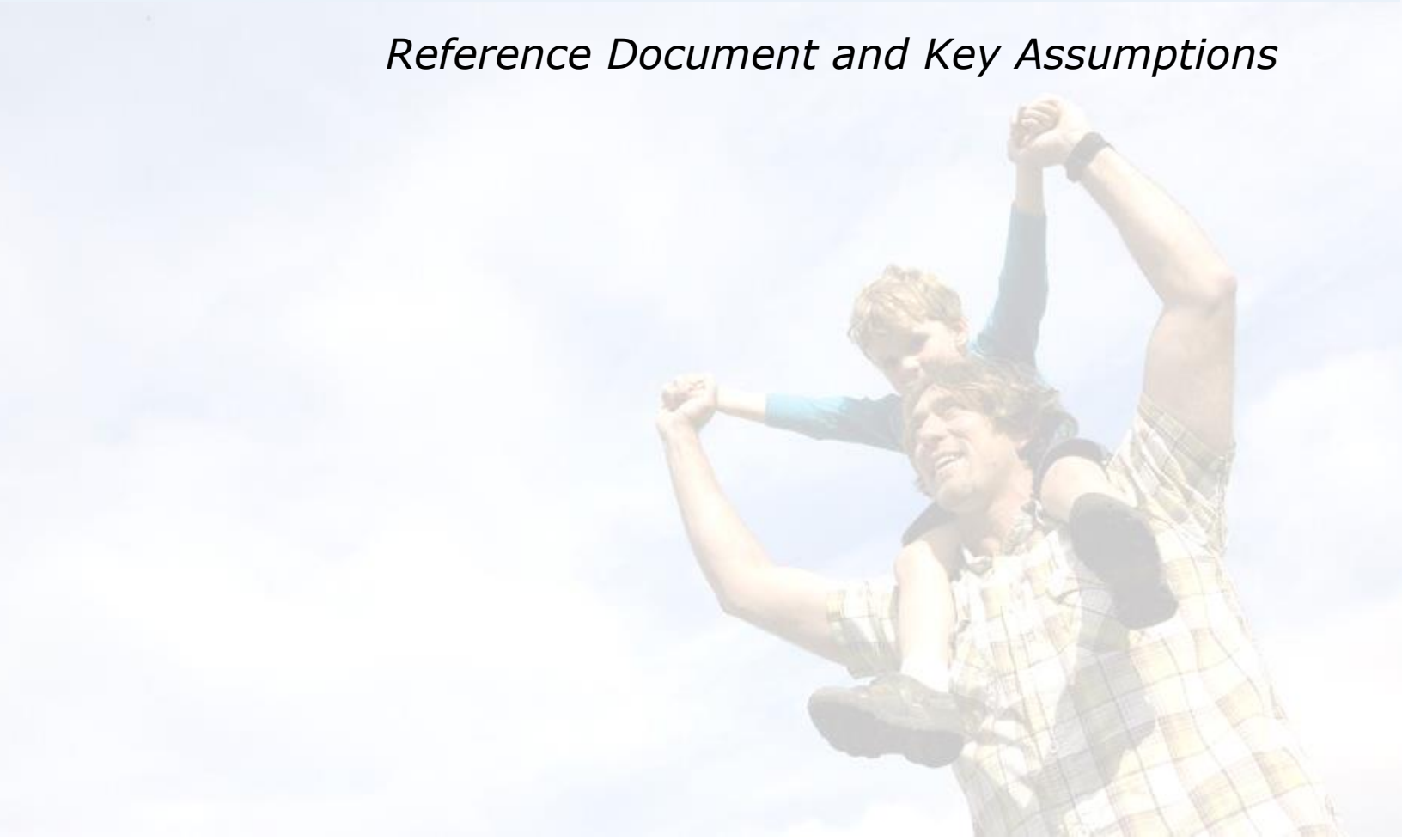
# Establishing Priorities among Effective Clinical Prevention Services in British Columbia

*Reference Document and Key Assumptions*



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## Acknowledgments

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# Establishing Priorities among Effective Clinical Prevention Services in British Columbia: *Reference Document and Key Assumptions*

## Introduction

The report, *A Lifetime of Prevention*, was published by the Clinical Prevention Policy Review Committee (CPPRC) in December of 2009.[1] A key goal of the CPPRC was to determine which clinical prevention services are worth doing in British Columbia (BC), culminating in a proposed Lifetime Prevention Schedule (LPS). Clinical prevention services were included on the LPS if they were considered to be effective, had a significant positive impact on population health and were cost-effective.

Clinical prevention services (CPS) are defined as:

> *Manoeuvres pertaining to primary and early secondary prevention (i.e., immunization, screening, counselling and preventive medication/device) offered to the general population (asymptomatic) based on age, sex and risk factors for disease and delivered on a one-provider-to-one-client basis, with two qualifications:*
>
> > *(i) the provider could work as a member of a care team or as part of a system tasked with providing, for instance, a screening service; and*
> >
> > *(ii) the client could belong to a small group (e.g. a family, a group of smokers) that is jointly benefiting from the service.*

This definition does not refer to the type of provider or the type of funding. This allows for the evaluation of the appropriate implementation of the service as a separate program planning matter.

Since 2009, a total of 29 CPS have been reviewed by the Lifetime Prevention Schedule Expert Committee (LPSEC) for potential inclusion in the LPS.

***For the current iteration of this project, the LPSEC requested that all 29 models be brought up to date using 2017 data (or the most recently available data) and that all modelling assumptions be consistently applied in each of the individual models.***

The **first step** in this process is the current document (*Reference Document and Key Assumptions*), in which all key model assumptions are recorded in one location. The **second step** will be to review and revise the models that calculate the clinically preventable burden (CPB) and cost-effectiveness (CE) for each of the 29 CPS. The second step will culminate in an updated technical document. Note also that the technical document will incorporate the results of an assessment of the CPB and CE associated with universal screening of newborns

[1] Clinical Prevention Policy Review Committee. *A Lifetime of Prevention: A Report of the Clinical Prevention Policy Review Committee*. 2009. Available at http://www.health.gov.bc.ca/library/publications/year/2009/CPPR_Lifetime_of_Prevention_Report.pdf. Accessed July 2017.

in BC for critical congenital heart defects, severe combined immune deficiency, biotinidase deficiency and carnitine uptake disorder.

This document is divided into the following sections:

- A brief **overview of the process** for reviewing CPS to determine whether or not the LPSEC will recommend the inclusion or exclusion of the CPS on the lifetime prevention schedule.
- An overview of the **key assumptions** made throughout the project.
- A **reference section** in which **specific assumptions** are considered in more detail and the impact of individual disease states in terms of their impact on life expectancy, quality of life and costs are identified and described. The reference section, for example, includes information on CPS intervention rates, how costs are converted into 2017 Canadian dollars, how a disease state affects an individual's (and their caregiver's) quality of life (QoL) and how to calculate this in the models, and the ongoing costs of care for disease state survivors.

## An Overview of the Process

The process for evaluating clinical prevention services in British Columbia is carried out in four sequential steps and includes addressing the following four questions.

### STEP 1 – Is the Service Effective?

To answer this question we depend on thorough reviews completed by other respected agencies, primarily the work by the Canadian Task Force on Preventive Health Care and the US Preventive Services Task Force.

If these agencies find that the prevention service works (i.e. effectively achieves what it is intended to achieve), then we move on to STEP 2. For example, both the Canadian Task Force on Preventive Health Care and the US Preventive Services Task Force recommend universal screening for colorectal cancer between the ages of 50 and 74.[2,3]

In British Columbia, there are approximately 3,400 new colorectal cancer cases[4] and 1,230 deaths from colorectal cancer each year.[5] Research by the Canadian Task Force on Preventive Health Care, applied to the British Columbia population, indicates that screening for colorectal cancer between the ages of 50 and 74 would result in a 22% reduction in mortality from colorectal cancer and an 18% reduction in the incidence of late stage colorectal cancer.[6]

### STEP 2 – What is the Impact on the British Columbia Population of Implementing the Service?

To answer this we calculate what we call the clinically preventable burden associated with implementing the service. The clinically preventable burden is defined as the total quality-adjusted life years that could be gained if the clinical preventive service were delivered at recommended intervals to a British Columbia birth cohort of 40,000 individuals over the years of life that a service is recommended.

When calculating the clinically preventable burden, two key drivers are considered. First, how much of the population does the service impact? If it only impacts a small proportion of the population, the clinically preventable burden would be small. In the case of screening for colorectal cancer, the population impacted is everyone living in British Columbia between the ages of 50-74. Furthermore, colorectal cancer is a fairly common cancer, with approximately 3,400 new cases identified annually in British Columbia.

Second, what is the effect size of the service? For example, if a service reduced the risk of death by 1%, its effect size would be 1/10th of a service that reduced the risk of death by 10%. As noted above, the effect size for screening for colorectal cancer is a 22% reduction in mortality from colorectal cancer and an 18% reduction in the incidence of late stage colorectal cancer. If the service impacts a larger proportion of the population but the effect is minimal, then the clinically preventable burden would also be small.

The services with the highest clinically preventable burden are those that impact a large segment of the population and have a relatively large effect.

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[2] Canadian Task Force on Preventive Health Care. Recommendations on screening for colorectal cancer in primary care. *Canadian Medical Association Journal*. 2016; 188(5): 340-8.
[3] US Preventive Services Task Force. Screening for colorectal cancer: US Preventive Services Task Force recommendation statement. *Journal of the American Medical Association*. 2016; 315(23): 2,564-75.
[4] See http://www.bccancer.bc.ca/statistics-and-reports-site/Documents/sas94Incident_Cancer_Report_2014.pdf
[5] See http://www.bccancer.bc.ca/statistics-and-reports-site/Documents/sas93_Cancer_Mortality_Counts_2014.pdf
[6] Canadian Task Force on Preventive Health Care. Recommendations on screening for colorectal cancer in primary care. *Canadian Medical Association Journal*. 2016; 188(5): 340-8.

In calculating the clinically preventable burden, we try and compare what is currently happening in British Columbia with other regions of the world for the service under consideration. We find a region that has done the best possible job of implementing the service and compare this "best-in-the-world" result to the current provision of this service in British Columbia. This gives a sense of how much service improvement is possible (i.e. the gap between the current British Columbia service and "best-in-the-world"). For example, current screening rates for colorectal cancer between the ages of 50 and 74 in British Columbia approximate 50%.[7] Screening in the US state of Massachusetts, however, has achieved rates of 76%.[8]

The clinically preventable burden is calculated using a measure called a quality-adjusted life year. In calculating clinically preventable burden both benefits and harms associated with the service are taken into account. Note that not all services have identified harms associated with them.

If we are able to achieve colorectal cancer screening rates of 76% in a British Columbia birth cohort of 40,000, then our calculations suggest that we could add 1,734 quality-adjusted life years or a clinically preventable burden of 1,734.

### STEP 3 – Is the Service Cost-Effective?

To answer this we calculate the cost per quality-adjusted life year added associated with implementing the service. The first part of this process, namely the calculation of the clinically preventable burden as the net gain in quality-adjusted life years, has been calculated during STEP 2. In STEP 3, we focus on estimating the costs associated with implementing the service, including the costs associated with screening and any interventions needed.

When looking at time costs, we include the time costs of both clinicians and the individuals receiving the service. Placing a monetary value on patient time costs is important as we are asking otherwise healthy individuals to engage with the health care system even though, in the long term, they may not be the ones who benefit.

In estimating the overall cost of the service, we take into account both costs resulting from the service as well as costs that might be avoided as a result of the service. For example, the costs associated with screening for colorectal cancer in a BC Birth cohort of 40,000 are estimated at $81.8 million. Since screening for colorectal cancer reduces mortality due to colorectal cancer, we would also expect fewer early deaths from colorectal cancer and the costs of $5.1 million associated with caring for these individuals during the process of dying from colorectal cancer would not be incurred. The net costs would therefore be $76.7 million ($81.8 million – $5.1 million).

At the end of STEP 3, we calculate the cost per quality-adjusted life year. In our example this means dividing the $76.7 million in net costs by the 1,734 quality-adjusted life years for a cost per quality-adjusted life year of $44,213.

We refer to this cost per quality-adjusted life year as the cost-effectiveness of providing the service. More specifically, cost-effectiveness is defined as the average net cost per quality-adjusted life year gained in typical practice by offering the clinical preventive service at recommended intervals to a British Columbia birth cohort over the recommended age range.

[7] Singh H, Bernstein C, Samadder J et al. Screening rates for colorectal cancer in Canada: a cross-sectional study. *Canadian Medical Association Journal Open*. 2015; 3(2): E149-57.
[8] National Cancer Institute. *Screening and Risk Factors Table*. 2017. Available at https://statecancerprofiles.cancer.gov/risk/index.php. Accessed August 2017.

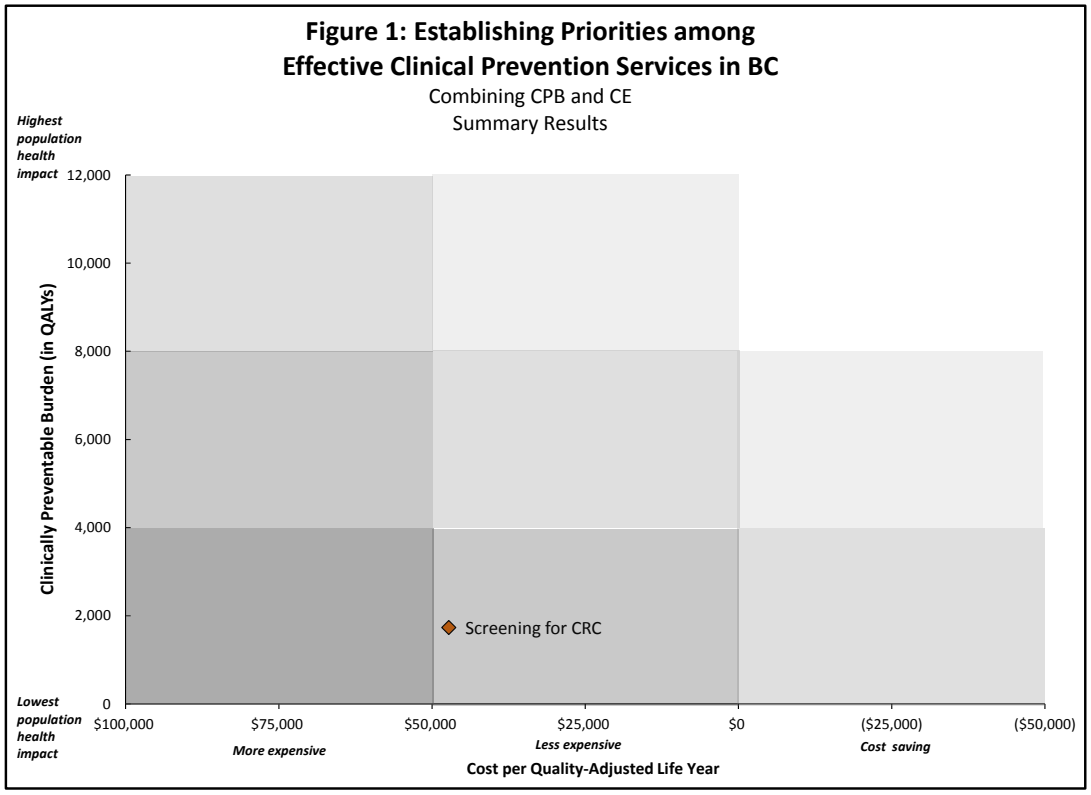
## STEP 4 – How Does the Service Compare with Other Effective Services?

In the final step we compare all the services that have gone through STEPS 1-3. By this stage we have calculated a unique clinically preventable burden value and cost-effectiveness ratio for each service. The clinically preventable burden and cost-effectiveness for each service is used to locate that service on the grid in Figure 1 below. Services that fall within the upper right hand segment have the highest population health impact (based on their clinically preventable burden) and are cost-saving. Services that fall within the lower left hand segment have the lowest population health impact and are relatively expensive to implement.

Screening for colorectal cancer between the ages of 50 and 74 in a British Columbia birth cohort of 40,000 results in an estimated clinically preventable burden of 1,734 and a cost-effectiveness of $44,213. This places the service in the lower row with respect to clinically preventable burden and the middle column with respect to cost-effectiveness (see Figure 1).

**Figure 1: Establishing Priorities among Effective Clinical Prevention Services in BC**

Combining CPB and CE
Summary Results




The results generated through this process are a key step in determining which current clinical prevention services in British Columbia require a concerted focus and which new clinical prevention services should be implemented. These results, however, should not be used in isolation. Any changes to service provision should be undertaken only when this research is supplemented by additional analyses, including a business plan and budget impact analysis. These supplementary analyses are important in addressing additional questions required in decision-making, such as the feasibility and total costs of enhancing current services or implementing new services.


## Acknowledgement

The process for evaluating clinical prevention services in British Columbia was initially based on the process developed by the HealthPartners Research Foundation in the United

States.[9,10] In 2008 the HealthPartners Research Foundation provided the Lifetime Prevention Schedule Expert Committee with a number of models assessing the clinically preventable burden and cost-effectiveness of various clinical prevention services in the US. The Lifetime Prevention Schedule Expert Committee updated these models using British Columbia-specific data. The process in both British Columbia and the US has since evolved. All British Columbia models, for example, are now 'homegrown'. In the US, the renamed HealthPartners Institute continues to assess clinical prevention services using more sophisticated modelling approaches.[11] They are also one of a number of groups in the US providing modelling support to the United States Preventive Services Task Force in assessing the effectiveness of various clinical prevention services.[12,13]

## Key Assumptions

The following key assumptions have been made throughout this project.

[9] Coffield A, Maciosek M, McGinnis J et al. Priorities among recommended clinical preventive services. *American Journal of Preventive Medicine*. 2001; 21(1): 1-9.
[10] Maciosek M, Coffield A, Edwards N et al. Priorities among effective clinical preventive services: results of a systematic review and analysis. *American Journal of Preventive Medicine*. 2006; 31(1): 52-61.
[11] Maciosek M, LaFrance A, Dehmer S et al. Updated priorities among effective clinical preventive services. *The Annals of Family Medicine*. 2017; 15(1): 14-22.
[12] Owens D, Whitlock E, Henderson J et al. Use of decision models in the development of evidence-based clinical preventive services recommendations: methods of the US Preventive Services Task Force. *Annals of Internal Medicine*. 2016; 165(7): 501-8.
[13] Dehmer S, Maciosek M, Flottemesch T et al. Aspirin for the primary prevention of cardiovascular disease and colorectal cancer: a decision analysis for the US Preventive Services Task Force. *Annals of Internal Medicine*. 2016; 164(12): 777-86.

### Duplication of Effort

In order to prevent duplicate evidence reviews, the Lifetime Prevention Schedule Expert Advisory Committee decided to refer any recommendations regarding immunizations to the Immunization Programs and Vaccine Preventable Diseases Service of the British Columbia Centre for Disease Control[14] and any recommendations regarding prenatal care, intrapartum care and immediate postpartum care (up to 8 weeks) to the Perinatal Services BC (PSBC) guidelines.[15] Note, however, that universal screening of newborns in BC for critical congenital heart defects, severe combined immune deficiency, biotinidase deficiency and carnitine uptake disorder has been assessed using the LPS methodology and these results will be included in the updated technical document.

### Delivery Mechanism(s)

The definition of clinical prevention is independent of delivery mechanism(s) or provider type(s). Determining which delivery mechanism or provider type would be most suitable for each service will be assessed in subsequent phases of the policy cycle where decisions will be made on whether and, if so, how to implement. Further evidence reviews may be undertaken during these phases as well as in operational planning.

For the purposes of this project, we have had to make assumptions about delivery mechanisms and provider type in order to estimate the costs of providing the service. Estimating costs is required in calculating cost-effectiveness. For consistency and comparability between the various preventive services, we chose to use a general physician's office as the delivery mechanism and provider type whenever appropriate. That is, if an established delivery mechanism is not in place, then we assumed, for costing purposes, that it would take place in a general physician's office. For example, no program currently exists in BC for screening and interventions to reduce falls in community-dwelling elderly, so we assumed this would take place in a general physician's office.

### Patient Costs

CPSs are offered to the asymptomatic general population. As such, people are being asked to give up some of their time for a service which has a (relatively small) chance of detecting a clinically relevant issue. Alternatively, they may be asked to give up some of their time for a behavioural counselling intervention that has a modest potential for success. As such, it is important to value this time and include it in the base case analysis in an assessment of the cost-effectiveness of the intervention. Increasingly, groups such the US Second Panel on Cost-effectiveness in Health and Medicine are recommending the inclusion of both patient and caregiver time and effects in economic evaluations (see below).

For the purposes of consistency and comparability, we have assessed this time by including travel time to and from the intervention as well as time during the intervention and then valued this total time based on average wage rates for the BC population. In the sensitivity analysis for each service, we have excluded patient costs so that the impact of these costs on the cost-effectiveness of the service can be more easily determined.

### Spillover Effects

Spillover effects occur when the illness of a child or family member has an economic or quality of life impact on the broader family or caregiver(s).

[14] See http://www.bccdc.ca/health-professionals/clinical-resources/communicable-disease-control-manual/immunization. Accessed September 2017.
[15] See http://www.perinatalservicesbc.ca/health-professionals/guidelines-standards. Accessed September 2017.

Few of the economic evaluation guidelines emanating from international health technology assessment agencies specifically mention spillover effects. They do, however, make broader recommendations of which costs and effects to include, often depending on the perspective of the analysis.

The Canadian Agency for Drugs and Technologies in Health (CADTH) *Guidelines for the Economic Evaluation of Health Technologies*[16] document, for example, recommends that the reference case take the perspective of the public health care payer with a more limited inclusion of costs and effects. If the perspective is a societal one, however, then "the impact of the intervention on time lost from paid and unpaid work by both patients and informal caregivers as a result of illness, treatment, disability or premature death should be included in an additional non-reference case analysis" (pg. 21). These guidelines do mention spillover effects, but only tangentially. They note that there "may be health states for which the estimation of utilities is particularly challenging, due to both limited data and the lack of consensus on methods (e.g., health states for individuals with disabilities, states affecting vulnerable populations, temporary health states, states with spillover effects on informal caregiving). Given the dearth of information with which to estimate utilities for such health states, the analysis of uncertainty will be especially important" (pg. 47).

The UK National Institute for Health and Care Excellence (NICE) *Guide to the Methods of Technology Appraisal*[17] is silent on the specific issue of spillover effects but does note that "the perspective on outcomes should be (the inclusion of) all direct health effects, whether for patients or other people" (pg. 34).

The recommendations from the US Second Panel on Cost-effectiveness in Health and Medicine[18] indicate that "all cost-effectiveness analyses should report 2 reference case analyses: one based on the health care sector and another based on the societal perspective" (p.1093). Furthermore, the analysis conducted from the societal perspective should consider "all parties affected by the intervention and (count) all significant outcomes and costs that flow from it, regardless of who experiences the outcomes or bears the costs" (p. 1095). The detailed recommendations from the US Second Panel indicate that "(i)f spillover effects on family/caregivers are likely to represent an important category of health outcomes associated with an intervention that averted or reduced the severity of an illness of a family member, an attempt should be made to value these effects and incorporate them into the CEA. Further, these spillover effects should be included in reference case analyses for both the health care sector and societal perspectives" (p. 188).[19] A reference case is "a set of standard methodological practices that all cost-effectiveness analyses should follow to improve comparability and quality."[20]

[16] Canadian Agency for Drugs and Technologies in Health Methods and Guidelines. *Guidelines for the Economic Evaluation of Health Technologies: Canada*. 2017. Available at https://www.cadth.ca/guidelines-economic-evaluation-health-technologies-canada-4th-edition. Accessed June 2017.

[17] National Institute for Health and Care Excellence. *Guide to the methods of technology appraisal 2013*. 2013. Available at https://www.nice.org.uk/process/pmg9. Accessed August 2017.

[18] Sanders G, Neumann P, Basu A. et al. Recommendations for conduct, methodological practices, and reporting of cost-effectiveness analyses: second panel on cost-effectiveness in health and medicine. *Journal of the American Medical Association*. 2016; 316(10): 1093-103.

[19] Neumann PJ, Sanders GD, Russell LB, et al, editors. *Cost-Effectiveness in Health and Medicine.* 2nd ed. New York: Oxford University Press; 2017.

[20] Sanders G, Neumann P, Basu A. et al. Recommendations for conduct, methodological practices, and reporting of cost-effectiveness analyses: second panel on cost-effectiveness in health and medicine. *Journal of the American Medical Association*. 2016; 316(10): 1093-103.

As noted earlier, one of the key assumptions is that patient costs should be part of the reference case and that the more narrow perspective of the health care system (*excluding* these patient costs) be included in a secondary sensitivity analysis. This same assumption should apply to spillover effects. The nascent nature of research on spillover effects, however, precludes their inclusion in the current analysis.

In making this assumption, the committee recognizes that while there is a large academic literature acknowledging the existence of spillover effects, there is a much smaller literature on how to measure such effects, and even less literature actually measuring the effects.[21,22,23,24,25,26,27,28,29]

The one exception in the current modelling is the inclusion of parental time costs associated with caring for a child with spina bifida in the sensitivity analysis of the *Folic Acid Supplementation in Reproductive-age Women for the Prevention of Neural Tube Defects* model.

### Broader Societal Costs

In general, the reference case includes known costs to the health care system and the patient. It has been argued that broader societal costs outside of the healthcare system, such as those in education or social services, should also be taken into account to detect possible cost shifting between sectors.[30] These broader costs have been taken into account in two models in which they are readily known and have a significant impact on the modelling. In addition to the inclusion of parental time costs associated with caring for a child with spina bifida in the sensitivity analysis of the *Folic Acid Supplementation in Reproductive-age Women for the Prevention of Neural Tube Defects* model, we also included special education and developmental service costs. For the *Alcohol Misuse Screening and Brief Intervention* model we included costs associated with law enforcement, fire and traffic accident damage and so on. These costs are estimated to be higher than the direct medical care costs.[31]

### Discounting

In the economic appraisal of health programs or interventions, costs and benefits that are spread over time are usually weighted according to when they are experienced. The further in

[21] Basu A and Meltzer D. Implications of spillover effects within the family for medical cost-effectiveness analysis. *Journal of Health Economics*. 2005; 24(4): 751-3.
[22] Wittenberg E, Ritter G and Prosser L. Evidence of spillover of illness among household members: EQ-5D scores from a US sample. *Medical Decision Making*. 2013; 33(2): 235-43.
[23] Wittenberg E, Saada A and Prosser L. How illness affects family members: a qualitative interview survey. *The Patient-Centered Outcomes Research*. 2013; 6(4): 257-68.
[24] Lavelle T, Wittenberg E, Lamarand K et al. Variation in the spillover effects of illness on parents, spouses, and children of the chronically ill. *Applied Health Economics and Health Policy*. 2014; 12(2): 117-24.
[25] Tilford J and Payakachat N. Progress in measuring family spillover effects for economic evaluations. *Expert Review of Pharmacoeconomics & Outcomes Research*. 2015; 15(2): 195-8.
[26] Al-Janabi H, Van Exel J, Brouwer W et al. Measuring health spillovers for economic evaluation: a case study in meningitis. *Health Economics*. 2016; 25(12): 1529-44.
[27] Prosser L, Lamarand K, Gebremariam A and Wittenberg E. Measuring family HRQoL spillover effects using direct health utility assessment. *Medical Decision Making*. 2015; 35: 81-93.
[28] Wittenberg E and Prosser L. Health as a family affair. *New England Journal of Medicine*. 2016; 374(19): 1804-6.
[29] Wittenberg E and Prosser L. Disutility of illness for caregivers and families: a systematic review of the literature. *Pharmacoeconomics*. 2013; 31(6): 489-500.
[30] Byford S and Raftery J. Perspectives in economic evaluation. *British Medical Journal*. 1998; 316(7143): 1529-30.
[31] Rehm J, Gnam W, Popova S et al. The costs of alcohol, illegal drugs, and tobacco in Canada, 2002. *Journal of Studies on Alcohol and Drugs*. 2007; 68(6): 886-95.

the future, the less heavily they are weighted or the more they are discounted. This can be particularly challenging for interventions in which costs are current and benefits are further in the future (e.g. prevention). The impact of discounting is most noticeable for preventive services in children and youth, given that costs are generally current, whereas benefits and potential costs avoided may stretch over the lifetime of the individual.[32,33,34,35]

From a health economics perspective, the usual approach is to discount both costs and benefits when calculating cost-effectiveness. However, discounting may fail to reflect a value we as a society might hold for the future of our children. The Netherlands, for example, require that a discount rate of 1.5% be applied to benefits while a discount rate of 4% be applied to costs.[36] It would thus be important to explicitly understand the impact of discounting in the current project. To do so, we use a 1.5% discount rate in the base case with a 3% and a 0% discount rate in the sensitivity analysis. A 0% discount rate is equivalent to not discounting. A 1.5% discount rate for the base case is currently (as of July 2017) recommended by both CADTH in Canada[37] and NICE in the UK.[38]

### Incorporating Information on Current Coverage

A number of the preventive services assessed in this project have an established history in the province while others may only be provided in a limited, fairly random approach (as 'random acts of kind prevention'). With this in mind, we set out to assess CPB and CE from two perspectives. First, assuming that the service had no current coverage in the province (i.e. that the service had not yet been established in the province). Second, assessing the gap between current coverage in the province and what arguably could be considered the best possible coverage (based on information on "best-in-the-world" coverage for the service).

### Incorporating Key Recent Evidence

The USPSTF is currently attempting to update their evidence review and recommendations every five years. It is possible that seminal research has been published during the interval between updates and that this research may alter recommendations. To take this into account, we considered evidence reviews from other organizations (e.g. the Cochrane Collaboration and NICE in the UK) for any USPSTF or CTFPHC recommendations published more than four years ago.

### Focus on the Best Available Evidence for a Conservative Approach to Implementation

An important assumption of this project is to focus on the highest level of available evidence. Given the limited capacity in the health care system, it is better to take a conservative approach by focussing on a limited number of preventive interventions that are clearly proven to be effective, will have an important impact on the health of the entire population of BC and

[32] Parsonage M and Neuburger H. Discounting and health benefits. *Health Economics*. 1992; 1(1): 71-6.
[33] Brouwer WB, Niessen LW, Postma MJ et al. Need for differential discounting of costs and health effects in cost effectiveness analyses. *British Medical Journal*. 2005; 331(7514): 446-8.
[34] Claxton K, Sculpher M, Culyer A et al. Discounting and cost-effectiveness in NICE – stepping back to sort out a confusion. *Health Economics*. 2006; 15(1): 1-4.
[35] Gravelle H, Brouwer W, Niessen L et al. Discounting in economic evaluations: stepping forward towards optimal decision rules. *Health Economics*. 2007; 16(3): 307-17.
[36] Tan S, Bouwmans C, Rutten F et al. Update of the Dutch manual for costing in economic evaluations. *International Journal of Technology Assessment in Health Care*. 2012; 28(2): 152-8.
[37] Canadian Agency for Drugs and Technologies in Health Methods and Guidelines. *Guidelines for the Economic Evaluation of Health Technologies: Canada*. 2017. Available at https://www.cadth.ca/guidelines-economic-evaluation-health-technologies-canada-4th-edition. Accessed July 2017.
[38] NICE. *Methods for the Development of NICE Public Health Guidance (Third Edition)*. Available online at https://www.nice.org.uk/process/pmg4/chapter/incorporating-health-economics. Accessed July 2017.

are likely to be cost-effective. The focus should be on achieving potential coverage and an effective dose for a limited number of preventive services rather than incomplete coverage of a larger number of preventive services.

## Reference Section

### CPS Intervention Rate

This section of the report provides an overview of the 29 CPSs reviewed by the LPSEC to date. The section begins with a one-page summary including the name of the CPS, the relevant cohort and the frequency with which the service is to be provided. In addition, an estimated rate of coverage for the service in British Columbia and the best rate in the world is provided.

Following the summary is a brief section on each of the 29 CPSs. Each of these sections begins with a recommendation regarding the provision of the service. The recommendations are most frequently those of the USPSTF or the CTFPHC. In all cases, the source of the recommendation is identified in the footnotes. This is followed by a proposed approach to

measuring coverage. We have focused on clearly defining numerators and denominators so the calculation of rates can take place within any given population, as long as data to calculate both the numerator(s) and denominator(s) are available for the population of interest.

The last two subsections for each CPS provide available data and sources for the rate of coverage for that CPS in BC and the best rate in the world.

### Summary

## Potential Clinical Prevention Services in B.C.
### Summary of the Applicable Cohort, Service Frequency and Coverage

| Clinical Prevention Services | Cohort / Timing | Frequency / Intensity | Estimated Coverage B.C. | Estimated Coverage 'BiW'(1) |
|---|---|---|---|---|
| **Screening for Asymptomatic Disease or Risk Factors - Children** | | | | |
| Vision screening for amblyopia | Ages 3-5 | At least once | 93% | 93% |
| **Behavioural Counseling Interventions - Children/Youth (C/Y)** | | | | |
| Interventions to support breastfeeding | During pregnancy and after birth | Multiple sessions | Unknown | 46% |
| Screening for obesity and referral to comprehensive, intensive behavioral intervention to promote improvement in weight status | Ages 6-17 | Screening - At all appropriate primary care visits | Unknown | 13% |
| | | Management - At least one-time of >25 hours of contact over a 6 month period | >3% for C/Y with obesity | >3% for C/Y with obesity |
| Preventing tobacco use (school-aged children & youth) | Ages 6-17 | Annually | Unknown | 53% |
| **Preventive Medication / Devices - Children** | | | | |
| Fluoride varnish | On primary teeth at time of tooth eruption (ages 1-5) | Every six months | Unknown | 62% |
| Dental sealants | On permanent teeth at time of tooth eruption (ages 6-12) | 4 times (on 1st and 2nd bicuspids & molars) | Unknown | 59% |
| **Screening for Asymptomatic Disease or Risk Factors - Adults** | | | | |
| Screening for breast cancer | Ages 50-74 | Every 2 -3 years | 52% | 88% |
| Screening (cytology-based) for cervical cancer | Ages 25-69 | Every 3 years | 69% | 88% |
| ***Addition*** of HPV-based cervical cancer screening | Ages 30-65 | Every 5 years | 0% | 88% |
| Screening for colorectal cancer | Ages 50-74 | FOBT every 2 years or sigmoidoscopy every 10 years | 50% | 76% |
| Screening for lung cancer | Ages 55 - 74 with a 30 pack-year smoking history | Annually for 3 consecutive years | Unknown | 6%/60% |
| Screening for hypertension | Ages 18 and older | Screening - At least once every 2 years | Unknown | 79% |
| Screening for cardiovascular disease risk and treatment (with statins) | Ages 40 -74 | Screening - Once every 5 years | Unknown | 48% |
| | | Management - Ongoing | Unknown | 30% |
| Screening for type 2 diabetes mellitus (T2DM) | Ages 18 and older - risk assessment | Every 3-5 years | Unknown | 58% |
| | High risk for T2DM - blood glucose | Every 3-5 years | Unknown | 80% |
| | Very high risk for T2DM - blood glucose | Every year | Unknown | 80% |
| Screening for depression | Nonpregnant adults ages 18+ | At least once | Unknown | 12% |
| Screening for depression | Pregnant and postpartum women | At least once per birth by 8 weeks postnatally | Unknown | 39% |
| **Screening for Sexually Transmitted Infections and Blood Borne Pathogens - Adults** | | | | |
| Screening for human immunodeficiency virus | Ages 15 - 65 | Low risk - Once | 20% | 45% |
| | | Increased risk - Every 3-5 years | | 63% |
| | | Very high risk - Every year | | 83% |
| | | During all pregnancies | 96% | 97% |
| Screening for chlamydia and gonorrhea | Sexually active females 24 years of age or younger | When sexual history reveals new or persistent risk factors since the last negative test | Unknown | 55% |
| Screening for hepatitis C virus | Adults born between 1945 & 1965 | One-time | 33% | 48% |
| **Behavioural Counseling Interventions - Adults** | | | | |
| Prevention of sexually transmitted infections (STIs) | All sexually active adolescents and adults who are at increased risk for STIs | 30 min to ≥2 hours of intensive behavioral counseling | Unknown | 29% |
| Counselling and interventions to prevent tobacco use | Ages 18 and older | Up to 90 min of total counseling time, during multiple contacts | 19% | 51% |
| Alcohol misuse screening and brief counseling | Ages 18 and older | Screening - Annually to at least once (every 10 years) | Unknown | 35% |
| | | Counseling - Up to 120 min of total time, during multiple contacts | Unknown | 30% |
| Screening for and management of obesity | Ages 18 and older | Screening - Ongoing | Unknown | 73% |
| | | Management - At least one-time of 12-26 sessions in a year | Unknown | 33% |
| Preventing falls | Community–dwelling elderly ages 65+ | Screening for risk - Every year | Unknown | 18% |
| | | Exercise or physical therapy - At least 150 minutes of moderate intensity / week | Unknown | Unknown |
| | | Vitamin D supplementation - 800 IU / day for at least 12 months | Unknown | 61% |
| **Preventive Medication / Devices - Adults** | | | | |
| Routine aspirin use for the prevention of cardiovascular disease (CVD) and colorectal cancer | Age 50-69 with a 10% or greater 10-year CVD risk & at low risk of bleeding | Screening for CVD risk - At age 50-59 | Unknown | 33% |
| | | Screening for bleeding risk - At age 50-59 | Unknown | 33% |
| | | Management - Low-dose daily aspirin use for 10 years | Unknown | 24% |
| Folic acid supplementation for the prevention of neural tube defects | Reproductive-age females | 0.4 to 0.8 mg (400-800µg) of folic acid daily | Unknown | 34% |

*(1) 'BiW' = best in world; (2) CPB = clinically preventable burden; (3) CE = cost-effectiveness*

### Hearing Screening

In newborns before one month of age.[39] This recommendation is based on the 2008 USPSTF which has since been inactivated.

[39] US Preventive Services Task Force. Universal screening for hearing loss in newborns: US preventive services task force recommendation statement. *Pediatrics*. 2008; 122(1): 143-8.

The USPSTF website notes that "the U.S. Preventive Services Task Force (USPSTF) has decided not to review the evidence and update its recommendations for this topic. The previous evidence review and recommendation may contain information that is outdated."[40]

The procedure manual for the USPSTF indicates that a topic may be inactivated for one or more of the following reasons:

- "Topic is no longer relevant to clinical practice because of changes in technology, new understanding of disease etiology/natural history, or evolving natural history of the disease
- Topic is not relevant to primary care because the service is not implemented in a primary care setting or not referable by a primary care provider
- Topic has a low public health burden
- Topic is otherwise outside of the Task Force's scope"

If a topic is inactivated…the status on the task force web site continues to be listed as "active" for a minimum of 5 years from the date of the original recommendation, unless considerations arise beforehand to change the status. After this period, the status changes to "inactive."[41]

We were unable to find a specific reason for the inactive status of the 2008 USPSTF recommendations regarding screening for hearing loss in newborn infants.

An older CTFPHC review (then known as the Canadian Task Force on the Periodic Health Examination) found that "there is insufficient evidence to recommend the inclusion or exclusion of screening for hearing impairment among preschool children."[42] No review has been completed since 1989.

#### Measurement

Numerator for hearing screening - Number of newborns one month of age with a documented hearing screening test.

Denominator for hearing screening - Number of newborns one month of age.

#### In British Columbia

Data from the BC Early Hearing Program for 2013/14 indicates that 42,223 of the 43,429 (97.2%) babies born in BC completed screening.[43]

#### Best in the World

The 2012/13 results from the Newborn Hearing Screening Program in England indicate that 97.54% of newborns are screened by 4/5 weeks and 98.95% by three months in that country.[44]

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[40] US Preventive Services Task Force. *Hearing Loss in Newborns: Screening*. 2008. Available at https://www.uspreventiveservicestaskforce.org/BrowseRec/InactiveTopic/218. Accessed December 2016.
[41] US Preventive Services Task Force. *Procedure Manual*. December 2015. Available at https://www.uspreventiveservicestaskforce.org/Page/Name/methods-and-processes. Accessed March 2017.
[42] Canadian Task Force on the Periodic Health Examination. Periodic health examination, 1989 update: 3. preschool examination for developmental, visual and hearing problems. *Canadian Medical Association Journal*. 1989; 141: 1136-40.
[43] Ministry of Children and Family Development. *British Columbia's Early Years Annual Report 2013/2015*. 2015. Available at http://www2.gov.bc.ca/assets/gov/family-and-social-supports/child-care/bc_early_years_annual_report.pdf. Accessed December 2016.

For the purposes of this project, we have assumed that BC's current screening rate of 97% is essentially equivalent to the best in the world.

## Screening for Critical Congenital Heart Defects

In newborns between 24 and 36 hours after birth but before discharge from hospital.[45]

This recommendation is based on a joint review by the Canadian Cardiovascular Society and Canadian Pediatric Cardiology Association. The review does not include a systematic analysis of the effectiveness of pulse oximetry screening (POS) in avoiding deaths in infants due to late diagnosed critical congenital heart defects (CCHD). Neither the CTFPHC nor the USPSTF have assessed, or are currently assessing, the effectiveness of screening for CCHD in newborns.

### Measurement

Numerator for screening for CCHD - Number of newborns 36 hours of age with a documented pulse oximetry screening test for CCHD.

Denominator for screening for CCHD - Number of newborns 36 hours of age.

### In British Columbia

We were unable to find any data on the prevalence of newborn screening for CCHD in BC. The Perinatal Services BC (PSBC) Neonatal Transfer Record contains a section to be completed if a CCHD screen is completed.[46] An online article by Dr. Hadad in 2014 also noted that "Interior Health and Island Health have led the way with the establishment of regional programs".[47] Searches of the PSBC[48], Interior Health[49] and Island Health[50] websites found no additional information on newborn screening for CCHD.

### Best in the World

According to a 2016 review by Hom and colleagues, the countries of Sweden, Norway and Finland are close to screening 100% of births.[51]

For the purposes of this project, we have assumed a best in the world screening rate of 99% (allowing for a modest number of parental refusals).

## Screening for Severe Combined Immune Deficiency, Biotinidase Deficiency and Carnitine Uptake Disorder

Screening in newborns between 24 and 48 hours old, either in hospital or at home.[52]

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[44] Wood SA, Sutton GJ and Davis AC. Performance and characteristics of the newborn hearing screening programme in England: the first seven years. *International Journal of Audiology*. 2015; 54(6): 353-8.

[45] Wong K, Fournier A, Fruitman D et al. Canadian Cardiovascular Society/Canadian Pediatric Cardiology Association position statement on pulse oximetry screening in newborns to enhance detection of critical congenital heart disease. *Canadian Journal of Cardiology*. 2017; 33(2): 199-208.

[46] Perinatal Services BC. *A Guide for Completion of the British Columbia Neonatal Transfer Record (PSBC 1600)*. 2017. Available at http://www.perinatalservicesbc.ca/Documents/Form/Form1600_Neonatal TransferRecord_Guide.pdf. Accessed July 2017.

[47] Hadad K. *Routine neonatal oximetry screening for critical congenital heart defects in British Columbia: It's time!* 2014. Available at http://thischangedmypractice.com/neonatal-oximetry-screening/. Accessed July 2017.

[48] Perinatal Services BC. *Perinatal Services BC*. 2017. Available at http://www.perinatalservicesbc.ca/. Accessed July 2017.

[49] British Columbia. *Interior Health* 2017. Available at https://www.interiorhealth.ca/Pages/default.aspx. Accessed July 2017.

[50] British Columbia. *Island Health*. 2017. Available at http://www.viha.ca/. Accessed July 2017.

[51] Hom L, Martin G and Oster M. An Update on Critical Congenital Heart Disease Screening Using Pulse Oximetry. *Current Pediatrics Reports*. 2016; 4(2): 18-27.

#### Measurement

Numerator for screening for SCID - Number of newborns 48 hours of age with a documented screening test for severe combined immune deficiency (SCID)

Numerator for screening for BD - Number of newborns 48 hours of age with a documented screening test for biotinidase deficiency (BD)

Numerator for screening for CUD - Number of newborns 48 hours of age with a documented screening test for carnitine uptake disorder (CUD).

Denominator for screening for SCID, BD and CUD - Number of newborns 48 hours of age.

#### In British Columbia

Universal screening for SCID, BD and CUD is not currently offered in British Columbia.[53] The uptake of universal screening for the 22 disorders currently part of the BC Newborn Screening Program is 99.9%.[54]

#### Best in the World

Universal newborn screening for CUD is offered in Alberta, Manitoba, Ontario, Nova Scotia, New Brunswick and Prince Edward Island. Universal newborn screening for BD is offered in Alberta, Saskatchewan, Manitoba and Ontario while universal screening for SCID is offered in Ontario.[55] When universally offered, the uptake of newborn blood spot screening approaches 100%.

For the purposes of this project, we have assumed a best in the world screening rate of 99.9% (allowing for a modest number of parental refusals).

### Vision Screening

For all children at least once between the ages of 3 and 5 years, to detect the presence of amblyopia or its risk factors.[56]

#### Measurement

Numerator for vision screening - Number of 5-year-old children with a documented vision screening test between the ages of 3 and 5.

Denominator for vision screening - Number of 5-year-old children.

#### In British Columbia

An average of 92.7% of kindergarten children were screened between 2007/08 and 2009/10 through the BC Early Childhood Vision Screening Program.[57]

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[52] Perinatal Services BC. *Newborn Screening Program: For Families*. 2017. Available at http://www.perinatalservicesbc.ca/our-services/screening-programs/newborn-screening-program. Accessed July 2017.

[53] Ibid.

[54] Dr. Hilary Vallance, Director of the BC Newborn Screening Program and the Biochemical Genetics Laboratory within the Department of Pathology, BC Children's Hospital. Personal communication, April 2016.

[55] Canadian Organization for Rare Disorders. *Newborn Screening in Canada Status Report*. 2015. Available at https://www.raredisorders.ca/content/uploads/Canada-NBS-status-updated-Sept.-3-2015.pdf. Accessed March 2016.

[56] U.S. Preventive Services Task Force. Vision screening in children 6 months to 5 years: US Preventive Services Task Force Recommendation statement. *Journal of the American Medical Association*. 2017; 318(9): 836-44.

[57] Early Childhood Screening Research & Evaluation Unit. *BC Early Childhood Vision Screening Program - Final Evaluation Report*. 2012. University of British Columbia. Available at http://www2.gov.bc.ca/assets/gov/health/managing-your-health/women-children-maternal-health/bc-early-childhood-vision-screening-program.pdf. Accessed July 2017.

#### Best in the World

In South Korea, a large sample of families with children aged 3 to 5 were mailed a home vision screening test in 2001. Of the 36,973 children receiving the invitation to screen, 97.1% (35,894) completed and returned the test with 95.3% (35,226) completing the test correctly.[58]

For the purposes of this project, we have assumed that BC's current screening rate of 93% is essentially equivalent to the best in the world.

### Interventions to Support Breastfeeding

Provide interventions during pregnancy and after birth to support breastfeeding. Interventions include professional support, peer support and formal education. Most successful interventions include multiple sessions and are delivered at more than one point in time.[59,60]

#### Measurement

Numerator for interventions to support breastfeeding - Number of new mother-infant pairs receiving at least two interventions during pregnancy and after birth to support breastfeeding.

Denominator for interventions to support breastfeeding - Number of new mother-infant pairs.

#### In British Columbia

A review of breastfeeding practices and programs in BC notes that health authorities are to proactively support breastfeeding exclusively for a 6-month period and that "most regions have established policies and/or guidelines on breastfeeding."[61] Furthermore, public health staff contact new mothers, primarily by phone, within 24 to 48 hours of hospital discharge. Ongoing breastfeeding support is provided "by all health authorities to mothers during breastfeeding clinics, public health clinics, immunization clinics, by appointment with public health staff or through telephone support."[62]

#### Best in the World

In Sweden, all parents are invited to parental groups organized by the child health service. In 2012, 46% of parents attended (61% of first-time parents and 33% of parents with more than one child).[63] A further study in Sweden found that 49% of all mothers sought help and support related specifically to breastfeeding.[64]

For the purposes of this project, we have assumed that a 46% participation rate in a structured antepartum educational program and/or postpartum support to promote breastfeeding initiation and duration is the best rate in the developed world (based on evidence from Sweden in 2012).

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[58] Lim HT, Yu YS, Park SH et al. The Seoul Metropolitan Preschool Vision Screening Programme: results from South Korea. *British Journal of Ophthalmology*. 2004; 88(7): 929-33.

[59] Palda VA, Guise J-M and Wathen CN. Interventions to promote breastfeeding: applying the evidence in clinical practice. *Canadian Medical Association Journal*. 2004; 170(6): 976-8.

[60] Bibbins-Domingo K, Grossman D, Curry S et al. Primary care interventions to support breastfeeding: US preventive services task force recommendation statement. *Journal of American Medical Association*. 2016; 316(16): 1688-93.

[61] British Columbia Ministry of Health. *Review of Breastfeeding Practices and Programs: British Columbia and Pan-Canadian Jurisdictional Scan*. 2012. Available at http://www.health.gov.bc.ca/library/publications/year/2012/breastfeeding-jurisdictional-scan.pdf. Accessed July 2017.

[62] Ibid.

[63] Lefèvre Å, Lundqvist P, Drevenhorn E et al. Parents' experiences of parental groups in Swedish child health-care: do they get what they want? *Journal of Child Health Care*. 2016; 20(1): 46-54.

[64] Ellberg L, Lundman B, Persson MEK et al. Comparison of health care utilization of postnatal programs in Sweden. *Journal of Obstetric, Gynecologic, & Neonatal Nursing*. 2005; 34(1): 55-62.

## Screening For and Management of Obesity – Children/Youth

Screen children and adolescents ages 6 to 17 years for obesity at all appropriate primary care visits and offer or refer children/youth with obesity (and their primary caregiver) to a comprehensive, intensive (≥26 hours of contact over a period of 2 to 12 months) behavioral intervention to promote improvement in weight status.[65,66]

#### Measurement

Numerator #1 for *screening* for obesity in children/youth - Number of youth age 17 with a documented *annual* screen for obesity between the ages of 6 and 17 (full compliance with recommendation).

Numerator #2 for *screening* for obesity in children/youth (alternate) - Number of youth age 17 with *at least one* documented screen for obesity between the ages of 6 and 17 (partial compliance with recommendation).

Denominator for *screening* for obesity in children/youth - Number of youth age 17.

Numerator #1 for *management* of obesity in children/youth – Number of youth age 17 with documented obesity between the ages of 6 and 17 who have been *referred* to a comprehensive, intensive behavioral intervention to promote improvement in weight status.

Numerator #2 for *management* of obesity in children/youth - Number of youth age 17 with documented obesity between the ages of 6 and 17 who have *attended* a comprehensive, intensive behavioral intervention to promote improvement in weight status.

Numerator #3 for *management* of obesity in children/youth - Number of youth age 17 with documented obesity between the ages of 6 and 17 who have *completed* at least 70% of a comprehensive, intensive behavioral intervention to promote improvement in weight status.

Denominator for #1 to #3 for *management* of obesity in children/youth - Number of youth age 17 with documented obesity between the ages of 6 and 17.

#### In British Columbia

We are unable to find any information on the proportion of 6 to 17-year-olds that are screened for obesity in the province. Some screening (whether documented or not) clearly takes place as children are being referred to two weight management programs in the province.

Between April 2013 and June 2015, 625 children participated in MEND (Mind, Exercise, Nutrition, Do It!) BC with 12 active sites across the province. MEND is a community based program for children who are working with their families towards a healthy lifestyle and a healthy weight.[67] Criteria for program entry include (a) age 5-13 years, (b) BMI > 85$^{th}$ percentile for age and no contraindications for participating in physical activity and (c) parent or caregiver participation. Physicians may recommend MEND, but a referral is not required for program entry.

[65] Canadian Task Force on Preventive Health Care. Recommendations for growth monitoring, and prevention and management of overweight and obesity in children and youth in primary care. *Canadian Medical Association Journal*. 2015; 187(6): 411-21.

[66] US Preventive Services Task Force. Screening for obesity in children and adolescents: US Preventive Services Task Force Recommendation Statement. *Journal of American Medical Association*. 2017; 317(23): 2417-26.

[67] Bradbury J, Day M, & Scarr J. *British Columbia's Continuum for the Prevention, Management, and Treatment of Health Issues Related to Overweight and Obesity in Children and Youth*, BC: Childhood Obesity Foundation & Child Health BC: October 2015. Available online at http://childhoodobesityfoundation.ca/wp-content/uploads/2016/07/ChildhoodObesity_report_webMRsingle_fnl-1.pdf. Accessed July 2017.

Between January 2013 and June 2015, 1,071 children and their parents were referred to Shapedown BC and almost 300 completed the program.[68] Shapedown BC is a multidisciplinary, weight-management program that provides medical, nutritional and psychological support for children and youth who are working with their families to recognize and overcome challenges to active living and healthy eating.[69] Shapedown BC is a family-based, obesity-reduction initiative for children and adolescents. Criteria for program entry to Shapedown BC includes (a) physician referral, (b) age 6-17 years, (c) BMI > 97$^{th}$ percentile for age (according to growth chart) or BMI >85$^{th}$ percentile and co-morbidities or other complex medical or psychosocial profiles and (d) parent or caregiver participation.

In 2017, there are an estimated 578,600 children and youth ages 6-17 living in BC (see following table). The majority of these children and youth would be eligible for growth monitoring. Based on *measured height and weight* as calculated for the 2004 Canadian Community Health Survey (CCHS), 6.6% (37,913 of 578,600) of BC children and youth ages 6-17 are obese.[70] The 37,913 children and youth with obesity are most likely to be offered structured behavioural interventions aimed at healthy weight management. Based on the 1,071 children and their parents who were referred to Shapedown BC between January 2013 and June 2015, at least 2.8% (1,071 of 37,913) of children and youth with obesity in BC have been referred to a comprehensive, intensive behavioral intervention.

**Estimated Number of Children and Youth With Obesity In British Columbia**
By Sex and Age, 2017
Prevalence Based on 2004 CCHS Data

| | Male | Female | Total |
|---|---|---|---|
| **Population** | | | |
| 6 to 8 | 73,200 | 68,100 | 141,300 |
| 9 to 13 | 122,600 | 114,600 | 237,200 |
| 14 to 17 | 103,100 | 97,000 | 200,100 |
| **Total** | **298,900** | **279,700** | **578,600** |
| **Prevalence of Obesity** | | | |
| 6 to 8 | 2.2% | 13.6% | 7.7% |
| 9 to 13 | 6.1% | 4.7% | 5.4% |
| 14 to 17 | 10.1% | 3.8% | 7.1% |
| **Total** | **6.6%** | **6.5%** | **6.6%** |
| **# of Individuals with Obesity** | | | |
| 4 to 8 | 1,634 | 9,274 | 10,908 |
| 9 to 13 | 7,536 | 5,336 | 12,872 |
| 14 to 17 | 10,425 | 3,709 | 14,133 |
| **Total** | **19,595** | **18,319** | **37,913** |

**Best in the World**

Research evidence suggests that growth monitoring in children and youth is, at best, inconsistent in paediatric practice. Dorsey et al. found that BMI was documented in only 3 of 600 (0.5%) charts they reviewed. Of the 239 children/youth at risk of being overweight or

[68] HealthyFamiliesBC. *Provincial Management and Evaluation Report Cycles I-VII: January 2013 – June 2015*. September 2015.

[69] Bradbury J, Day M, & Scarr J. *British Columbia's Continuum for the Prevention, Management, and Treatment of Health Issues Related to Overweight and Obesity in Children and Youth*, BC: Childhood Obesity Foundation & Child Health BC: October 2015. Available online at http://childhoodobesityfoundation.ca/wp-content/uploads/2016/07/ChildhoodObesity_report_webMRsingle_fnl-1.pdf. Accessed July 2017.

[70] Statistics Canada. Canadian Community Health Survey (CCHS) - Nutrition, 2004 Public Use Microdata file (Catalogue number 82M0024GPE). 2004: All computations, use and interpretation of these data are entirely that of H. Krueger & Associates Inc.

obese, 41 (17%) had documented treatment recommendations, usually consisting of general advice regarding diet and exercise.[71]

Barlow and colleagues noted that only 6.1% of charts they reviewed contained a plot of BMI. They conclude, however, that "despite low BMI curve use, paediatricians recognized most overweight/obese children with a BMI at or above the 95$^{th}$ percentile. BMI plotting may increase recognition in mildly overweight children." [72]

Based on self-report, an estimated 11% of Community Paediatricians and 7% of Family Physicians across Canada routinely assess their paediatric patients for obesity. Furthermore, only 60% of Community Paediatricians and 30% of Family Physicians across Canada use recommended methods for identifying paediatric obesity.[73]

Based on a review of medical records in the US, only 5.5% of physicians documented BMI and 4.3% plotted BMI. Residents were more likely to document (13.0% vs 3.0%) and plot (9.0% vs 2.7%) BMI than attending physicians.[74]

For the purposes of this project, we have assumed that screening rates of 13% are equivalent to the best in the world (based on rates observed for US physician residents).

Estimating the best in the world rate for the proportion of children with obesity who have been referred to a comprehensive, intensive behavioral intervention is challenging. In the UK, MEND has been implemented on a national scale since 2007.[75] Between 2007 and 2010, 21,132 families were referred to MEND 7-13 in that country.[76] We were unable to find more recent estimates. In 2016, there were 5,328,000 children ages 7-13 in the UK[77] with a 19% rate of obesity[78] (or 1,012,320 7-13-year-olds with obesity). The 21,132 families thus represents approximately 2.1% of children with obesity in the UK.

For the purposes of this project, we have assumed that a referral rate of approximately 3% of children/youth with obesity to a comprehensive, intensive behavioral intervention (as observed in BC) is equivalent to the best rate in the world.

### Education or Brief Counseling to Prevent Initiation of Tobacco Use and to Treat Tobacco Smoking – Children / Youth

The CTFPHC recommends asking children and youth (age 5–18 years) or their parents about tobacco use by the child or youth and offering brief information and advice, as appropriate, during primary care visits to prevent tobacco smoking among children and youth and to treat

[71] Dorsey KB, Wells C, Krumholz HM et al. Diagnosis, evaluation, and treatment of childhood obesity in pediatric practice. *Archives of Pediatrics & Adolescent Medicine*. 2005; 159(7): 632-8.
[72] Barlow SE, Bobra SR, Elliott MB et al. Recognition of childhood overweight during health supervision visits: Does BMI help pediatricians? *Obesity*. 2007; 15(1): 225-32.
[73] He M, Piché L, Clarson CL et al. Childhood overweight and obesity management: a national perspective of primary health care providers' views, practices, perceived barriers and needs. *Paediatrics & Child Health*. 2010; 15(7): 419-26.
[74] Hillman JB, Corathers SD and Wilson SE. Pediatricians and screening for obesity with body mass index: does level of training matter? *Public Health Reports*. 2009; 124(4): 561-7.
[75] Aicken C, Roberts H and Arai L. Mapping service activity: the example of childhood obesity schemes in England. *BioMed Central Public Health*. 2010; 10(1): 310.
[76] Fagg J, Chadwick P, Cole T et al. From trial to population: a study of a family-based community intervention for childhood overweight implemented at scale. *International Journal of Obesity*. 2014; 38(10): 1343-49.
[77] Ibid.
[78] Arai L, Panca M, Morris S et al. Time, monetary and other costs of participation in family-based child weight management interventions: qualitative and systematic review evidence. *PloS ONE*. 2015; 10(4): 1-12.

tobacco smoking among children and youth. These are both weak recommendations based on low-quality evidence.[79]

The USPSTF also recommends that primary care clinicians provide interventions, including education or brief counseling, to prevent initiation of tobacco use in school-aged children and adolescents. This is a "B" recommendation.[80]

#### Measurement

Numerator #1 for education or brief counseling to prevent initiation of tobacco use in children / youth - Number of youth age 17 with a documented *annual* intervention to prevent initiation of tobacco use between the ages of 6 and 17 (full compliance with recommendation).

Numerator #2 for education or brief counseling to prevent initiation of tobacco use in children / youth (alternate) - Number of youth age 17 with *at least one* documented intervention to prevent initiation of tobacco use between the ages of 6 and 17 (partial compliance with recommendation).

Denominator for education or brief counseling to prevent initiation of tobacco use in children / youth - Number of youth age 17.

#### In British Columbia

We were unable to find any information about the utilization of primary care-based interventions aimed at reducing smoking initiation among non-smoking children and youth in British Columbia.

#### Best in the World

In the US, 71.5% of outpatient visits to office-based physicians by patients aged 11-17 years include screening for tobacco use.[81] Approximately 63% to 85% of adolescents in the US are seen for preventive care visits each year.[82,83,84]

For the purposes of this project, we have assumed that 74% (the midpoint of 63% and 85%) of children and youth see a primary care provider annually and that 71.5% of the visits include screening for tobacco use, for a best rate in the world of 53% (0.74 * 0.715) of children / youth receiving tobacco prevention advice.

### Application of Fluoride Varnish

Apply fluoride varnish once every six months to the primary teeth of all infants and children starting at the age of primary tooth eruption.[85,86]

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[79] Canadian Task Force on Preventive Health Care. Recommendations on behavioural interventions for the prevention and treatment of cigarette smoking among school-aged children and youth. *Canadian Medical Association Journal*. 2017;189 (8): E310-16.

[80] Moyer VA. Primary care interventions to prevent tobacco use in children and adolescents: U.S. Preventive Services Task Force recommendation statement. *Annals of Internal Medicine*. 2013; 159(8): 552-7.

[81] Jamal A, Dube S, Babb S et al. Tobacco use screening and cessation assistance during physician office visits among persons aged 11–21 years—National Ambulatory Medical Care Survey, United States, 2004–2010. *Morbidity and Mortality Weekly Report*. 2014; 63(2): 71-9.

[82] Hedberg V, Byrd R, Klein J et al. The role of community health centers in providing preventive care to adolescents. *Archives of Pediatrics & Adolescent Medicine*. 1996; 150(6): 603-8.

[83] Klein J, Wilson K, McNulty M et al. Access to medical care for adolescents: results from the 1997 Commonwealth Fund Survey of the Health of Adolescent Girls. *Journal of Adolescent Health*. 1999; 25(2): 120-30.

[84] Igra V and Millstein S. Current status and approaches to improving preventive services for adolescents. *Journal of American Medical Association*. 1993; 269(11): 1408-12.

[85] Moyer VA. Prevention of dental caries in children from birth through age 5 years: US Preventive Services Task Force recommendation statement. *Pediatrics*. 2014; 133(5): 1-10.

#### Measurement

Numerator #1 for the application of fluoride varnish - Number of children age 5 with a documented fluoride varnish application *every six months* between the ages of 1 and 5 (full compliance with recommendation).

Numerator #2 for the application of fluoride varnish (alternate) - Number of children age 5 with a documented fluoride varnish application *at least once* between the ages of 1 and 5 (partial compliance with recommendation).

Denominator for the application of fluoride varnish - Number of children age 5.

#### In British Columbia

We were unable to find any information on the prevalence of the application of fluoride varnish in infants and children in BC.

#### Best in the World

In a school-based program of 589 children ages 3 to 7 from deprived neighbourhoods in the UK, 82.7% (487) consented to three fluoride applications over the period of a year while 61.6% (363) received all three applications. The greatest number of refusals was from younger children.[87]

A school-based oral health program targeting 3 to 6-year-old children in East London, UK, found that 21% of eligible children received two fluoride applications in year 1 of the program. This increased to 29% in year 2 and 53% in year 3.[88]

For the purposes of this project, we have assumed that the best rate in the world for fluoride application in children ages 1 to 5 is 62%, the rate achieved by a pilot project in the UK.[89]

### Application of Dental Sealants

Professionally-applied fissure sealants for selective use on permanent molar teeth soon after their eruption.[90,91,92]

#### Measurement

Numerator #1 for the application of dental sealants - Number of children age 12 with *four* documented fissure sealant applications (on 1st and 2nd bicuspids and molars) between the ages of 6 and 12 (full compliance with recommendation).

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[86] Fluoride Recommendations Work Group. Recommendations for using fluoride to prevent and control dental caries in the United States. *Morbidity and Mortality Weekly Report Recommendations and Reports*. 2001; 50 (RR-14): 1-42.

[87] Buckingham S and John J. Recruitment and participation in preschool and school-based fluoride varnish pilots–the South Central experience. *British Dental Journal*. 2013; 215(E8): 1-4.

[88] Evans P, Pearson N and Simons D. A school-based oral health intervention in East London: the Happy Teeth fluoride varnish programme. *British Dental Journal*. 2013; 215(E14): 1-5.

[89] Buckingham S and John J. Recruitment and participation in preschool and school-based fluoride varnish pilots–the South Central experience. *British Dental Journal*. 2013; 215(E8): 1-4.

[90] Lewis DW and Ismail AI. *Canadian Guide to Clinical Preventive Health Care: Chapter 36: Prevention of Dental Caries*. 1994. Available at http://canadiantaskforce.ca/wp-content/uploads/2013/03/Chapter36_dental_caries94.pdf. Accessed September 2017.

[91] Cochrane Oral Health Group. *Pit and fissure sealants for preventing dental decay in permanent teeth*. The Cochrane Library. July 31, 2017. Available online at http://www.cochrane.org/CD001830/ORAL_sealants-preventing-tooth-decay-permanent-teeth. Accessed September 2017.

[92] Canadian Agency for Drugs and Technologies in Health. *Dental Sealants and Preventive Resins for Caries Prevention: A Review of the Clinical Effectiveness, Cost-effectiveness and Guidelines.* October 31, 2016. Available online at https://www.cadth.ca/sites/default/files/pdf/htis/2016/RC0816%20Dental%20Sealants%20Final.pdf. Accessed September 2017.

Numerator #2 for the application of dental sealants (alternate) - Number of children age 12 with *at least one* documented fissure sealant application between the ages of 6 and 12 (partial compliance with recommendation).

Denominator for the application of dental sealants - Number of children age 12.

#### In British Columbia

In 2012/13, 91.8% of BC kindergarten children were screened for dental health. Of these, 67.3% were caries free, 18.1% had treated caries and 14.6% had visible decay in one or more teeth. 12.9% were referred for non-urgent treatment and 2.1% for urgent treatment.[93] Despite a decline in the prevalence of visible tooth decay from 17.3% in 2006/07 to 14.6% in 2012/13, we were unable to find any information on the prevalence of dental sealant use in BC.[94]

#### Best in the World

In the US, the prevalence of dental sealant use in 2011/12 was 43.1% among youth aged 12 to 19, ranging from 30.0% among the non-Hispanic black population to 46.7% among the non-Hispanic white population.[95]

A study in Portugal based on a sample of 447 adolescents aged 12 to 18 found that 58.8% had at least one fissure sealant applied.[96]

For the purposes of this project, we have assumed that the best rate in the world for the application of at least one fissure sealant in children ages 6 to 12 is 59%, based on the results from Portugal.

### Screening for Breast Cancer

Mammography screening between the ages of 50 and 74 every two to three years.[97,98]

#### Measurement

Numerator for screening for breast cancer - Number of women ages 50 to 74 with a documented screening mammogram in the previous three years.

Denominator for screening for breast cancer - Number of women ages 50 to 74, excluding those with diagnosed breast cancer.

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[93] Healthy Development and Women's Health Directorate - BC Ministry of Health. *BC Dental Survey of Kindergarten Children 2012-2013: A Provincial and Regional Analysis* 2014. Available at http://www.health.gov.bc.ca/women-and-children/pdf/provincial-kindergarten-dental-survey-2012-13.pdf. Accessed September 2017.

[94] Office of the Provincial Health Officer. *Is "Good", Good Enough? The Health & Well-Being of Children & Youth in BC*. 2016. Available at http://www2.gov.bc.ca/assets/gov/health/about-bc-s-health-care-system/office-of-the-provincial-health-officer/reports-publications/annual-reports/pho-annual-report-2016.pdf. Accessed August 2017.

[95] Dye B, Thornton-Evans G, Li X et al. *Dental Caries and Sealant Prevalence in Children and Adolescents in the United States, 2011-2012*. 2015. U.S. Department of Health and Human Services Available at http://fluoridealert.org/wp-content/uploads/cdc.dye-2015.pdf. Accessed August 2017.

[96] Veiga N, Pereira C, Ferreira P et al. Prevalence of dental caries and fissure sealants in a Portuguese sample of adolescents. *PloS ONE*. 2015; 10(3): 1-12.

[97] Canadian Task Force on Preventive Health Care. *Screening for Breast Cancer*. 2011. Available at http://canadiantaskforce.ca/guidelines/2011-breast-cancer/. Accessed October 2013.

[98] Siu AL. Screening for breast cancer: US Preventive Services Task Force recommendation statement. *Annals of Internal Medicine*. 2016; 164(4): 279-96.

#### In British Columbia

According to the BC Cancer Agency's *Screening Mammography Program 2016 Annual Report*, the following participation rates were observed during the 30-month screening period between July 1, 2013 and December 31, 2015.

Ages 40-49 – 36%
Ages 50-59 – 50%
Ages 60-69 – 55%
Ages 70-79 – 39%
Ages 80-89 – 3%

The average screening rate for 50-69-year-old females was 52.4%.[99]

#### Best in the World

In Canada in 2014, the highest participation rates for females aged 50 to 69 was in Quebec at 62.3%.[100]

In the U.S., participation rates (mammography within the past two years) in 2014 for the population ages 50-74 were 78.5%, with a high of 88.1% in the state of Massachusetts.[101]

In Finland, a nationwide mammography screening program with a two year interval for women aged 50-59 years was established in 1987. The program allowed optional participation for women aged 60-69 years. The compliance rate for screening in the 50-59 year age group was 89% for the first 10 years of the program.[102] From 1992 to 2003 the compliance rate increased to over 95% in women aged 50-59 but remained at just 20-40% among women aged 60-69.[103] In 2007, all women aged 50-69 were invited for screening.[104] According to the Finnish Cancer Registry, the 2009 rates of breast cancer screening, which included women aged 50 to 69, were 85.5% of invited women.[105] In fact, for women who have been invited to screening, the participation rate since 1992 has remained in the range of 84-89%.[106]

For the purposes of this project, we have assumed that the best rate in the world for screening mammography in women ages 50-74 is 88%, based on results in the state of Massachusetts in 2014.

[99] BC Cancer Agency. *Screening Mammography Program: 2016 Annual Report*. 2016. Available at http://www.bccancer.bc.ca/screening/Documents/SMP_Report-AnnualReport2016.pdf. Accessed August 2017.
[100] Canadian Partnership against Cancer. *Breast Cancer Screening in Canada: Monitoring and Evaluation of Quality Indicators - Results Report January 2011 to December 2012*. 2017. Available at http://www.cancerview.ca/preventionandscreening/breastcancerscreening/. Accessed August 2017.
[101] National Cancer Institute. *Screening and Risk Factors Table: Had a Mammogram in the Past 2 Years*. 2017. Available at https://statecancerprofiles.cancer.gov/risk/index.php. Accessed July 2017.
[102] Dean PB and Pamilo M. Screening mammography in Finland--1.5 million examinations with 97 percent specificity. Mammography Working Group, Radiological Society of Finland. *Acta Oncologica*. 1999; 38 Suppl 13: 47-54.
[103] Sarkeala T, Heinavaara S and Anttila A. Organised mammography screening reduces breast cancer mortality: a cohort study from Finland. *International Journal of Cancer*. 2008; 122(3): 614-9.
[104] Schopper D and de Wolf C. How effective are breast cancer screening programmes by mammography? Review of the current evidence. *European Journal of Cancer*. 2009; 45(11): 1916-23.
[105] Finnish Cancer Registry. *Organised Breast Cancer Screening Programme in Finland in the Invitation Year 2009*. 2012. Available at http://www.cancer.fi/@Bin/73184124/v2009eng0039r2.html. Accessed October 2013.
[106] Finnish Cancer Registry. *Breast Cancer Screening Programme in Finland in 1992-2009, Women Aged 50-69 Years*. Available at http://www.cancer.fi/@Bin/73500045/Peitt%C3%A4vyys.pdf. Accessed October 2013.

## Screening for Cervical Cancer – Cytology-Based

Routine cytology-based (Pap) screening in females every three years between the ages of 25 and 69.[107,108]

### Measurement

Numerator for screening for cervical cancer - Number of women ages 25 to 69 with a documented cytology-based screen in the previous three years.

Denominator for screening for cervical cancer - Number of women ages 25 to 69, excluding those with diagnosed cervical cancer or a total hysterectomy (including removal of the cervix).

### In British Columbia

The average participation rate for women age 20-69 was 69.3% between 2012 and 2014, after adjusting for hysterectomy (see following table). The majority of these women (76%) are re-screened every 36 months.[109]

**Pap Smear Participation Rates (%) by Age Groups in BC 2012 – 2014**

| Age (Years) | Overall | Adjusted for Hysterectomy |
|---|---|---|
| 20-29 | 63.1% | 63.1% |
| 30-39 | 71.4% | 71.4% |
| 40-49 | 64.2% | 74.7% |
| 50-59 | 56.6% | 70.8% |
| 60-69 | 44.5% | 65.4% |
| 20-69 | 60.3% | 69.3% |

### Best in the World

In the UK, women are recalled for screening every 3.5 years if they are aged 25 to 49 and every 5.5 years if they are aged 50 to 64. In 2016, 72.7% of women ages 25 to 64 were screened within those time frames.[110] In the U.S., participation rates (Pap test within the past three years) in 2014 for the population ages 21 to 65 were 82.3%, with a high of 88.0% in the state of Massachusetts.[111]

We have assumed that the best rate in the world for routine cytology-based screening in females every three years between the ages of 25 and 69 is 88%, based on results in the state of Massachusetts in 2014.

[107] Canadian Task Force on Preventive Health Care. Recommendations on screening for cervical cancer. *Canadian Medical Association Journal*. 2013; 185(1): 35-45.
[108] US Preventive Services Task Force. Draft Recommendation Statement *Cervical Cancer: Screening.* 2017. Available online at https://www.uspreventiveservicestaskforce.org/Page/Document/draft-recommendation-statement/cervical-cancer-screening2. Accessed December 2017.
[109] BC Cancer Agency. *Cervical Cancer Screening Program 2015 Annual Report*. 2016. Available at http://www.bccancer.bc.ca/screening/Documents/CCSP_Report-AnnualReport2015.pdf. Accessed August 2017.
[110] BC Cancer Agency. *Cervical Cancer Screening Program 2015 Annual Report*. 2016. Available at http://www.bccancer.bc.ca/screening/Documents/CCSP_Report-AnnualReport2015.pdf. Accessed August 2017.
[111] National Cancer Institute. *Screening and Risk Factors Table: Pap Test in Past 3 Years, No Hysterectomy*. 2017. Available at https://statecancerprofiles.cancer.gov/risk/index.php. Accessed July 2017.

## Screening for Cervical Cancer – HPV-Based

Addition of HPV-based screening every five years in females between the ages of 30 and 65.[112,113]

#### Measurement

Numerator for HPV-based screening for cervical cancer - Number of women ages 30 to 65 with a documented HPV-based screen in the previous five years.

Denominator for HPV-based screening for cervical cancer - Number of women ages 30 to 65, excluding those with diagnosed cervical cancer or a total hysterectomy (including removal of the cervix).

#### In British Columbia

Primary screening using HPV testing is not currently available in BC. The BC Cervical Cancer Screening Guidelines Committee is in the process of recommending the inclusion of HPV testing as a component of the provincial cervical cancer screening program.[114]

#### Best in the World

The Netherlands is the first country to implement a national HPV-based screening program, started on January 1, 2016.[115] Other countries, such as the UK[116] and Australia[117] are considering recommendations to implement such a program.

In the US in 2014, 32% of women ages 40-64 reported having an HPV-based screening test (together with a conventional test) over the previous five years.[118]

For the purposes of this project, we have assumed that the implementation of a national HPV-based screening program would result in no change to the current best rate in the world for routine cytology-based screening of 88% seen in the state of Massachusetts (see above).

## Screening for Colorectal Cancer

Screening for colorectal cancer using fecal occult blood testing (FOBT) every two years or flexible sigmoidoscopy every 10 years in adults between the ages of 50 and 74.[119,120]

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[112] Moyer VA. Screening for cervical cancer: US Preventive Services Task Force recommendation statement. *Annals of Internal Medicine*. 2012; 156(12): 880-91.

[113] US Preventive Services Task Force. Draft Recommendation Statement *Cervical Cancer: Screening.* 2017. Available online at https://www.uspreventiveservicestaskforce.org/Page/Document/draft-recommendation-statement/cervical-cancer-screening2. Accessed September 2017.

[114] BC Cancer Agency. *Cervical Cancer Screening Policy Change 2016 Reference Guide Supporting Healthcare Professionals in Communicating Screening Information to Patients: Frequently Asked Questions*. May 2017. Available online at http://www.bccancer.bc.ca/screening/Documents/CCSP_GuidelinesManual-CervicalCancerScreeningPolicyChangeReferenceGuide.pdf. Accessed September 2017.

[115] National Institute for Public Health and the Environment. *Cervical Cancer Screening in the Netherlands*. 2016. Available at http://www.rivm.nl/en/Documents_and_publications/Common_and_Present/Newsmessages/2014/Cervical_cancer_screening_in_the_Netherlands. Accessed August 2017.

[116] Kitchener H. *Report to the National Screening Committee*. 2015. Available at https://legacyscreening.phe.org.uk/policydb_download.php?doc=555. Accessed August 2017.

[117] Australian Government Department of Health. *Medical Service Advisory Committee Recommendations*. 2017. Available at http://www.cancerscreening.gov.au/internet/screening/publishing.nsf/Content/MSAC-recommendations. Accessed August 2017.

[118] Goding Sauer A, Siegel L, Jemal A et al. Updated Review of Prevalence of Major Risk Factors and Use of Screening Tests for Cancer in the United States. *Cancer Epidemiology Biomarkers Prevention*. 2017: 1-47.

[119] Canadian Task Force on Preventive Health Care. Recommendations on screening for colorectal cancer in primary care. *Canadian Medical Association Journal*. 2016; 188(5): 340-8.

[120] US Preventive Services Task Force. Screening for colorectal cancer: US Preventive Services Task Force recommendation statement. *Journal of the American Medical Association*. 2016; 315(23): 2564-75.

#### Measurement

Numerator for screening for colorectal cancer - Number of adults ages 50 to 74 with a documented FOBT in the previous two years or a flexible sigmoidoscopy in the previous ten years.

Denominator for screening for colorectal cancer - Number of adults ages 50 to 74, excluding those with diagnosed colorectal cancer.

#### In British Columbia

Based on data from the 2012 Canadian Community Health Survey, 49.6% of BC residents ages 50-74 had a fecal occult blood test (FOBT) within the two years before being surveyed or a flexible sigmoidoscopy or colonoscopy within 10 years of being surveyed.[121]

#### Best in the World

In the US, the 2014 screening rates for males and females ages 50-75 vary by state, with a high of 76.5% in Massachusetts.[122]

In 2004, Finland launched a biennial guaiac-based fecal occult blood test for ages 60-69 to be phased in and expanded over 6 years. The first cohort of 74,592 achieved an adherence rate of 62% for men and 77% for women. From the first cohort, 26,866 people were asked to participate in another round of screening in which adherence rates were 68% for men and 80% for women.[123] The Finnish Cancer Registry lists the overall participation rate for 2009 at 70.4%,[124] with a decrease in 2011 to 66.3%.[125]

For the purposes of this project, we have assumed that the best rate in the world for routine colorectal cancer screening in males and females between the ages of 50 and 74 is 76%, based on results in the state of Massachusetts in 2014.

### Screening for Lung Cancer

The CTFPHC recommends screening for lung cancer among adults 55 to 74 years of age with at least a 30 pack-year smoking history, who smoke or quit smoking less than 15 years ago. Screening should take place annually for three consecutive years.[126] This is a weak recommendation based on low quality evidence.

The USPSTF recommends screening asymptomatic adults aged 55 to 80 years, who have a 30 pack-year smoking history and currently smoke or have quit smoking within the past 15 years, annually. Discontinue screening when the patient has not smoked for 15 years.[127] This is a "B" recommendation.

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[121] Singh H, Bernstein C, Samadder J et al. Screening rates for colorectal cancer in Canada: a cross-sectional study. *Canadian Medical Association Journal Open*. 2015; 3(2): E149-57.
[122] National Cancer Institute. *Screening and Risk Factors Table*. 2017. Available at https://statecancerprofiles.cancer.gov/risk/index.php. Accessed August 2017.
[123] Malila N, Palva T, Malminiemi O et al. Coverage and performance of colorectal cancer screening with the faecal occult blood test in Finland. *Journal of Medical Screening*. 2011; 18(1): 18-23.
[124] Finnish Cancer Registry. *Colorectal Screening: Persons Invited to Colorectal Screening in 2009*. 2010. Available at http://www.cancer.fi/@Bin/56135596/Whole+Finland_net.pdf. Accessed August 2017.
[125] Finnish Cancer Registry. *Colorectal Cancer Screening: Year 2011 Statistics by Health District*. 2012. Available at http://www.cancer.fi/@Bin/71240778/English+Tilastot+sairaanhoitopiireitt%C3%A4in.pdf. Accessed August 2017.
[126] Canadian Task Force on Preventive Health Care. Recommendations on screening for lung cancer. *Canadian Medical Association Journal*. 2016: 1-8.
[127] Moyer VA. Screening for lung cancer: U.S. Preventive Services Task Force Recommendation Statement. *Annals of Internal Medicine*. 2014; 160: 330-8.

#### Measurement

Numerator #1 for screening for lung cancer - Number of adults 55 to 74 years of age with at least a 30 pack-year smoking history, who smoke or quit smoking less than 15 years ago who received an *annual low-dose computed tomography (LDCT) screen for three consecutive years* (full compliance with recommendation).

Numerator #2 for screening for lung cancer (alternate) - Number of adults 55 to 74 years of age with at least a 30 pack-year smoking history, who smoke or quit smoking less than 15 years ago who received *at least one* LDCT screen (partial compliance with recommendation).

Denominator for screening for lung cancer - Number of adults 55 to 74 years of age with at least a 30 pack-year smoking history, who smoke or quit smoking less than 15 years ago and have not been diagnosed with lung cancer.

#### In British Columbia

BC is currently considering a lung cancer screening policy for the province.[128] The BC Cancer Agency is enrolling patients in the Lung Health Study who are current or former smokers, are between 45-74 years of age and have smoked at least 30 pack-years.[129]

Screening for lung cancer using low-dose computed tomography is available privately at the False Creek Healthcare Centre.[130]

#### Best in the World

Several research projects have asked high-risk smokers whether or not they would be willing to undergo screening with LDCT. In the US, 82% of high-risk smokers said they would participate in screening if their physician recommended it.[131] However, only 32% said they would undergo screening if they had to pay for it. In Ireland, this proportion reached 98%, with 67% willing to pay for the screening.[132] Similarly high 'willingness to screen' rates (96%) have also been noted in Australia.[133]

Models assessing the cost-effectiveness of lung cancer screening make a variety of assumptions with respect to adherence to lung cancer screening, with adherence estimates ranging from 60% to 100%.[134,135,136]

Despite these optimistic estimates, real world data suggest a much lower uptake.[137,138] Data from the US indicates that the screening rate for the high-risk cohort of 55-74-year-olds has increased from 3.2% in 2010 to 6.0% in 2015.[139]

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[128] BC Cancer Agency. *Screening Programs*. 2017. Available at http://www.bccancer.bc.ca/our-services/services/screening-programs. Accessed August 2017.
[129] BC Cancer Agency. *Lung Health*. 2017. Available at http://www.bccancer.bc.ca/our-research/participate/lung-health. Accessed August 2017.
[130] Centre FCH. *CT Lung Cancer Screening*. 2015. Available at http://www.falsecreekdiagnostics.com/services/ct-scan-cat-scan/ct-lung-cancer-screening/. Accessed August 2017.
[131] Jonnalagadda S, Bergamo C, Lin JJ et al. Beliefs and attitudes about lung cancer screening among smokers. *Lung Cancer*. 2012; 77(3): 526-31.
[132] Pallin M, Walsh S, O'Driscoll MF et al. Overwhelming support among urban Irish COPD patients for lung cancer screening by low-dose CT scan. *Lung*. 2012; 190(6): 621-8.
[133] Flynn AE, Peters MJ, Morgan LC. Attitudes towards lung cancer screening in an Australian high-risk population. *Lung Cancer International*. 2013; doi: 10.1155/2013/789057
[134] Goulart BH, Bensink ME, Mummy DG et al. Lung cancer screening with low-dose computed tomography: costs, national expenditures, and cost-effectiveness. *Journal of the National Comprehensive Cancer Network*. 2012; 10(2): 267-75.
[135] McMahon PM, Kong CY, Bouzan C et al. Cost-effectiveness of computed tomography screening for lung cancer in the United States. *Journal of Thoracic Oncology*. 2011; 6(11): 1841-8.
[136] Goffin JR, Flanagan WM, Miller AB et al. Cost-effectiveness of lung cancer screening in Canada. *JAMA Oncology*. 2015; 1(6): 807-13.

For the purposes of this project, we have therefore assumed a best in the world rate of 6%. This rate may increase over time and / or in the context of a provincially or nationally organised lung cancer screening program. To take this into account, we have assumed that the rate in BC would eventually approximate rates associated with other cancer screening programs in the province (of approximately 50%-70%). For modelling purposes we chose the midpoint or 60%.

## Screening for Hypertension

Blood pressure measurement at least once every two years for adults aged 18 years and older without previously diagnosed hypertension.[140,141]

#### Measurement

Numerator for screening for hypertension - Number of adults aged 18 years or older, excluding those with previously diagnosed hypertension, who have at least one documented blood pressure measurement in the last 24 months.

Denominator for screening for hypertension - Number of adults aged 18 years or older, excluding those with previously diagnosed hypertension.

#### In British Columbia

We are not aware of any information which indicates the proportion of individuals in BC who routinely have their blood pressure checked. Nor are we aware of BC-specific data on the proportion of adults with hypertension who have achieved blood pressure control targets. A study by Robitaille and co-authors does suggest that BC had the lowest prevalence of diagnosed hypertension among adults aged 20 years and older (18.1%) of any Canadian province in 2007/08.[142]

#### Best in the World

Canada has become a world leader in the identification and management of hypertension.[143,144] An estimated 79% of Canadian adults are screened for blood pressure at least once every two years.[145] In 2012/13, the prevalence of hypertension among Canadian adults was 22.6%.[146] Of these adults, 68%[147] to 78%[148] have achieved blood pressure control targets.

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[137] Jemal A and Fedewa S. Lung cancer screening with low-dose computed tomography in the United States—2010 to 2015. *Journal of American Medical Association Oncology*. 2017: E1-3.
[138] Soneji S, Yang J, Tanner N et al. Underuse of chest radiography versus computed tomography for lung cancer screening. *American Public Health Association*. 2017; 107(8): 1248-50.
[139] Huo J, Shen C, Volk R et al. Use of CT and chest radiography for lung cancer screening before and after publication of screening guidelines: intended and unintended uptake. *Journal of American Medical Association Internal Medicine*. 2017; 177(3): 439-41.
[140] Lindsay P, Gorber S, Joffres M et al. Recommendations on screening for high blood pressure in Canadian adults. *Canadian Family Physician*. 2013; 59(9): 927-33.
[141] Siu A on behalf of the U.S. Preventive Services Task Force. Screening for high blood pressure in adults: U.S. Preventive Services Task Force Recommendation Statement. *Annals of Internal Medicine*. 2015; 163(10): 778-86.
[142] Robitaille C, Dai S, Waters C et al. Diagnosed hypertension in Canada: incidence, prevalence and associated mortality. *Canadian Medical Association Journal*. 2012; 184(1): E49-E56.
[143] Schiffrin E, Campbell N, Feldman R et al. Hypertension in Canada: past, present, and future. *Annals of Global Health*. 2016; 82(2): 288-99.
[144] Padwal R and Campbell N. Blood pressure control in Canada: through the looking-glass into a glass half empty? *American Journal of Hypertension*. 2017; 30(3): 223-5.
[145] Godwin M, Williamson T, Khan S et al. Prevalence and management of hypertension in primary care practices with electronic medical records: a report from the Canadian Primary Care Sentinel Surveillance Network. *Canadian Medical Association Journal Open*. 2015; 3(1): E76-E82.
[146] Padwal R, Bienek A, McAlister F et al. Epidemiology of hypertension in Canada: an update. *Canadian Journal of Cardiology*. 2016; 32(5): 687-94.
[147] Ibid.

For the purposes of this project, we have assumed that the Canadian screening rate of 79% is equivalent to the best rate in the world.

### Screening for Cardiovascular Disease and Treatment with Statins

Complete a cardiovascular risk assessment every five years for adults aged 40 to 74 years. Initiate the use of low- to moderate-dose statins in adults without a history of cardiovascular disease (CVD) who have one or more CVD risk factors (dyslipidemia, diabetes, hypertension or smoking) and a calculated 10-year CVD event risk of 10% or greater (intermediate risk).[149,150]

#### Measurement

Numerator for screening for cardiovascular disease - Number of adults 40 to 74 years of age, excluding those with a history of CVD, who have had a cardiovascular risk assessment in the past five years.

Denominator for screening for cardiovascular disease - Number of adults 40 to 74 years of age, excluding those with a history of CVD.

Numerator #1 for treatment with statins - Number of adults 40 to 74 years of age with a calculated 10-year CVD event risk of 10% or greater but without a history of CVD who have been *prescribed a low- to moderate-dose statin.*

Numerator #2 for treatment with statins - Number of adults 40 to 74 years of age with a calculated 10-year CVD event risk of 10% or greater but without a history of CVD who have *taken a low- to moderate-dose statin for at least three years*.

Denominator for treatment with statins - Number of adults 40 to 74 years of age with a calculated 10-year CVD event risk of 10% or greater but without a history of CVD.

#### In British Columbia

We are not aware of any information which indicates the proportion of adults aged 40 to 74 years in BC who have had a cardiovascular risk assessment within the past five years. Nor are we aware of BC-specific data on the proportion of adults at intermediate or higher risk of CVD who are taking statins over the longer term for primary prevention purposes.

#### Best in the World

The Health Check program in England has offered a cardiovascular risk assessment every five years to all adults aged 40-74 years with no known cardiovascular diseases since 2009. During the four years between April 1, 2009 and March 31, 2013, 21.4% of eligible patients attended a Health Check.[151,152] The proportion of eligible patients who attend a Health Check

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[148] Godwin M, Williamson T, Khan S et al. Prevalence and management of hypertension in primary care practices with electronic medical records: a report from the Canadian Primary Care Sentinel Surveillance Network. *Canadian Medical Association Journal Open*. 2015; 3(1): E76-E82.

[149] Bibbins-Domingo K, Grossman D, Curry S et al. Statin use for the primary prevention of cardiovascular disease in adults: US Preventive Services Task Force recommendation statement. *Journal of the American Medical Association*. 2016; 316(19): 1997-2007.

[150] Anderson T, Gregiore J, Pearson G et al. 2016 Canadian Cardiovascular Society guidelines for the management of dyslipidemia for the prevention of cardiovascular disease in the adult. *Canadian Journal of Cardiology.* 2016; 32: 1263-82.

[151] Chang K, Soljak M, Lee J et al. Coverage of a national cardiovascular risk assessment and management programme (NHS Health Check): retrospective database study. *Preventive Medicine*. 2015; 78: 1-8.

[152] Chang K, Lee J, Vamos E et al. Impact of the National Health Service Health Check on cardiovascular disease risk: a difference-in-differences matching analysis. *Canadian Medical Association Journal*. 2016; 188(10): E228-38.

has increased year over year, from 5.8% in 2009/10 to 30.1% in 2012/13.[153] More recently (between April 1, 2013 and March 31, 2017), 74.1% of the eligible population were offered a Health Check. Of these 74.1%, 48.9% received a Health Check resulting in 36.2% (.741* .489) of eligible patients attending a Health Check.[154] In the Nottingham region of England, 47.7% of eligible patients ages 40-74 attended a Health Check between April 1, 2013 and March 31, 2017.[155]

For the purposes of this project, we have assumed that the cardiovascular risk assessment rate observed in the Nottingham region of England (48%) is the best in the world.

Statins were prescribed to 39.9% of Health Check attendees in England between April 1, 2009 and March 31, 2013 with a calculated 10-year CVD event risk of *20% or greater*.[156] During that time, the recommendation from the National Institute for Health and Care Excellence (NICE) was to offer statins for primary prevention only if the 10-year CVD event risk was *20% or greater*. NICE has since modified this to a 10-year CVD event risk of 10% or greater,[157] in line with the Canadian Cardiovascular Society and USPSTF guidelines noted above. While a statin may be prescribed, a challenge is the issue of long-term persistence with statin therapy. Individuals within clinical trials tend to have 90% adherence after one year, 85% after two years and 80% after three years, but real world adherence is much lower at 60%, 45% and 40% after years one, two and three. After three years, rates of adherence tend to stabilize.[158,159,160,161]

For the purposes of this project, after taking into account prescribing rates to high risk individuals in England and long-term persistence, we have assumed that 30% of intermediate and high risk individuals would be willing to take statins over the longer term for primary prevention purposes.

### Screening for Type 2 Diabetes Mellitus

The CTFPHC suggests a two-phase approach to screening.[162] First, it recommends screening all adults ages 18 and older using a validated risk calculator such as Finnish Diabetes Risk Score (FINDRISC) or Canadian Diabetes Risk Assessment Questionnaire (CANRISK). This first level of screening should be completed once every 3-5 years. Those with a FINDRISC score of 15 to 20 are considered to be at high risk of diabetes (an individual's risk of developing type 2 diabetes within 10 years is between 33% and 49%) and those with a score greater than 21 are at very high risk (an individual's risk of developing diabetes within 10

[153] Robson J, Dostal I, Sheikh A et al. The NHS Health Check in England: an evaluation of the first 4 years. *British Medical Journal Open*. 2016; 6(1): 1-10.
[154] England PH. *Public Health Outcomes Framework*. 2017. Available at http://www.phoutcomes.info/search/health%20check#pat/6/ati/102/par/E12000004. Accessed August 2017.
[155] Ibid.
[156] Chang K, Lee J, Vamos E et al. Impact of the National Health Service Health Check on cardiovascular disease risk: a difference-in-differences matching analysis. *Canadian Medical Association Journal*. 2016; 188(10): E228-38.
[157] National Institute for Health and Care Excellence. *Guide to the methods of technology appraisal 2013*. 2013. Available at https://www.nice.org.uk/process/pmg9. Accessed August 2017.
[158] Avorn J, Monette J, Lacour A. et al. Persistence of use of lipid-lowering medications: a cross-national study. *Journal of the American Medical Association*. 1998; 279(18): 1458-62.
[159] Perreault S, Blais L, Dragomir A. et al. Persistence and determinants of statin therapy among middle-aged patients free of cardiovascular disease. *European Journal of Clinical Pharmacology*. 2005; 61(9): 667-74.
[160] Helin-Salmivaara A, Lavikainen P, Korhonen M et al. Long-term persistence with statin therapy: a nationwide register study in Finland. *Clinical Therapeutics*. 2008; 30(1): 2228-40.
[161] Greving J, Visseren F, De Wit G et al. Statin treatment for primary prevention of vascular disease: whom to treat? Cost-effectiveness analysis. *British Medical Journal*. 2011; 342(1): d1672.
[162] Canadian Task Force on Preventive Health Care. Recommendations on screening for type 2 diabetes in adults. *Canadian Medical Association Journal*. 2012; 184(15): 1687-96.

years is 50% or higher). The second phase of screening involves either an A1C, fasting glucose or oral glucose tolerance test. The CTFPHC recommends the use of the A1C test given its "convenience for patients." Individuals at high risk are to be screened every 3-5 years while individuals at very high risk are to be screened every year. The CTFPHC considers these recommendations to be "weak" based on "low-quality evidence".[163]

The USPSTF recommends screening for abnormal blood glucose in all adults ages 40 to 70 who are overweight or obese as part of a cardiovascular risk assessment. This is a "B" recommendation.[164]

#### Measurement

Numerator for calculating diabetes risk status - Number of adults aged 18 and older, excluding those with diagnosed diabetes, whose risk status has been assessed at least once in the past five years using a validated diabetes risk calculator.

Denominator for calculating diabetes risk status - Number of adults aged 18 and older, excluding those with diagnosed diabetes.

Numerator for screening for diabetes in high risk individuals - Number of adults aged 18 and older, excluding those with diagnosed diabetes, whose risk of developing type 2 diabetes within 10 years is between 33% and 49% and who have had a least one A1C test in the past five years.

Denominator for screening for diabetes in high risk individuals - Number of adults aged 18 and older, excluding those with diagnosed diabetes, whose risk of developing type 2 diabetes within 10 years is between 33% and 49%.

Numerator for screening for diabetes in very high risk individuals - Number of adults aged 18 and older, excluding those with diagnosed diabetes, whose risk of developing type 2 diabetes within 10 years is ≥50% and who have had an A1C test in the past year.

Denominator for screening for diabetes in very high risk individuals - Number of adults aged 18 and older, excluding those with diagnosed diabetes, whose risk of developing type 2 diabetes within 10 years is ≥50%.

#### In British Columbia

We are not aware of any information which indicates the proportion of adults aged 18 and older in BC who have been screened for diabetes risk at least once over the past five years using a validated risk calculator. Nor are we aware of BC-specific data on the proportion of adults at high or very high risk of diabetes who are being screened at least once every five years (if at high risk) or annually (if at very high risk) using the A1C test.

#### Best in the World

In Sweden, 9,734 individuals aged 35 – 75 years were invited by mail to complete a FINDRISC questionnaire, with 58% returning a completed questionnaire.[165] A higher response rate might be expected if the assessment was encouraged while waiting within a caregiver's' office, but a study from Denmark suggests that only 28% to 45% of individuals

[163] Ibid.

[164] Siu A. Screening for Abnormal Blood Glucose and Type 2 Diabetes Mellitus: U.S. Preventive Services Task Force Recommendation Statement. *Annals of Internal Medicine.* 2015; 163(11): 861-8.

[165] Hellgren M, Petzold M, Björkelund C et al. Feasibility of the FINDRISC questionnaire to identify individuals with impaired glucose tolerance in Swedish primary care. A cross-sectional population-based study. *Diabetic Medicine*. 2012; 29(12): 1501-5.

were given and/or completed a diabetes risk questionnaire while waiting for a general practitioner appointment.[166]

We have assumed that the best risk assessment screening rate in the world is 58%, based on results from Sweden.

In Ontario, 74% of the adult population aged 20 years or older were screened with a fasting blood glucose test within a 5 year period after 2000/01.[167] In the Anglo-Danish-Dutch Study of Intensive Treatment in People with Screen-detected Diabetes in Primary Care (ADDITION-Europe study), 73% of individuals ages 40-69 identified as high risk for diabetes participated in blood glucose testing.[168] The highest rate was observed in Denmark were 95.1% of patients identified as high risk participated in blood glucose testing if the testing occurred immediately following their general practitioner appointment. If the patient was invited to return for a fasting blood glucose test on another occasion, then 80.7% participated.[169] Ongoing attendance for blood glucose testing declines over time.[170]

For the purposes of this project, we have assumed that the best ongoing screening rate in the world for individuals identified as high (every 3-5 years) or very high (every year) risk for diabetes would be 80%, based on rates observed in Denmark.

## Screening for Depression

Screen for depression in the general adult population aged 18 and older if adequate systems are in place to ensure accurate diagnosis, effective treatment and appropriate follow-up. This recommendation receives a B grade from the USPSTF.[171] The CTFPHC recommends *against* routine screening for depression in adults at average risk of depression. This is a weak recommendation based on very-low-quality evidence.[172]

The USPSTF found no evidence on ideal screening intervals. In the absence of data, they recommend "screening all adults who have not been screened previously and using clinical judgment in consideration of risk factors, comorbid conditions and life events to determine if additional screening of high-risk patients is warranted."[173]

### Measurement

Numerator for screening for depression - Number of non-perinatal adults aged 18 and older, excluding those with diagnosed depression, who have been screened for depression at least once.

Denominator for screening for depression - Number of non-perinatal adults aged 18 and older, excluding those with diagnosed depression.

[166] Dalsgaard E, Christensen J, Skriver M et al. Comparison of different stepwise screening strategies for type 2 diabetes: finding from Danish general practice, addition-DK. *Primary Care Diabetes*. 2010; 4(4): 223-9.
[167] Wilson SE, Rosella LC, Lipscombe LL et al. The effectiveness and efficiency of diabetes screening in Ontario, Canada: a population-based cohort study. *BMC Public Health*. 2010; 10(1): 506.
[168] Simmons R, Echouffo-Tcheugui J, Sharp S et al. Screening for type 2 diabetes and population mortality over 10 years (ADDITION-Cambridge): a cluster-randomised controlled trial. *The Lancet*. 2012; 380(9855): 1741-8.
[169] Van den Donk M, Sandbaek A, Borch-Johnsen K et al. Screening for Type 2 diabetes. Lessons from the ADDITION-Europe study. *Diabetic Medicine*. 2011; 28(11): 1416-24.
[170] Ibid.
[171] Siu AL and the US Preventive Services Task Force (USPSTF). Screening for depression in adults: US Preventive Services Task Force recommendation statement. *JAMA*. 2016; 315(4): 380-7.
[172] Canadian Task Force on Preventive Health Care. Recommendations on screening for depression in adults. *Canadian Medical Association Journal*. 2013; 185(9): 775-82.
[173] Siu AL and the US Preventive Services Task Force (USPSTF). Screening for depression in adults: US Preventive Services Task Force recommendation statement. *JAMA*. 2016; 315(4): 380-7.

#### In British Columbia

We were unable to find any information that specifically identifies what proportion of non-perinatal adults ages 18 and older are being routinely screened for depression in BC.

#### Best in the World

Based on the National Ambulatory Medical Care Survey in the US, an estimated 885 million physician office visits occurred in 2014.[174] Approximately 36.1 million of these visits included depression screening. That is, depression screening was provided during 4.08% of physician office visits. The 4.08% represents an increase from 1.43% in 2012[175], 1.36% in 2010[176] and 1.07% in 2008.[177]

Of the 885 million visits provided in 2014, 462 million visits were provided by a primary care physician. If we assume that all visits which included depression screening were provided by a primary care physician, then 7.83% of visits to a primary care physician included depression screening. Finally, an average of 1.47 visits per year are made to a primary care physician.[178] If we further assume that patients are only screened once per year, then approximately 11.5% (.0783 * 1.47) of the US population were screened for depression by their primary care physician in 2014.

The US Affordable Care Act, signed into law on March 23, 2010, amends the US Social Security Act to remove "barriers to preventive services in Medicare" (Section 4104-5) and improve "access to preventive services for eligible adults in Medicaid" (Section 4106). A common amendment is the incorporation of "diagnostic, screening, preventive and rehabilitative services including any clinical preventive services that are assigned a grade of A or B by the United States Preventive Services Task Force" [Section 4106 (a)(13)].[179]

The implementation of the Affordable Care Act and the focus on preventive services appears to have resulted in a tripling in screening rates for depression in the US (from screening occurring during 1.36% of physician office visits in 2010 to 4.08% in 2014).

For the purposes of this project, we have assumed that the best screening rate for depression in the world in asymptomatic adults ages 18 and older is 12%, based on the estimated screening rate in the US in 2014 noted above.

### Screening for Depression in Pregnant and Postpartum Females

The USPSTF recommends "screening for depression in the general adult population, *including pregnant and postpartum women* [emphasis added]. Screening should be implemented with adequate systems in place to ensure accurate diagnosis, effective

[174] Rui P, Hing E, Okeyode T. *National Ambulatory Medical Care Survey: 2014 State and National Summary Tables*. Available at http://www.cdc.gov/nchs/ahcd/ahcd_products.htm. Accessed August 2017.
[175] National Center for Health Statistics. *National Ambulatory Medical Survey: 2012 Summary Tables*. 2012. Available at http://www.cdc.gov/nchs/data/ahcd/namcs_summary/2012_namcs_web_tables.pdf. Accessed August 2017.
[176] National Center for Health Statistics. *National Ambulatory Medical Care Survey: 2010 Summary Tables*. 2010. Available at http://www.cdc.gov/nchs/data/ahcd/namcs_summary/2010_namcs_web_tables.pdf. Accessed August 2017.
[177] National Center for Health Statistics. *National Ambulatory Medical Care Survey: 2008 Summary Tables*. 2008. Available at http://www.cdc.gov/nchs/data/ahcd/namcs_summary/2008_namcs_web_tables.pdf. Accessed August 2017.
[178] Rui P, Hing E, Okeyode T. *National Ambulatory Medical Care Survey: 2014 State and National Summary Tables*. Available at http://www.cdc.gov/nchs/ahcd/ahcd_products.htm. Accessed August 2017.
[179] U.S. Department of Health & Human Services. *The Affordable Care Act*. 2010. Available at http://www.hhs.gov/healthcare/about-the-law/read-the-law/index.html. Accessed August 2017.

treatment and appropriate follow-up."[180] This recommendation receives a "B" grade from the USPSTF.

The CTFPHC, on the other hand, recommends *against* routinely screening for depression in adults in subgroups of the population who may be at increased risk of depression, including pregnant and postpartum women. This is a weak recommendation based on very-low-quality evidence.[181]

The Lifetime Prevention Schedule Expert Committee acknowledges the conflict between the two recommendations. Upon further examination, the USPSTF review included literature investigating screening and treatment of depression in perinatal and postpartum women. The CTFPHC included literature examining screening only, which was sparse; literature examining screening and treatment was excluded. In BC, the current standard for delivery of public health services is offering the Edinburgh Postnatal Depression Scale (EPDS) by eight weeks postpartum, with education/intervention/referral for treatment as needed. The USPSTF review includes a number of validation studies on perinatal and postpartum depression screening tools (including the Edinburgh Postnatal Depression Scale) in a variety of settings. These do not appear in the CTFPHC review. Finally, there are several studies on perinatal and postpartum depression screening and treatment that were published after the CTFPHC review in 2013, but were included in the more recent USPSTF review. Therefore, the LPS will use the USPSTF recommendation as the most current evidence of clinical effectiveness and proceed with the modeling of population health impact and cost effectiveness of screening and treatment for depression in perinatal and postpartum women.

#### Measurement

Numerator for screening for depression in pregnant and postpartum females - Number of new mothers, excluding those with diagnosed depression, who have been screened for depression using the EPDS at least once by eight weeks after giving birth.

Denominator for screening for depression in pregnant and postpartum females - Number of new mothers, excluding those with diagnosed depression.

#### In British Columbia

The BC Reproductive Mental Health Program recommends screening during pregnancy at 28-32 weeks and again at six to eight weeks postnatally using the EPDS.[182] We were unable to find information on formal screening rates for depression in perinatal and postpartum women in BC.

#### Best in the World

Eighty percent of mothers are comfortable with the idea of being screened for postpartum depression (PPD).[183,184] Eighty-three percent of family practitioners and 73% of paediatricians

[180] Siu AL and the US Preventive Services Task Force (USPSTF). Screening for depression in adults: US Preventive Services Task Force recommendation statement. *JAMA*. 2016; 315(4): 380-7.
[181] Canadian Task Force on Preventive Health Care. Recommendations on screening for depression in adults. *Canadian Medical Association Journal*. 2013; 185(9): 775-82.
[182] BC Reproductive Mental Health Program and Perinatal Services BC. *Best Practice Guidelines for Mental Health Disorders in the Perinatal Period*. 2014. Available at http://www.perinatalservicesbc.ca/Documents/Guidelines-Standards/Maternal/MentalHealthDisordersGuideline.pdf. Accessed August 2017.
[183] Buist A, Condon J, Brooks J et al. Acceptability of routine screening for perinatal depression. *Journal of Affective Disorders*. 2006; 93(1): 233-7.
[184] Gemmill AW, Leigh B, Ericksen J et al. A survey of the clinical acceptability of screening for postnatal depression in depressed and non-depressed women. *BMC Public Health*. 2006; 6: 211.

are willing to screen for PPD.[185] The theoretical maximum screening rate might therefore be 66% (0.8 * 0.83). In actual practice, however, screening rates using a validated screening tool appear to be closer to 20%.[186,187,188] Even in an outpatient academic medical center, the screening rate only reached 39%.[189]

For the purposes of this project, we have assumed that the best screening rate for postpartum depression in the world is 39%.[190]

### Screening for HIV

Screen youth and adults 15 to 65 years of age for HIV infection. Younger adolescents and older adults who are at increased risk should also be screened. Finally, screen all pregnant women for HIV, including those who present in labor who are untested and whose HIV status is unknown.[191] These recommendations all receive an "A" grade from the USPSTF.

The CTFPHC has reviewed the USPSTF guideline on screening for HIV infection and conclude that it "is a high-quality guideline, but the CTFPHC does not recommend its use in Canada. In the opinion of the CTFPHC, available evidence does not justify routinely screening all adult Canadians for HIV." Instead, the focus should be on screening high-risk groups and pregnant women.[192]

The USPSTF found insufficient evidence to determine optimum time intervals for HIV screening. They recommend 1-time screening to identify persons who are already HIV-positive, with repeated screening of those who are known to be at risk for HIV infection, those who are actively engaged in risky behaviors, and those who live or receive medical care in a high-prevalence setting (a geographic location or community with an HIV seroprevalence of at least 1%). All pregnant women should be screened. Individuals at increased risk should be screened every 3 to 5 years while those at very high risk should be screened every year.[193]

The 2014 HIV Testing Guidelines for the Province of British Columbia recommend that health care providers offer an HIV test[194]

- Routinely, every five years, to all patients aged 18-70 years
- Routinely, every year, to all patients aged 18-70 years who belong to populations with a higher burden of HIV infection
- Once for patients older than 70 years of age, if HIV status is not known

[185] Glasser S, Levinson D, Bina R et al. Primary care physicians' attitudes toward postpartum depression is it part of their job? *Journal of Primary Care & Community Health*. 2016; 7(1): 24-9.
[186] Seehusen DA, Baldwin L-M, Runkle GP et al. Are family physicians appropriately screening for postpartum depression? *The Journal of the American Board of Family Practice*. 2005; 18(2): 104-12.
[187] Psaros C, Geller PA, Sciscione AC et al. Screening practices for postpartum depression among various health care providers. *The Journal of Reproductive Medicine*. 2009; 55(11-12): 477-84.
[188] Ford E, Shakespeare J, Elias F et al. Recognition and management of perinatal depression and anxiety by general practitioners: a systematic review. *Family Practice*. 2016; 34(1): 11-9.
[189] Delatte R, Cao H, Meltzer-Brody S et al. Universal screening for postpartum depression: an inquiry into provider attitudes and practice. *American Journal of Obstetrics and Gynecology*. 2009; 200(5): e63-e4.
[190] Ibid.
[191] Moyer VA. Screening for HIV: U.S. Preventive Services Task Force Recommendation Statement. *Annals of Internal Medicine*. 2013; 159(1): 51-60.
[192] Canadian Task Force on Preventive Health Care. *HIV 2013 Critical Appraisal Report.* Available online at https://canadiantaskforce.ca/wp-content/uploads/2016/05/2013-hiv-en-ca-final.pdf. Accessed September 2017.
[193] Moyer VA. Screening for HIV: U.S. Preventive Services Task Force Recommendation Statement. *Annals of Internal Medicine*. 2013; 159(1): 51-60.
[194] Office of the Provincial Health Officer. *HIV Testing Guidelines for the Province of British Columbia*. 2014. Available online at http://www2.gov.bc.ca/assets/gov/health/about-bc-s-health-care-system/office-of-the-provincial-health-officer/hiv-testing-guidelines-bc.pdf. Accessed September 2017.

AND offer an HIV test to patients including adults 18-70, youth and the elderly, whenever

- Ordering diagnostic bloodwork for a new or worsening medical condition
- They present with symptoms of HIV infection or advanced HIV disease
- They or their providers identify a risk for HIV acquisition
- They request an HIV test
- They are pregnant
- They test for or diagnose a sexually transmitted infection, hepatitis C, hepatitis B or tuberculosis

#### Measurement

Numerator #1 for screening for HIV - Number of youth and adults 15 to 65 years of age, excluding those with diagnosed HIV, who are at *low risk* of HIV infection and who have been screened at least once.

Denominator #1 for screening for HIV - Number of youth and adults 15 to 65 years of age, excluding those with diagnosed HIV, who are at *low risk* of HIV infection.

Numerator #2 for screening for HIV - Number of youth and adults 15 to 65 years of age, excluding those with diagnosed HIV, who are at *high risk* of HIV infection and who have been screened at least once in the past five years.

Denominator #2 for screening for HIV - Number of youth and adults 15 to 65 years of age, excluding those with diagnosed HIV, who are at *high risk* of HIV infection.

Numerator #3 for screening for HIV - Number of youth and adults 15 to 65 years of age, excluding those with diagnosed HIV, who are at *very high risk* of HIV infection and who have been screened during the past year.

Denominator #3 for screening for HIV - Number of youth and adults 15 to 65 years of age, excluding those with diagnosed HIV, who are at *very high risk* of HIV infection.

Numerator #4 for screening for HIV - Number of women giving birth who have been screened for HIV during their pregnancy.

Denominator #4 for screening for HIV - Number of women giving birth.

#### In British Columbia

During the five-year time period from 2009 to 2013, a total of 963,022 HIV tests were provided for 653,417 unique individuals aged 15 to 65 in BC,[195] suggesting a current five-year screening rate in this population of approximately 20% (653,417 divided by the 3,267,099 persons aged 15 to 65 living in British Columbia in 2013).

In 2011, the uptake of prenatal HIV screening in BC reached 95.9%.[196]

#### Best in the World

In the U.S. in 2013, the proportion of the population ages 18 to 64 who have ever been tested for HIV is approximately 40-45%.[197]

In England in 2016, 63% of adolescents and adults ages 15 to 64 who sought sexual health services were tested for HIV. This cohort is considered to be at increased risk for HIV. For

[195] Dr. Mark Gilbert, Surveillance & Online Sexual Health Services, Clinical Prevention Services, BC Centre for Disease Control. Personal communication, May, 2014.

[196] Kuo M, Money DM, Alvarez M et al. Test uptake and case detection of syphilis, HIV, and hepatitis C among women undergoing prenatal screening in British Columbia, 2007 to 2011. *Journal of Obstetrics and Gynaecology Canada*. 2014; 36(6): 482-90.

[197] Van Handel M and Branson B. Monitoring HIV testing in the United States: consequences of methodology changes to national surveys. *PloS ONE*. 2015; 10(4): 1-12.

men who have sex with men who also sought sexual health services (a cohort considered to be at very high risk), 83% were tested for HIV.[198]

In the U.K. in 2011, 97% of pregnant women were tested for HIV.[199]

We have assumed that the best HIV screening rates in the world would be 45% for the general population (based on 2013 data from the US), 63% for individuals at increased risk (based on 2016 data from England for adolescents and adults ages 15 to 64 who sought sexual health services), 83% for individuals at very high risk (based on 2016 data from England for men who have sex with men who also sought sexual health services) and 97% for pregnant women (based on 2011 data from the U.K.).

## Screening for Chlamydia and Gonorrhea

Screen for chlamydia and gonorrhea in all sexually active women age 24 years or younger.[200]

In the absence of studies on screening intervals, the USPSTF recommends that a reasonable approach would be to screen patients whose sexual history reveals new or persistent risk factors since the last negative test result.[201]

#### Measurement

Numerator for screening for chlamydia and gonorrhea - Number of sexually active women age 24 years or younger who have been screened for chlamydia and gonorrhea at least once.

Denominator for screening for chlamydia and gonorrhea - Number of sexually active women age 24 years or younger.

#### In British Columbia

We were unable to find information on screening rates for chlamydia or gonorrhea in sexually active women age 24 years or younger in BC.

#### Best in the World

In the United States, screening for chlamydia among sexually active women aged 16 to 24 years in commercial health maintenance organization (HMO) plans increased from 23.1% in 2001 to 47.0% in 2014. Among sexually active women aged 16 to 24 years covered by Medicaid, screening rates increased from 40.4% in 2001 to 54.6% in 2014.[202] We were unable to find screening rates specific to gonorrhea in sexually active women age 24 years or younger.

For the purposes of this project, we have assumed that the best chlamydia and gonorrhea screening rates among sexually active women age 24 years or younger in the world would be 55% (based on the US screening rate for chlamydia observed in 2014).

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[198] England PH. *Sexually Transmitted Infections (STIs): Annual Data Tables*. 2017. Available at https://www.gov.uk/government/statistics/sexually-transmitted-infections-stis-annual-data-tables. Accessed August 2017.

[199] Health Protection Agency. *HIV in the United Kingdom: 2012 Report*. 2012. Available at http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1317137200016. Accessed August 2017.

[200] LeFevre ML. Screening for chlamydia and gonorrhea: US Preventive Services Task Force recommendation statement. *Annals of Internal Medicine*. 2014; 161(12): 902-10.

[201] LeFevre ML. Screening for chlamydia and gonorrhea: US Preventive Services Task Force recommendation statement. *Annals of Internal Medicine*. 2014; 161(12): 902-10.

[202] Centers for Disease Control and Prevention. *Sexually Transmitted Disease Surveillance 2015*. Atlanta: U.S. Department of Health and Human Services; 2016. Available online at https://www.cdc.gov/std/stats15/STD-Surveillance-2015-print.pdf. Accessed August 2017.

## Screening for Hepatitis C Virus Infection

The USPSTF recommends one-time screening for HCV infection to asymptomatic adults born between 1945 and 1965. This is a "B" recommendation.[203]

The CTFPHC recommends *against* screening for HCV in adults who are not at elevated risk. This is a "strong recommendation" based on "very low-quality evidence".[204]

#### Measurement

Numerator for screening for hepatitis C virus infection - Number of adults born between 1945 and 1965, excluding those with diagnosed HCV infection, who have been screened for HCV infection.

Denominator for screening for hepatitis C virus infection - Number of adults born between 1945 and 1965, excluding those with diagnosed HCV infection.

#### In British Columbia

Between 1992 and 2013, a total of 443,018 unique individuals between the ages of 48 to 68 years have been tested for HCV,[205] suggesting an overall screening rate in this population in BC of 32.7% (1,354,520 / 443,018).

#### Best in the World

One-time screening rates for HCV infection in adults born between 1945 and 1965 in the US are up to 76% for high risk patients[206,207] but much lower, at 8 to 10%, for the general population of this cohort.[208,209] In Scotland, an average screening rate of 48% was achieved in eight general practices.[210]

We have assumed that the best one-time screening rate for HCV infection in the general population of adults born between 1945 and 1965 is 48%.

## Prevention of Sexually Transmitted Infections

Recommend intensive behavioral counseling ranging in intensity from 30 min to ≥2 hours of contact time for all sexually active youth and for adults who are at increased risk for STIs.[211] Adults at increased risk include those with current STIs or other infections within the past year, adults who have multiple sex partners and adults who do not consistently use condoms.

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[203] Moyer VA. Screening for hepatitis C virus infection in adults: U.S. Preventive Services Task Force recommendation statement. *Annals of Internal Medicine*. 2013; 159(5): 349-57.
[204] Canadian Task Force on Preventive Health Care. Recommendations on hepatitis C screening for adults. *Canadian Medical Association Journal*. 2017; 189(16): E594-E604.
[205] Dr. Mark Gilbert, Surveillance & Online Sexual Health Services, Clinical Prevention Services, BC Centre for Disease Control. Personal communication, May, 2014.
[206] Cartwright E, Rentsch C and Rimland D. Hepatitis C virus screening practices and seropositivity among US veterans born during 1945–1965. *BioMed Central*. 2014; 7(1): 449.
[207] Gemelas J, Locker R, Rudd S et al. Impact of screening implementing HCV screening of persons born 1945-1965: a primary care case study. *Journal of Primary Care & Community Health*. 2016; 7(1): 30-2.
[208] Litwin A, Smith B, Drainoni M et al. Primary care-based interventions are associated with increases in hepatitis C virus testing for patients at risk. *Digestive and Liver Disease*. 2012; 44(6): 497-503.
[209] Cook N, Turse E, Garcia A et al. Hepatitis C virus infection screening within community health centers. *The Journal of the American Osteopathic Association*. 2016; 116(1): 1-11.
[210] Cullen B, Hutchison S, Cameron S, et al. Identifying former injecting drug users infected with hepatitis C: An evaluation of a general practice-based case-finding intervention. *Journal of Public Health*. 2012; 34(1): 14-23.
[211] LeFevre ML. Behavioral counseling interventions to prevent sexually transmitted infections: US Preventive Services Task Force recommendation statement. *Annals of Internal Medicine*. 2014; 161(12): 894-901.

#### Measurement

Numerator for prevention of sexually transmitted infections - Number of sexually active individuals less than 20 years of age who receive at least 30 minutes of intensive behavioral counseling.

Denominator for prevention of sexually transmitted infections - Number of sexually active individuals less than 20 years of age.

#### In British Columbia

We were unable to find data on the use of behavioural counselling interventions in BC to reduce a person's likelihood of acquiring an STI.

#### Best in the World

Between 2006 and 2010 in the US, 31.2% of sexually experienced females aged 15 to 19 years received STI counseling from a health care provider during the previous 12 months. For sexually experienced males aged 15 to 19 years the rate was 26.1%.[212]

For modelling purposes, we have assumed that the best rate in the world for behavioral counseling in sexually active adolescents is 29%, based on the midpoint for sexually active 15 to 19 year old males and females in the US.

### Counselling and Interventions to Prevent Tobacco Use

Screen all adults 18 years and older for tobacco use and provide up to 90 minutes of tobacco cessation interventions over multiple contacts for those who use tobacco products.[213]

#### Measurement

Numerator #1 for counselling and interventions to prevent tobacco use - Number of adults 18 years and older with documented evidence that they have been screened for tobacco use.

Denominator #1 for counselling and interventions to prevent tobacco use - Number of adults 18 years and older.

Numerator #2 for counselling and interventions to prevent tobacco use - Number of adults 18 years and older who use tobacco and have received at least one tobacco cessation intervention.

Denominator #2 for counselling and interventions to prevent tobacco use - Number of adults 18 years and older who use tobacco.

#### In British Columbia

The BC Smoking Cessation Program was launched in September of 2011. Between September 30, 2011 and October 31, 2014, this program provided almost 122,000 BC residents with free nicotine gum or patches. There were an estimated 644,600 smokers in BC in 2013, suggesting that at least 19% (122,000 / 644,600) of BC tobacco smokers received a tobacco cessation intervention.[214]

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[212] Tyler C, Warner L, Gavin L et al. Receipt of reproductive health services among sexually experienced persons aged 15–19 years—National Survey of Family Growth, United States, 2006–2010. *Morbidity and Mortality Weekly Report*. 2014; 63(2): 2-5.

[213] U.S. Preventive Services Task Force. Counseling and interventions to prevent tobacco use and tobacco-caused disease in adults and pregnant women: U.S. Preventive Services Task Force reaffirmation recommendation statement. *Annals of Internal Medicine*. 2009; 150(8): 551-5.

[214] Province of British Columbia. *BC Smoking Cessation Program: Evaluation of the Nicotine Replacement Therapy Component*. 2015. British Columbia. Available at http://www2.gov.bc.ca/assets/gov/health/health-drug-coverage/pharmacare/smokingcessationevaluationreport.pdf. Accessed August 2017.

#### Best in the World

According to results from the 2005 Canadian Tobacco Use Monitoring Survey (CTUMS), 88% of current Canadian smokers reported visiting a health care provider in the preceding 12 months and 54% of those were advised to reduce or quit smoking.[215] Those who reported receiving such advice were asked if they were provided with information on smoking-cessation aids such as nicotine patches and 55% confirmed that they had. Based on this information, for all 2005 Canadian smokers, 47.5% of individuals received advice to quit and 26.1% were also provided with advice on smoking-cessation aids.

In the United States, the Behavioural Risk Factor Surveillance System has tracked the percentage of smokers who received advice to quit smoking from health care providers. The sample size was persons aged 18 and older who are current smokers (ever smoked 100 or more cigarettes and currently smoked every day or some days) who had also seen a health care provider in the past 12 months. Under these conditions, in 2010 it was found that 50.7% of smokers had received advice to quit in the past 12 months. This was down from 53.3% in 2000 and 58.9% in 2005.[216]

We have assumed that the best rate in the world for the provision of tobacco cessation interventions is 51% (based on data from the US in 2010).

### Alcohol Misuse Screening and Brief Counselling

Screen and provide behavioral counseling interventions to reduce alcohol misuse by adults 18 years and older, including pregnant women.[217] The 2013 USPSTF review found no evidence to determine the optimal interval for screening but did note that brief multi-contact (each contact is 6 to 15 minutes) interventions are most effective, requiring up to 120 minutes of total counseling contact.[218]

BC guidelines for alcohol misuse screening and brief interventions recommend screening annually[219] while economic evaluations have assumed that screening would occur at least once a year to at least once every 10 years.[220,221,222]

#### Measurement

Numerator #1 for alcohol misuse screening - Number of adults 18 years and older with documented evidence that they have been screened for alcohol misuse *in the last year*.

Numerator #2 for alcohol misuse screening (alternate) - Number of adults 18 years and older with documented evidence that they have been screened for alcohol misuse *at least once in the last 10 years*.

Denominator for #1 & #2 for alcohol misuse screening - Number of adults 18 years and older.

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[215] Centers for Disease Control and Prevention. Smoking-cessation advice from health-care providers--Canada, 2005. *Morbidity and Mortality Weekly Report*. 2007; 56(28): 708-12.
[216] Kruger J, Shaw L, Kahende J et al. Health care providers' advice to quit smoking, National Health Interview Survey, 2000, 2005, and 2010. *Preventing Chronic Disease*. 2012; 9: E130.
[217] Moyer VA. Screening and behavioral counseling interventions in primary care to reduce alcohol misuse: U.S. preventive services task force recommendation statement. *Annals of Internal Medicine*. 2013; 159(3): 210-8.
[218] Ibid.
[219] BC Ministry of Health and British Columbia Medical Association. *BC Guidelines: Problem Drinking* 2013. Available at http://www2.gov.bc.ca/gov/content/health/practitioner-professional-resources/bc-guidelines/problem-drinking. Accessed August 2017.
[220] Purshouse R, Brennan A, Rafia R et al. Modelling the cost-effectiveness of alcohol screening and brief interventions in primary care in England. *Alcohol and Alcoholism*. 2012; 48(2): 180-8.
[221] Angus C, Scafato E, Ghirini S et al. Cost-effectiveness of a programme of screening and brief interventions for alcohol in primary care in Italy. *BioMed Central Family Practice*. 2014; 15(1): 1-26.
[222] Zur R and Zaric G. A microsimulation cost–utility analysis of alcohol screening and brief intervention to reduce heavy alcohol consumption in Canada. *Addiction*. 2016; 111(5): 817-31.

Numerator #3 for alcohol misuse intervention - Number of adults 18 years and older who misuse alcohol who received at least one multi-contact intervention.

Denominator #3 for alcohol misuse intervention - Number of adults 18 years and older who misuse alcohol.

#### In British Columbia

We are not aware of any data in BC which indicates the overall proportion of adults who are screened for alcohol misuse or the proportion of problem drinkers who receive a brief intervention.

Based on a 2008/09 survey, BC health care providers talked to 58% of pregnant women and 10% of non-pregnant women about alcohol and its effects on conception and/or pregnancy.[223]

#### Best in the World

In the US, approximately 29% of adult patients have been screened for alcohol misuse in the previous 12 months.[224,225] In Finland, approximately 35% of the adults aged 15 to 69 have ever been screened for alcohol misuse.[226,227] In both countries, some form of follow-up was provided to approximately 50% of heavy drinkers.[228,229] More formal interventions including medications and counselling are provided to between 20% and 30% of heavy drinkers in the US.[230,231]

We have assumed that the best rate in the world is 35% for alcohol screening of adults 18 years and older (based on evidence from Finland) and 30% for brief counseling of heavy drinkers (based on evidence from the US).

### Screening For and Management of Obesity in Adults

Screen all adults 18 years and older for obesity and offer or refer patients with a body mass index (BMI) of 30 $kg/m^2$ or higher to intensive, multicomponent behavioral interventions involving between 12 and 26 sessions in a year.[232,233] Screening should take place on a regular basis to measure weight trajectories over time.

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[223] BC Stats, Ministry of Citizens' Services and the Women's Healthy Living Secretariat and Ministry of Healthy Living and Sport. *Healthy Choices in Pregnancy: Results from the Community Health Education and Social Services Omnibus Survey in British Columbia, April 2008 to March 2009*. Available at http://www.health.gov.bc.ca/library/publications/year/2010/bcstats-hcip-report.pdf. Accessed August 2017.

[224] Edlund M, Unützer J and Wells K. Clinician screening and treatment of alcohol, drug, and mental problems in primary care: results from health care for communities. *Medical Care*. 2004; 42(12): 1158-66.

[225] D'Amico EJ, Paddock SM, Burnam A et al. Identification of and guidance for problem drinking by general medical providers: results from a national survey. *Medical Care*. 2005; 43(3): 229-36.

[226] Aalto M, Pekuri P and Seppä K. Primary health care professionals' activity in intervening in patients' alcohol drinking: a patient perspective. *Drug and Alcohol Dependence*. 2002; 66(1): 39-43.

[227] Mäkelä P, Havio M and Seppä K. Alcohol-related discussions in health care - a population view. *Addiction*. 2011; 106(7): 1239-48.

[228] D'Amico EJ, Paddock SM, Burnam A et al. Identification of and guidance for problem drinking by general medical providers: results from a national survey. *Medical Care*. 2005; 43(3): 229-36.

[229] Mäkelä P, Havio M and Seppä K. Alcohol-related discussions in health care - a population view. *Addiction*. 2011; 106(7): 1239-48.

[230] Edlund M, Unützer J and Wells K. Clinician screening and treatment of alcohol, drug, and mental problems in primary care: results from health care for communities. *Medical Care*. 2004; 42(12): 1158-66.

[231] D'Amico EJ, Paddock SM, Burnam A et al. Identification of and guidance for problem drinking by general medical providers: results from a national survey. *Medical Care*. 2005; 43(3): 229-36.

[232] Canadian Task Force on Preventive Health Care. Recommendations for prevention of weight gain and use of behavioural and pharmacologic interventions to manage overweight and obesity in adults in primary care. *Canadian Medical Association Journal*. 2015; 187(3): 184-95.

[233] Moyer VA. Screening for and management of obesity in adults: US Preventive Services Task Force recommendation statement. *Annals of Internal Medicine*. 2012; 157(5): 373-8.

#### Measurement

Numerator #1 for screening for obesity - Number of adults 18 years and older, excluding individuals with eating disorders or who are pregnant, with documented evidence of measured height and weight and calculated BMI each year.

Denominator for #1 for screening for obesity - Number of adults 18 years and older, excluding individuals with eating disorders or who are pregnant.

Numerator #1 for management of obesity - Number of adults 18 years and older with a calculated BMI ≥30 who have been *referred* to an intensive, multicomponent behavioral interventions to promote improvement in weight status at least once.

Numerator #2 for management of obesity - Number of adults 18 years and older with a calculated BMI ≥30 who have *attended* an intensive, multicomponent behavioral intervention to promote improvement in weight status.

Numerator #3 for management of obesity - Number of adults 18 years and older with a calculated BMI ≥30 who have *completed* at least 70% of an intensive, multicomponent behavioral intervention to promote improvement in weight status.

Denominator for #1 to #3 for management of obesity - Number of adults 18 years and older with a calculated BMI ≥30.

#### In British Columbia

We were unable to find information for BC regarding the frequency of measuring height and weight in primary care or what proportion of individuals with a BMI of 30 $kg/m^2$ or higher were being referred to an intensive, multicomponent behavioral intervention.

#### Best in the World

In the US, the measurement of both height and weight in adults 18+ during a primary care visit increased from 33% in 2005/06 to 54% in 2008/09 and 73% in 2012/13.[234] In 2006/07, 37% of patients with diagnosed obesity in the US received some counselling for diet, exercise or weight reduction in primary care.[235] This proportion has declined to 33% in 2008/09 and 21% in 2012/13. Primary care visits where weight management counseling occurred lasted an average of 22 minutes.[236] In a recent US study of 14 primary care clinics, however, 33% of patients with obesity had documentation of obesity treatment (between January and July of 2015) but only 2.2% of patients had a *referral* to a weight management intervention.[237]

We have assumed that the best rate in the world for obesity screening of adults 18 years and older is 73% (based on evidence from the US in 2012/13) while the best rate in the world for offering or referring patients with a BMI of ≥30 to an intensive, multicomponent behavioral intervention is 33% (based on evidence from the US in 2015).

### Preventing Falls in Community-Dwelling Elderly

Exercise or physical therapy and vitamin D supplementation to prevent falls in community-dwelling adults aged 65 years or older who are at increased risk for falls.[238]

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[234] Fitzpatrick S and Stevens V. Adult obesity management in primary care, 2008–2013. *Preventive Medicine*. 2017; 99: 128-33.
[235] Ma J, Xiao L and Stafford R. Adult obesity and office-based quality of care in the United States. *Obesity*. 2009; 17(5): 1077-85.
[236] Fitzpatrick S and Stevens V. Adult obesity management in primary care, 2008–2013. *Preventive Medicine*. 2017; 99: 128-33.
[237] Fitzpatrick S, Dickins K, Avery E et al. Effect of an obesity best practice alert on physician documentation and referral practices. *Translational Behavioral Medicine*. 2017: 1-10.
[238] Moyer VA. Prevention of falls in community-dwelling older adults: U.S. Preventive Services Task Force recommendation statement. *Annals of Internal Medicine*. 2012; 157(3): 197-204.

The USPSTF suggests annual screening for risk using "a pragmatic, expert-supported approach to identifying high risk persons (based on) a history of falls and mobility problems and the results of a timed Get-Up-and-Go test. The test is performed by observing the time it takes a person to rise from an armchair, walk 3 meters (10 feet), turn, walk back, and sit down again." Exercise should consist of at least 150 minutes of moderate intensity activity per week while Vitamin D supplementation of 800 IU per day should occur for at least one year.[239]

#### Measurement

Numerator #1 for screening for fall risk - Number of community-dwelling adults aged 65 years or older who have been screened for fall risk during the last year.

Denominator for #1 for screening for fall risk - Number of community-dwelling adults aged 65 years or older.

Numerator #2 for interventions to prevent falls - Number of community-dwelling adults aged 65 years or older at increased risk for falls for whom exercise, physical therapy and/or vitamin D supplementation has been recommended.

Denominator for #2 for interventions to prevent falls - Number of community-dwelling adults aged 65 years or older at increased risk for falls.

#### In British Columbia

We are not aware of any information identifying the proportion of community-dwelling elderly in BC who are at risk for falls nor the proportion of those at risk of falls who are engaging in at least 150 minutes of moderate intensity exercise per week or taking 800 IU of vitamin D supplements daily.

#### Best in the World

We were unable to find any comprehensive data on the proportion of community-dwelling elderly who are screened for fall risk and, when at higher risk, are encouraged to engage in exercise or physical therapy and vitamin D supplementation to reduce that risk.

In a survey of 100 primary care physicians, 63% said they only screened for fall risk if their patients expressed a concern about falling.[240] However, another study found that just 31.2% of elderly females and 24.3% of elderly males talked to their health care provider even after they fell.[241] Based on these two pieces of evidence, and the assumption that 53%[242] of the population age 65 and older are females, 17.6% of the elderly would be screened for fall risk (((0.312 * 0.53) + (0.243 * 0.47)) * 0.63).

Adhering to falls prevention interventions by the community-dwelling elderly is another challenge. Even in the context of a research project, a third[243] to half[244] of participants do not adhere to falls prevention interventions.

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[239] Ibid.

[240] Jones T, Ghosh T, Horn K et al. Primary care physician's perceptions and practices regarding fall prevention in adults 65 years and over. *Accident Analysis & Prevention*. 2011; 43(5): 1605-9.

[241] Stevens J, Ballesteros M, Mack K et al. Gender differences in seeking care for falls in the aged Medicare population. *American Journal of Preventive Medicine*. 2012; 43(1): 59-62.

[242] Based on BC population data for 2017

[243] Osho O, Owoeye O and Armijo-Olivo S. Adherence and attrition in fall prevention exercise programs for community-dwelling older adults: a systematic review and meta-analysis. *Journal of Aging and Physical Activity*. 2017: 1-41.

[244] Nyman S and Victor C. Older people's participation in and engagement with falls prevention interventions in community settings: an augment to the Cochrane systematic review. *Age and Ageing*. 2011; 41(1): 16-23.

In 2011/12, 61% of noninstitutionalized adults ≥65 years of age living in the US took a vitamin D supplement, either as part of a multi-vitamin or multi-mineral supplement or as an individual supplement.[245]

Based on this indirect evidence, we have assumed for the purposes of this project that the best screening rate in the world for fall risk is 18% (see calculation of 17.6% above) and that the best rate in the world for vitamin D supplementation is 61% (based on evidence from the US in 2011/12). We were unable to find even indirect evidence indicating the proportion of the elderly at high risk of falling who were encouraged to engage in exercise or physical therapy.

## Routine Aspirin Use for the Prevention of Cardiovascular Disease and Colorectal Cancer

Initiate low dose aspirin use for the primary prevention of cardiovascular disease (CVD) and colorectal cancer in adults aged 50 to 59 years who have a 10% or greater 10-year CVD risk, are not at increased risk for bleeding, have a life expectancy of at least 10 years, and are willing to take low-dose aspirin daily for at least 10 years. [246]

### Measurement

Numerator for screening for CVD and bleeding risk - Number of adults 50 to 59 years of age, excluding those with diagnosed CVD, who have been screened for CVD and bleeding risk.

Denominator for screening for CVD and bleeding risk - Number of adults 50 to 59 years of age, excluding those with diagnosed CVD.

Numerator for recommendation of aspirin use - Number of adults 50 to 59 years of age who have a 10% or greater 10-year CVD risk, do not have diagnosed CVD and are not at increased risk for bleeding for whom a daily low dose aspirin for the primary prevention of cardiovascular disease (CVD) and colorectal cancer has been recommended.

Denominator for recommendation of aspirin use - Number of adults 50 to 59 years of age who have a 10% or greater 10-year CVD risk, do not have diagnosed CVD and are not at increased risk for bleeding.

Numerator for long-term aspirin use - Number of adults 60 to 69 years of age who have a 10% or greater 10-year CVD risk, do not have diagnosed CVD and are not at increased risk for bleeding who consumed a daily low dose aspirin for the primary prevention of cardiovascular disease (CVD) and colorectal cancer for at least 10 years.

Denominator for long-term aspirin use - Number of adults 60 to 69 years of age who have a 10% or greater 10-year CVD risk, do not have diagnosed CVD and are not at increased risk for bleeding.

### In British Columbia

We were unable to find specific data on low-dose aspirin use for primary prevention purposes in the BC population ages 50-69 who have a 10% or greater 10-year CVD risk and are not at increased risk for bleeding.

### Best in the World

Evidence regarding compliance with the very specific 2016 USPSTF guidelines regarding aspirin use for the primary prevention of cardiovascular disease and colorectal cancer is not yet available. Previous data indicates that 32% of US adults ages 50-59 and 45% ages 60-69

[245] Kantor E, Rehm C, Du M et al. Trends in dietary supplement use among US adults from 1999-2012. *Journal of American Medical Association*. 2016; 316(14): 1464-74.

[246] Bibbins-Domingo K. Aspirin use for the primary prevention of cardiovascular disease and colorectal cancer: US Preventive Services Task Force recommendation statement. *Annals of Internal Medicine*. 2016; 164(12): 836-45.

reported using aspirin for primary prevention in 2011/12.[247] This decreased to 24% of US adults ages 50-64 between 2012 and 2015.[248]

Based on the previous 2009 USPSTF guideline[249] recommendations, approximately one-third of clinicians recommended aspirin to patients who would have been eligible for primary prevention of cardiovascular disease.[250,251] If patient compliance with their clinician's recommendation is taken into account, then 24% of patients eligible for aspirin primary prevention as per the 2009 USPSTF guidelines take aspirin.[252]

We have assumed a 'best in the world' rate for screening (CVD and bleeding risk) of 33% (equivalent to the proportion of clinicians in the US who are willing to recommend aspirin to their patients for the primary prevention of CVD). We have assumed the best rate in the world for ongoing use of aspirin in individuals eligible based on the current USPSTF guidelines would be 24% (based on estimated adherence in the US to the 2009 USPSTF guidelines).

## Folic Acid Supplementation for the Prevention of Neural Tube Defects

All women who are planning or capable of pregnancy take a daily supplement containing 0.4 to 0.8 mg (400-800µg) of folic acid.[253]

#### Measurement

Numerator for folic acid supplementation - Number of women 15 to 45 years of age who take a daily supplement containing 0.4 to 0.8 mg of folic acid.

Denominator for folic acid supplementation - Number of women 15 to 45 years of age.

#### In British Columbia

In a survey conducted at Children's and Women's Health Center in BC in 1999, 71% of women surveyed knew that vitamins could prevent birth defects, however only 49.4% of all women took vitamins prior to pregnancy.[254]

Based on the Canadian Maternity Experiences Survey conducted between October of 2006 and January of 2007, 61.3% of women who were 5 to 14 months postpartum living in BC

[247] Gu Q, Dillon C, Eberhardt M et al. Preventive aspirin and other antiplatelet medication use among US adults aged ≥ 40 years: data from the National Health and Nutrition Examination Survey, 2011–2012. *Public Health Reports*. 2015; 130(6): 643-54.
[248] Stuntz M and Bernstein B. Recent trends in the prevalence of low-dose aspirin use for primary and secondary prevention of cardiovascular disease in the United States, 2012–2015. *Preventive Medicine Reports*. 2017; 5: 183-6.
[249] US Preventive Services Task Force. Aspirin for the prevention of cardiovascular disease: US Preventive Services Task Force recommendation statement. *Annals of Internal Medicine*. 2009; 150(6): 396-404.
[250] Fiscella K, Winters P, Mendoza M et al. Do clinicians recommend aspirin to patients for primary prevention of cardiovascular disease? *Journal of General Internal Medicine*. 2013; 30(2): 155-60.
[251] Malayala S and Raza A. Compliance with USPSTF recommendations on aspirin for prevention of cardiovascular disease in men. *International Journal of Clinical Practice*. 2016; 70(11): 898-906.
[252] Ibid.
[253] Bibbins-Domingo K, Grossman D, Curry S et al. Folic acid supplementation for the prevention of neural tube defects: US Preventive Services Task Force recommendation statement. *Journal of American Medical Association*. 2017; 317(2): 183-9.
[254] Morin V, Mondor M and Wilson R. Knowledge on periconceptional use of folic acid in women of British Columbia. *Fetal Diagnosis and Therapy*. 2001; 16(2): 111-5.

reported taking folic acid supplementation three months before pregnancy and 93.9% reported taking it during the first three months of pregnancy.[255]

In a 2003 survey of 148 women aged 18 to 45 years living in Vancouver, 28% used a supplement containing folic acid on a daily basis.[256]

Folic acid supplementation is just one source of folic acid. For example, folic acid is naturally available in some foods and is added to white flour, pasta and cornmeal during manufacturing. Fortification of grains began in 1996 as a response to the growing awareness of the benefits of folic acid. It is therefore important to consider all sources of folic acid.

One way to do this is by measuring the concentration of red blood cell folate. Based on the 2007 – 2009 *Canadian Health Measures Survey*, 22% of women of childbearing age (ages 15 to 45) exhibited a low concentration of red blood cell folate. Specifically, it was below the level considered to be optimal for minimizing the risk of neural tube defects (<906 nmol/L). The inverse argument could also be made, namely that 78% of Canadian women of reproductive age have sufficient folate intake to minimize the risk of neural tube defects.[257]

#### Best in the World

In 2011/12, 34% of US women between the ages of 20 and 44 used folic acid supplementation, most commonly as part of a multi-vitamin or multi-mineral supplement.[258]

We have assumed a 'best in the world' rate for taking a daily supplement containing folic acid to be 34% (based on the evidence from the US in 2011/12).

### Adherence

There are two levels of adherence that need to be taken into account when calculating a rate of coverage for the service in British Columbia or the best rate in the world. The first is clinician adherence with guideline recommendations. For example, guidelines may recommend that 100% of a specific population be offered a particular type of screening. For a variety of reasons, however, not all clinicians offer that screening to the population. The second is patient adherence or compliance. When offered the screening by a clinician, not all patients would agree to have the screening done. Calculating a rate of coverage in the population is based on a combination of these two levels of adherence. For example, if 70% of clinicians offer a service to their patients and 70% of patients accept, then the rate of coverage in the population would be 49% (70% * 70%).

### Converting Foreign Currency to Canadian Dollars

Whenever possible, unit costs developed in BC are used in the calculation of cost-effectiveness. Unfortunately, BC-specific unit costs are often not available. In this case, we search for unit cost estimates from other Canadian sources followed by unit cost estimates from international sources. The CCEMG – EPPI-Centre Cost Converter[259,260] is a free web-

[255] Nelson C, Leon J and Evans J. The relationship between awareness and supplementation: which Canadian women know about folic acid and how does that translate into use. *Canadian Journal of Public Health*. 2014; 105(1): e40-6.
[256] French M, Barr S and Levy-Milne R. Folate intakes and awareness of folate to prevent neural tube defects: a survey of women living in Vancouver, Canada. *Journal of the American Dietetic Association*. 2003; 103(2): 181-5.
[257] Colapinto C, O'Connor D and Tremblay M. Folate status of the population in the Canadian Health Measures Survey. *Canadian Medical Association Journal*. 2011; 183(2): E100-E6.
[258] Kantor E, Rehm C, Du M et al. Trends in dietary supplement use among US adults from 1999-2012. *Journal of American Medical Association*. 2016; 316(14): 1464-74.
[259] Shemilt I, Thomas J and Morciano M. A web-based tool for adjusting costs to a specific target currency and price year. *Evidence & Policy: A Journal of Research, Debate and Practice*. 2010; 6(1): 51-9.

based tool for adjusting estimates of unit costs expressed in one currency and price year to a specific target currency and price year. In every situation, we want to convert estimated unit costs into 2017 Canadian dollars (CAD).

The CCEMG – EPPI-Centre Cost Converter currently converts unit costs up to the 2016 year. When converting unit costs into 2017 CAD we have increased the output from the CCEMG – EPPI-Centre Cost Converter by 1.32%, the average annual rate of inflation in Canada between 2016 and 2017.[261]

For example, unit costs estimates of $100 in 2010 in Canada are converted to $107.64 in 2016 in Canada by the CCEMG – EPPI-Centre Cost Converter. Adding the 1.32% for inflation results in a unit cost of $109.06 in 2017 CAD.

As a further example, unit costs estimates of $100 in 2010 Australian dollars (AUD) are converted to $89.53 in 2016 CAD by the CCEMG – EPPI-Centre Cost Converter. Adding the 1.32% for inflation results in a unit cost of $90.71 in 2017 CAD.

As a final example, unit costs estimates of $100 in 2010 US dollars (USD) are converted to $132.18 in 2016 CAD by the CCEMG – EPPI-Centre Cost Converter. Adding the 1.32% for inflation results in a unit cost of $133.92 in 2017 CAD.

A challenge specific to converting US health care unit costs to Canadian unit costs is the substantially higher unit costs (or prices) in the US compared to those in Canada for the same output. That is, unit costs are estimated to be 29% higher in the US than in Canada.[262263,264] To reflect these excess health care prices in the US, we take a final step and reduce the estimate generated above using the CCEMG – EPPI-Centre Cost Converter by 29%. Thus the $133.92 in the example above is reduced from $133.92 (by $38.84) to $95.09.

*Note that if the US unit costs included in a given model are not health care-based, then this final step is not taken.* Such costs might include, for example, the additional educational costs associated with caring for a child with fetal alcohol spectrum disorder or spina bifida.

To keep relatively current, unit costs should be updated at least once every five years.

### Patient Time Costs

Patient time costs resulting from receiving, as well as travelling to and from, a service are valued based on the average hourly wage rate in BC in 2017 ($25.16[265]) plus 18% benefits for an average cost per hour of $29.69. In the absence of specific data on the amount of time required, we assume two hours per service.

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[260] The Campbell and Cochrane Economics Methods Group and Evidence for Policy and Practice Information and Coordinating Centre. *CCEMG - EPPI-Centre Cost Converter*. 2016. Available at https://eppi.ioe.ac.uk/costconversion/. Accessed July 2017.

[261] Bank of Canada. *Inflation Calculator*. 2017. Available at http://www.bankofcanada.ca/rates/related/inflation-calculator/. Accessed July 2017.

[262] Papanicolas I, Woskie L Jha A. Health care spending in the United States and other high-income countries. *JAMA*. 2018; 319(10):1024-1039.

[263] Anderson GF, Reinhardt UE, Hussey PS et al. It's the prices, stupid: why the United States is so different from other countries. *Health Affairs*. 2003; 22(3): 89-105.

[264] Reinhardt U. *Why Does US Health Care Cost So Much? (Part I)*. 2008. Available at https://economix.blogs.nytimes.com/2008/11/14/why-does-us-health-care-cost-so-much-part-i/. Accessed July 2017.

[265] Statistics Canada. *Average Hourly Wages of Employees by Selected Characteristics and Occupation, Unadjusted Data, by Province (monthly) (British Columbia)*. 2017. Available at http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/labr69k-eng.htm. Accessed July 2017.

Patient time costs are truncated at $222.67 per day (7.5 hours times $29.69). If, for example, we are valuing a patient's time costs while in hospital, each day would be assessed a value of $222.67 (rather than 24 hours times $29.69 or $712.56).

### GP Office Visit Cost

The cost of an office visit to a General Practitioner (GP) in BC varies by the age of the patient, as follows:[266]

- Visit in office age 0-1 (MSP fee 12100) - $33.70
- Visit in office age 2-49 (MSP fee 00100) - $30.64
- Visit in office age 50-59 (MSP fee 15300) - $33.70
- Visit in office age 60-69 (MSP fee 16100) - $35.24
- Visit in office age 70-79 (MSP fee 17100) - $39.83
- Visit in office age 80+ (MSP fee 18100) - $45.95

The estimated cost of a visit to a GP of $34.85 is based on the average cost of an office visit between the ages of 2 and 79.

The cost of a follow-up phone call or email correspondence is $15.00 (MSP fee G14079 - GP Telephone/Email Management Fee).[267]

A key question is whether one or more preventive maneuvers might be completed during an individual office visit. If evidence is available on this question, either research evidence or specific advice from our GP advisors given their knowledge of the BC practice environment, then that evidence is used in the modelling. If no evidence is available, however, then we assume that 50% of an office visit is required per preventive maneuver and modify this from 33% to 66% in the sensitivity analysis.

### Life Table

Data on the number and proportion of expected deaths, life-years lived and life expectancy by sex and age group in British Columbia are based on Statistics Canada data for 2010 to 2012 (see following table).[268]

[266] Ministry of Health. *Medical Services Commission Payment Schedule*. 2016. Available at http://www2.gov.bc.ca/assets/gov/health/practitioner-pro/medical-services-plan/msc-payment-schedule-december-2016.pdf. Accessed July 2017.
[267] Ibid.
[268] Statistics Canada. *Elements of the Life Table, Canada, Provinces and Territories*. 2016. Available at http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=530003. Accessed July 2017.

| Life Tables, British Columbia, 2010 to 2012 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Females | | | | Males | | | | Both Sexes | | | |
| Age | # of Survivors | # of Deaths | Life Years Lived, Age x to x+n | Life Exp. | # of Survivors | # of Deaths | Life Years Lived, Age x to x+n | Life Exp. | # of Survivors | # of Deaths | Life Years Lived, Age x to x+n | Life Exp. |
| 0 | 100,000 | 339 | 99,700 | 84.2 | 100,000 | 418 | 99,635 | 80.2 | 100,000 | 379 | 99,667 | 82.2 |
| 1 | 99,661 | 23 | 99,652 | 83.5 | 99,582 | 21 | 99,574 | 79.6 | 99,621 | 22 | 99,612 | 81.5 |
| 2 | 99,639 | 18 | 99,629 | 82.5 | 99,562 | 14 | 99,551 | 78.6 | 99,599 | 16 | 99,588 | 80.5 |
| 3 | 99,621 | 14 | 99,613 | 81.5 | 99,547 | 10 | 99,546 | 77.6 | 99,583 | 13 | 99,577 | 79.6 |
| 4 | 99,607 | 11 | 99,598 | 80.5 | 99,537 | 8 | 99,534 | 76.6 | 99,570 | 10 | 99,564 | 78.6 |
| 5 | 99,596 | 9 | 99,592 | 79.5 | 99,529 | 7 | 99,526 | 75.6 | 99,560 | 8 | 99,556 | 77.6 |
| 6 | 99,587 | 7 | 99,584 | 78.6 | 99,522 | 6 | 99,519 | 74.6 | 99,551 | 7 | 99,548 | 76.6 |
| 7 | 99,580 | 6 | 99,577 | 77.6 | 99,516 | 6 | 99,513 | 73.6 | 99,544 | 7 | 99,541 | 75.6 |
| 8 | 99,574 | 5 | 99,571 | 76.6 | 99,511 | 6 | 99,508 | 72.6 | 99,537 | 6 | 99,534 | 74.6 |
| 9 | 99,569 | 5 | 99,567 | 75.6 | 99,505 | 7 | 99,501 | 71.6 | 99,531 | 6 | 99,528 | 73.6 |
| 10 | 99,564 | 4 | 99,562 | 74.6 | 99,498 | 8 | 99,494 | 70.6 | 99,525 | 6 | 99,521 | 72.6 |
| 11 | 99,560 | 4 | 99,558 | 73.6 | 99,490 | 9 | 99,486 | 69.6 | 99,518 | 7 | 99,515 | 71.6 |
| 12 | 99,556 | 5 | 99,553 | 72.6 | 99,482 | 11 | 99,476 | 68.6 | 99,511 | 8 | 99,507 | 70.6 |
| 13 | 99,551 | 6 | 99,548 | 71.6 | 99,471 | 13 | 99,464 | 67.6 | 99,503 | 10 | 99,498 | 69.6 |
| 14 | 99,545 | 9 | 99,540 | 70.6 | 99,458 | 17 | 99,449 | 66.6 | 99,493 | 13 | 99,486 | 68.6 |
| 15 | 99,535 | 14 | 99,528 | 69.6 | 99,441 | 21 | 99,431 | 65.7 | 99,479 | 19 | 99,470 | 67.6 |
| 16 | 99,521 | 22 | 99,510 | 68.6 | 99,420 | 28 | 99,406 | 64.7 | 99,460 | 26 | 99,447 | 66.6 |
| 17 | 99,499 | 29 | 99,484 | 67.6 | 99,392 | 36 | 99,374 | 63.7 | 99,434 | 34 | 99,417 | 65.7 |
| 18 | 99,469 | 32 | 99,453 | 66.6 | 99,356 | 46 | 99,333 | 62.7 | 99,400 | 41 | 99,380 | 64.7 |
| 19 | 99,437 | 33 | 99,421 | 65.7 | 99,310 | 58 | 99,281 | 61.7 | 99,360 | 47 | 99,336 | 63.7 |
| 20 | 99,405 | 33 | 99,388 | 64.7 | 99,252 | 69 | 99,218 | 60.8 | 99,312 | 52 | 99,286 | 62.7 |
| 21 | 99,372 | 33 | 99,356 | 63.7 | 99,184 | 78 | 99,145 | 59.8 | 99,260 | 56 | 99,232 | 61.8 |
| 22 | 99,339 | 33 | 99,323 | 62.7 | 99,106 | 83 | 99,065 | 58.9 | 99,204 | 58 | 99,175 | 60.8 |
| 23 | 99,307 | 32 | 99,290 | 61.7 | 99,023 | 84 | 98,981 | 57.9 | 99,146 | 58 | 99,117 | 59.8 |
| 24 | 99,274 | 32 | 99,258 | 60.8 | 98,939 | 81 | 98,899 | 57.0 | 99,088 | 56 | 99,060 | 58.9 |
| 25 | 99,242 | 32 | 99,227 | 59.8 | 98,858 | 76 | 98,820 | 56.0 | 99,032 | 54 | 99,005 | 57.9 |
| 26 | 99,211 | 32 | 99,195 | 58.8 | 98,782 | 74 | 98,745 | 55.1 | 98,977 | 53 | 98,951 | 56.9 |
| 27 | 99,179 | 33 | 99,163 | 57.8 | 98,709 | 72 | 98,672 | 54.1 | 98,925 | 53 | 98,898 | 56.0 |
| 28 | 99,146 | 34 | 99,129 | 56.8 | 98,636 | 72 | 98,600 | 53.1 | 98,872 | 53 | 98,845 | 55.0 |
| 29 | 99,112 | 36 | 99,095 | 55.9 | 98,564 | 74 | 98,527 | 52.2 | 98,819 | 55 | 98,791 | 54.0 |
| 30 | 99,077 | 38 | 99,058 | 54.9 | 98,490 | 77 | 98,451 | 51.2 | 98,764 | 58 | 98,735 | 53.1 |
| 31 | 99,039 | 41 | 99,018 | 53.9 | 98,413 | 81 | 98,373 | 50.2 | 98,706 | 61 | 98,675 | 52.1 |
| 32 | 98,997 | 44 | 98,975 | 52.9 | 98,332 | 85 | 98,289 | 49.3 | 98,645 | 65 | 98,612 | 51.1 |
| 33 | 98,953 | 48 | 98,929 | 51.9 | 98,247 | 90 | 98,202 | 48.3 | 98,579 | 69 | 98,545 | 50.2 |
| 34 | 98,905 | 52 | 98,879 | 51.0 | 98,157 | 95 | 98,109 | 47.4 | 98,510 | 74 | 98,474 | 49.2 |
| 35 | 98,854 | 56 | 98,826 | 50.0 | 98,062 | 101 | 98,011 | 46.4 | 98,437 | 78 | 98,398 | 48.2 |
| 36 | 98,798 | 60 | 98,768 | 49.0 | 97,961 | 107 | 97,908 | 45.5 | 98,359 | 83 | 98,317 | 47.3 |
| 37 | 98,738 | 65 | 98,706 | 48.1 | 97,854 | 113 | 97,798 | 44.5 | 98,275 | 89 | 98,230 | 46.3 |
| 38 | 98,673 | 70 | 98,638 | 47.1 | 97,741 | 120 | 97,681 | 43.6 | 98,186 | 95 | 98,138 | 45.4 |
| 39 | 98,603 | 75 | 98,566 | 46.1 | 97,621 | 128 | 97,557 | 42.6 | 98,091 | 102 | 98,040 | 44.4 |
| 40 | 98,528 | 82 | 98,487 | 45.1 | 97,493 | 136 | 97,425 | 41.7 | 97,989 | 109 | 97,934 | 43.4 |
| 41 | 98,446 | 88 | 98,402 | 44.2 | 97,357 | 146 | 97,284 | 40.7 | 97,880 | 117 | 97,822 | 42.5 |
| 42 | 98,358 | 95 | 98,311 | 43.2 | 97,211 | 156 | 97,134 | 39.8 | 97,763 | 125 | 97,700 | 41.5 |
| 43 | 98,263 | 103 | 98,212 | 42.3 | 97,056 | 166 | 96,973 | 38.9 | 97,638 | 135 | 97,571 | 40.6 |
| 44 | 98,161 | 111 | 98,105 | 41.3 | 96,889 | 178 | 96,800 | 37.9 | 97,503 | 145 | 97,431 | 39.6 |
| 45 | 98,050 | 120 | 97,990 | 40.4 | 96,711 | 191 | 96,615 | 37.0 | 97,359 | 156 | 97,281 | 38.7 |

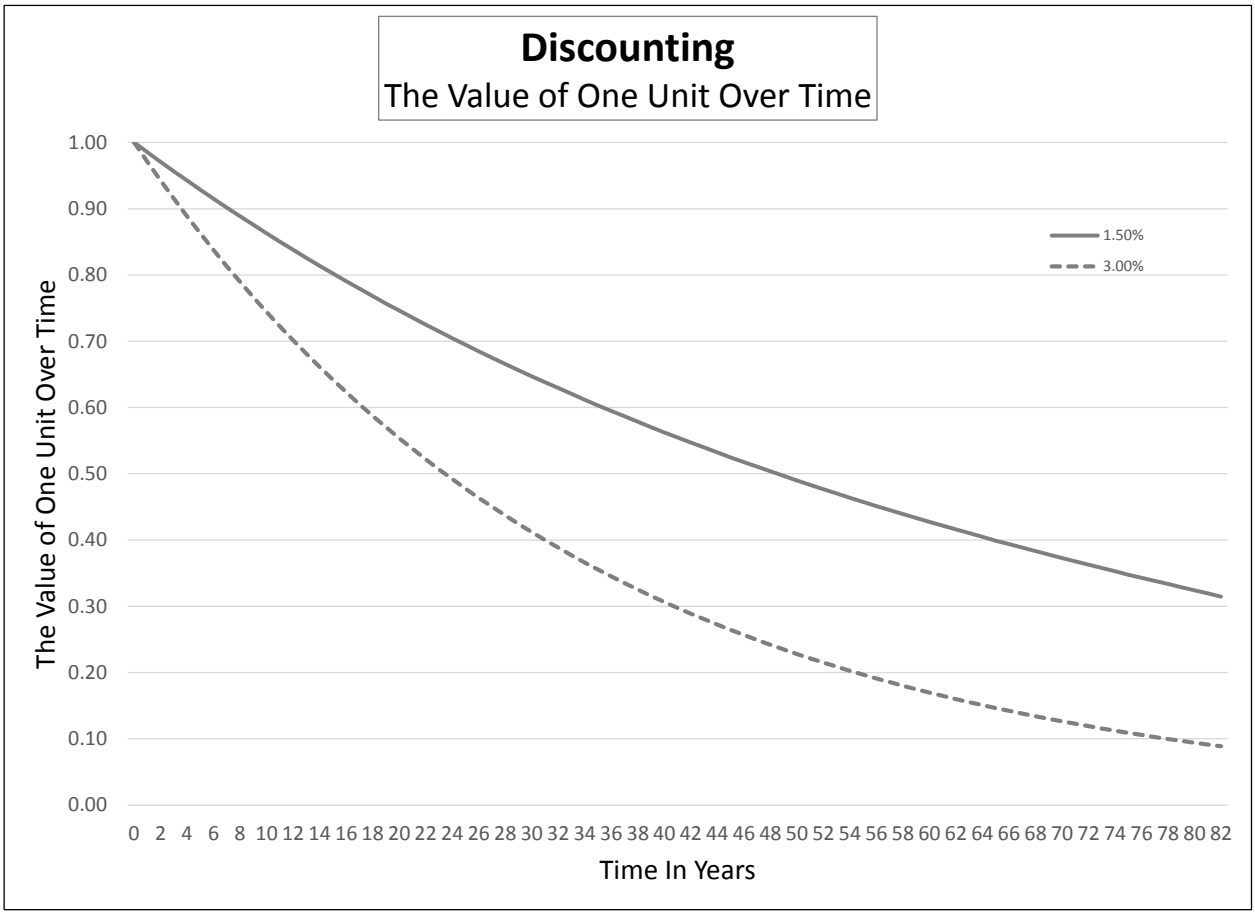
| Life Tables, British Columbia, 2010 to 2012 (continued) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Females | | | | Males | | | | Both Sexes | | | |
| Age | # of Survivors | # of Deaths | Life Years Lived, Age x to x+n | Life Exp. | # of Survivors | # of Deaths | Life Years Lived, Age x to x+n | Life Exp. | # of Survivors | # of Deaths | Life Years Lived, Age x to x+n | Life Exp. |
| 46 | 97,930 | 130 | 97,865 | 39.4 | 96,519 | 206 | 96,417 | 36.1 | 97,203 | 168 | 97,119 | 37.8 |
| 47 | 97,800 | 140 | 97,730 | 38.5 | 96,314 | 221 | 96,203 | 35.1 | 97,035 | 181 | 96,945 | 36.8 |
| 48 | 97,660 | 151 | 97,584 | 37.5 | 96,092 | 239 | 95,973 | 34.2 | 96,855 | 195 | 96,757 | 35.9 |
| 49 | 97,509 | 164 | 97,427 | 36.6 | 95,854 | 257 | 95,725 | 33.3 | 96,659 | 211 | 96,554 | 35.0 |
| 50 | 97,345 | 177 | 97,256 | 35.6 | 95,596 | 278 | 95,457 | 32.4 | 96,449 | 228 | 96,335 | 34.0 |
| 51 | 97,168 | 191 | 97,072 | 34.7 | 95,318 | 301 | 95,168 | 31.5 | 96,221 | 247 | 96,098 | 33.1 |
| 52 | 96,977 | 207 | 96,873 | 33.8 | 95,017 | 325 | 94,855 | 30.6 | 95,974 | 267 | 95,841 | 32.2 |
| 53 | 96,769 | 225 | 96,657 | 32.8 | 94,692 | 352 | 94,516 | 29.7 | 95,707 | 289 | 95,562 | 31.3 |
| 54 | 96,545 | 244 | 96,423 | 31.9 | 94,340 | 382 | 94,149 | 28.8 | 95,418 | 314 | 95,261 | 30.4 |
| 55 | 96,301 | 265 | 96,168 | 31.0 | 93,958 | 414 | 93,751 | 27.9 | 95,104 | 341 | 94,933 | 29.5 |
| 56 | 96,036 | 288 | 95,892 | 30.1 | 93,544 | 449 | 93,319 | 27.0 | 94,763 | 370 | 94,578 | 28.6 |
| 57 | 95,748 | 313 | 95,591 | 29.2 | 93,095 | 487 | 92,852 | 26.2 | 94,393 | 402 | 94,192 | 27.7 |
| 58 | 95,435 | 341 | 95,264 | 28.3 | 92,608 | 529 | 92,344 | 25.3 | 93,991 | 437 | 93,773 | 26.8 |
| 59 | 95,093 | 372 | 94,907 | 27.4 | 92,079 | 574 | 91,792 | 24.4 | 93,554 | 475 | 93,317 | 25.9 |
| 60 | 94,721 | 406 | 94,518 | 26.5 | 91,505 | 624 | 91,193 | 23.6 | 93,079 | 517 | 92,821 | 25.1 |
| 61 | 94,315 | 443 | 94,094 | 25.6 | 90,881 | 678 | 90,543 | 22.7 | 92,562 | 563 | 92,280 | 24.2 |
| 62 | 93,872 | 484 | 93,630 | 24.7 | 90,204 | 737 | 89,835 | 21.9 | 91,999 | 613 | 91,692 | 23.4 |
| 63 | 93,388 | 530 | 93,123 | 23.8 | 89,467 | 801 | 89,067 | 21.1 | 91,385 | 668 | 91,051 | 22.5 |
| 64 | 92,858 | 580 | 92,568 | 22.9 | 88,666 | 871 | 88,231 | 20.3 | 90,717 | 728 | 90,353 | 21.7 |
| 65 | 92,278 | 635 | 91,961 | 22.1 | 87,796 | 946 | 87,322 | 19.5 | 89,989 | 794 | 89,592 | 20.8 |
| 66 | 91,644 | 695 | 91,296 | 21.2 | 86,849 | 1,029 | 86,335 | 18.7 | 89,195 | 866 | 88,762 | 20.0 |
| 67 | 90,948 | 762 | 90,567 | 20.4 | 85,820 | 1,118 | 85,261 | 17.9 | 88,329 | 944 | 87,857 | 19.2 |
| 68 | 90,186 | 836 | 89,768 | 19.6 | 84,702 | 1,215 | 84,095 | 17.1 | 87,385 | 1,029 | 86,871 | 18.4 |
| 69 | 89,350 | 917 | 88,892 | 18.7 | 83,487 | 1,319 | 82,827 | 16.4 | 86,356 | 1,122 | 85,795 | 17.6 |
| 70 | 88,434 | 1,005 | 87,931 | 17.9 | 82,168 | 1,432 | 81,452 | 15.6 | 85,235 | 1,222 | 84,624 | 16.9 |
| 71 | 87,428 | 1,103 | 86,877 | 17.1 | 80,736 | 1,553 | 79,959 | 14.9 | 84,013 | 1,331 | 83,347 | 16.1 |
| 72 | 86,325 | 1,210 | 85,720 | 16.3 | 79,183 | 1,682 | 78,342 | 14.2 | 82,681 | 1,449 | 81,957 | 15.3 |
| 73 | 85,115 | 1,327 | 84,452 | 15.6 | 77,501 | 1,821 | 76,590 | 13.5 | 81,232 | 1,576 | 80,444 | 14.6 |
| 74 | 83,788 | 1,455 | 83,061 | 14.8 | 75,680 | 1,967 | 74,696 | 12.8 | 79,656 | 1,713 | 78,800 | 13.9 |
| 75 | 82,334 | 1,594 | 81,537 | 14.1 | 73,713 | 2,122 | 72,651 | 12.1 | 77,944 | 1,859 | 77,015 | 13.2 |
| 76 | 80,740 | 1,745 | 79,867 | 13.3 | 71,590 | 2,285 | 70,448 | 11.5 | 76,085 | 2,014 | 75,078 | 12.5 |
| 77 | 78,995 | 1,908 | 78,041 | 12.6 | 69,305 | 2,454 | 68,078 | 10.8 | 74,071 | 2,179 | 72,982 | 11.8 |
| 78 | 77,088 | 2,083 | 76,046 | 11.9 | 66,851 | 2,629 | 65,537 | 10.2 | 71,892 | 2,352 | 70,716 | 11.2 |
| 79 | 75,005 | 2,270 | 73,870 | 11.2 | 64,222 | 2,807 | 62,819 | 9.6 | 69,540 | 2,533 | 68,274 | 10.5 |
| 80 | 72,735 | 2,469 | 71,500 | 10.6 | 61,415 | 2,986 | 59,922 | 9.0 | 67,007 | 2,720 | 65,647 | 9.9 |
| 81 | 70,266 | 2,678 | 68,927 | 9.9 | 58,429 | 3,163 | 56,848 | 8.4 | 64,288 | 2,910 | 62,833 | 9.3 |
| 82 | 67,587 | 2,896 | 66,139 | 9.3 | 55,266 | 3,334 | 53,599 | 7.9 | 61,378 | 3,102 | 59,827 | 8.7 |
| 83 | 64,691 | 3,120 | 63,132 | 8.7 | 51,932 | 3,494 | 50,185 | 7.4 | 58,276 | 3,291 | 56,631 | 8.1 |
| 84 | 61,572 | 3,346 | 59,899 | 8.1 | 48,438 | 3,638 | 46,619 | 6.9 | 54,986 | 3,472 | 53,249 | 7.6 |
| 85 | 58,226 | 3,570 | 56,441 | 7.5 | 44,800 | 3,759 | 42,921 | 6.4 | 51,513 | 3,642 | 49,692 | 7.1 |
| 86 | 54,656 | 3,785 | 52,764 | 7.0 | 41,041 | 3,851 | 39,115 | 5.9 | 47,871 | 3,792 | 45,975 | 6.6 |
| 87 | 50,871 | 3,984 | 48,879 | 6.5 | 37,190 | 3,906 | 35,237 | 5.5 | 44,079 | 3,916 | 42,121 | 6.1 |
| 88 | 46,888 | 4,157 | 44,809 | 6.0 | 33,284 | 3,916 | 31,326 | 5.1 | 40,163 | 4,005 | 38,161 | 5.7 |
| 89 | 42,731 | 4,294 | 40,583 | 5.5 | 29,368 | 3,874 | 27,431 | 4.7 | 36,158 | 4,052 | 34,132 | 5.2 |
| 90 | 38,436 | 4,384 | 36,244 | 5.1 | 25,494 | 3,774 | 23,607 | 4.3 | 32,106 | 4,046 | 30,083 | 4.8 |

**Source**: CANSIM Table 053-0003 "*Elements of the life table, Canada, provinces and territorie* s" Available online at http://www5.statcan.gc.ca/cansim/a47.

### Discounting

As noted earlier, we use a 1.5% discount rate in the reference case with a 3% and a 0% discount rate in the sensitivity analysis. A 0% discount rate is equivalent to not discounting. The following chart and table identify the present value of one unit over an 82-year period (the average lifespan of a British Columbian, see above) using a 1.5% and a 3.0% discount rate.[269] The same discount rate is used for both costs and benefits when calculating cost-effectiveness.

In essence, the present value of one unit (either a dollar or a QALY in the current study) is reduced to 31% of its 'full' value if it is incurred 82 years in the future based on a 1.5% discount rate and to 9% of its 'full' value based on a 3.0% discount rate.




[269] The data in the table and chart are derived from Annex 4.2 of Drummond M, Stoddart G and Torrance G. *Methods for the Economic Evaluation of Health Care Programmes.* Oxford: Oxford University Press; 1987.

| The Effect of Discounting Over Time | | |
|---|---|---|
| Time | Discount Rate | |
| (in years) | 1.5% | 3.0% |
| 0 | 1.0000 | 1.0000 |
| 1 | 0.9853 | 0.9709 |
| 2 | 0.9708 | 0.9426 |
| 3 | 0.9565 | 0.9151 |
| 4 | 0.9424 | 0.8885 |
| 5 | 0.9286 | 0.8626 |
| 6 | 0.9150 | 0.8375 |
| 7 | 0.9017 | 0.8131 |
| 8 | 0.8885 | 0.7894 |
| 9 | 0.8756 | 0.7664 |
| 10 | 0.8628 | 0.7441 |
| 11 | 0.8503 | 0.7224 |
| 12 | 0.8380 | 0.7014 |
| 13 | 0.8259 | 0.6810 |
| 14 | 0.8140 | 0.6611 |
| 15 | 0.8022 | 0.6419 |
| 16 | 0.7906 | 0.6232 |
| 17 | 0.7793 | 0.6050 |
| 18 | 0.7681 | 0.5874 |
| 19 | 0.7571 | 0.5703 |
| 20 | 0.7463 | 0.5537 |
| 21 | 0.7356 | 0.5375 |
| 22 | 0.7251 | 0.5219 |
| 23 | 0.7148 | 0.5067 |
| 24 | 0.7047 | 0.4919 |
| 25 | 0.6947 | 0.4776 |
| 26 | 0.6848 | 0.4637 |
| 27 | 0.6752 | 0.4502 |
| 28 | 0.6656 | 0.4371 |
| 29 | 0.6562 | 0.4243 |
| 30 | 0.6470 | 0.4120 |
| 31 | 0.6382 | 0.4000 |
| 32 | 0.6294 | 0.3883 |
| 33 | 0.6206 | 0.3770 |
| 34 | 0.6118 | 0.3660 |
| 35 | 0.6030 | 0.3554 |
| 36 | 0.5948 | 0.3450 |
| 37 | 0.5867 | 0.3350 |
| 38 | 0.5786 | 0.3252 |
| 39 | 0.5704 | 0.3158 |
| 40 | 0.5623 | 0.3066 |
| 41 | 0.5548 | 0.2976 |
| 42 | 0.5472 | 0.2890 |
| 43 | 0.5397 | 0.2805 |
| 44 | 0.5322 | 0.2724 |
| 45 | 0.5247 | 0.2644 |
| 46 | 0.5177 | 0.2567 |
| 47 | 0.5107 | 0.2493 |
| 48 | 0.5037 | 0.2420 |
| 49 | 0.4967 | 0.2350 |
| 50 | 0.4898 | 0.2281 |
| 51 | 0.4833 | 0.2215 |
| 52 | 0.4768 | 0.2150 |
| 53 | 0.4703 | 0.2088 |
| 54 | 0.4638 | 0.2027 |
| 55 | 0.4574 | 0.1968 |
| 56 | 0.4513 | 0.1910 |
| 57 | 0.4453 | 0.1855 |
| 58 | 0.4393 | 0.1801 |
| 59 | 0.4332 | 0.1748 |
| 60 | 0.4272 | 0.1697 |
| 61 | 0.4216 | 0.1648 |
| 62 | 0.4159 | 0.1600 |
| 63 | 0.4103 | 0.1553 |
| 64 | 0.4047 | 0.1508 |
| 65 | 0.3991 | 0.1464 |
| 66 | 0.3938 | 0.1421 |
| 67 | 0.3885 | 0.1380 |
| 68 | 0.3832 | 0.1340 |
| 69 | 0.3779 | 0.1301 |
| 70 | 0.3727 | 0.1263 |
| 71 | 0.3677 | 0.1226 |
| 72 | 0.3627 | 0.1190 |
| 73 | 0.3577 | 0.1156 |
| 74 | 0.3527 | 0.1122 |
| 75 | 0.3478 | 0.1089 |
| 76 | 0.3430 | 0.1058 |
| 77 | 0.3383 | 0.1027 |
| 78 | 0.3336 | 0.0997 |
| 79 | 0.3288 | 0.0968 |
| 80 | 0.3241 | 0.0940 |
| 81 | 0.3194 | 0.0913 |
| 82 | 0.3146 | 0.0887 |

## The Disutility Attributable to Taking Preventive Medication

The disutility of taking pills for preventing adverse health outcomes is estimated at 0.24% (95% confidence interval [CI] of 0.17% to 0.33%).[270, 271, 272] The studies by Hutchins and colleagues also found that a significant proportion of respondents (9.5% using the willingness-to-pay approach, 57.5% using the standard gamble approach and 87% using the time trade-off approach) identified no disutility associated with taking one pill daily. In the sensitivity analysis, we therefore ranged the disutility from 0% to 0.33%.

## Summary Measures of Population Health

### Background

Population health has historically been measured based on mortality indicators, including summary measures such as life expectancy and infant mortality. More recently, summary measures have attempted to take into account both mortality and *morbidity*.

This has led to two types of composite summary measures, health expectancy measures and health gap measures.[273] Health expectancy measures include disability-free life expectancy (DFLE) and health-adjusted life expectancy (HALE). These measures start with a standard theoretical life expectancy (usually based on the best life expectancy observed in the world) and then assess the amount of life lost due to premature death combined with time lost due to morbidity or disability. Health-adjusted life expectancy, for example, estimates the average time in years that a person at a given age can expect to live in the equivalent of full health.[274]

Health gap measures consist primarily of disability-adjusted life years (DALYs) and quality-adjusted life years (QALYs). QALYs were originally developed by economists in the 1960s for use in cost-effectiveness analyses, primarily in higher-income countries. Measures of the effect of morbidity used in calculating QALYs are based on the value or preference that people have for health outcomes or states along a continuum between death (0) and full health (1.0). DALYs, however, have been favoured in measures of global health and have been championed by the Global Burden of Disease (GBD) study since the original publication of results in 1997.[275,276,277] Measures of the effect of morbidity used in calculating DALYs are based on estimates of the impact of a disease or disability on the performance of an individual.

The DALY is essentially the complement to the QALY, with the focus of DALYs being on disability-adjusted life years *averted* and the focus of QALYs on quality-adjusted life years *gained*. The approach to measurement (and corresponding methodological issues) are similar

[270] Thompson A, Guthrie B and Payne K. Do pills have no ills? capturing the impact of direct treatment disutility. *PharmacoEconomics*. 2016; 34(4): 333-6.
[271] Hutchins R, Pignone M, Sheridan S et al. Quantifying the utility of taking pills for preventing adverse health outcomes: a cross-sectional survey. *British Medical Journal Open*. 2015; 5(e006505): 1-9.
[272] Hutchins R, Viera AJ, Sheridan SL et al. Quantifying the utility of taking pills for cardiovascular prevention. *Circulation: Cardiovascular Quality and Outcomes*. 2015; 8(2): 155-63.
[273] Hyder A, Puvanachandra P and Morrow R. Measuring the health of populations: explaining composite indicators. *Journal of Public Health Research*. 2012; 1(3): 222-8.
[274] Gold M, Stevenson D and Fryback DG. HALYS and QALYS and DALYS, Oh My: Similarities and differences in summary measures of population health. *Annual Review of Public Health*. 2002; 23(1): 115-34.
[275] Murray CJL and Lopez AD. Regional patterns of disability-free life expectancy and disability-adjusted life expectancy. Global Burden of Disease Study. *The Lancet*. 1997; 349: 1347-52.
[276] Salomon JA, Vos T, Hogan DR et al. Common values in assessing health outcomes from disease and injury: disability weights measurement study for the Global Burden of Disease Study 2010. *The Lancet*. 2012; 380(9859): 2129-43.
[277] Salomon JA, Haagsma JA, Davis A et al. Disability weights for the Global Burden of Diseases 2013 study. *The Lancet Global Health*. 2015; 3: e712-e723.

in calculating QALYs and DALYs. Among the key issues in measuring both QALYs and DALYs are whom to ask (the three choices tend to be clinicians, patients with the disease/injury or the general population), how the impact of the disease/injury is described to the general population if that group is being queried and whether the resulting weights are universally applicable. The GBD study, for example, has developed standardized disability weights by health states based on feedback from 60,890 individuals aged 18-65 in the general population across multiple continents.[278]

The enormous influence of the GBD study has meant that a greater number of cost-effectiveness analyses are now using a cost-per-DALY *averted* as their main outcome measure rather than a cost-per-QALY *gained*.[279]

As noted above, the approach for this project is to use QALYs in assessing both the clinically preventable burden and cost-effectiveness of a CPS.

### Sources of Quality of Life Values

Ideal sources of quality of life (QoL) values include large population-based studies assessing a considerable variety of health-related outcomes, such as the studies by Sullivan and colleagues in the US[280] and the UK[281] (see below). Disability weights developed for the GBD study are another useful source as a proxy for QoL.[282] While the disability weights for the 2013 GBD study are the latest available in the academic literature, detailed weights for the 2016 GBD study are publically accessible online.[283]

If data is not available from such large population-based studies, then larger studies (or meta-analyses, if they are available) assessing the QoL for a specific health-related outcome are used.

### Calculating Changes in QoL

Assessing QoL on a 0 – 1 scale assumes that 0 is equivalent to death and 1 is equivalent to full health. A number of publications have assessed the QoL of the general population. The study by Sullivan and colleagues in the US, for example, used a nationally representative survey of 38,678 individuals to estimate a mean population QoL value of 0.867 (0.854 for females and 0.880 for males).[284] Their study in the UK (with a sample size of 79,522) found a mean QoL of 0.828 for the general population (0.815 for females and 0.850 for males).[285] That is, while many individuals within a population may self-identify as a 1.0 (full health), the majority do not.

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[278] Salomon JA, Haagsma JA, Davis A et al. Disability weights for the Global Burden of Diseases 2013 study. *The Lancet Global Health*. 2015; 3: e712-e723.

[279] Neumann PJ, Thorat T, Zhong Y et al. A systematic review of cost-effectiveness studies reporting cost-per-DALY averted. *PLOS ONE*. 2016; 11(12): e0168512.doi:10.1371/journal.

[280] Sullivan P and Ghushchyan V. Preference-based EQ-5D index scores for chronic conditions in the United States. *Medical Decision Making*. 2006; 26(4): 410-20.

[281] Sullivan PW, Slejko JF, Sculpher MJ et al. Catalogue of EQ-5D scores for the United Kingdom. *Medical Decision Making*. 2011; 31(6): 800-4.

[282] Salomon JA, Haagsma JA, Davis A et al. Disability weights for the Global Burden of Diseases 2013 study. *The Lancet Global Health*. 2015; 3: e712-e723.

[283] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.

[284] Sullivan P and Ghushchyan V. Preference-based EQ-5D index scores for chronic conditions in the United States. *Medical Decision Making*. 2006; 26(4): 410-20.

[285] Sullivan PW, Slejko JF, Sculpher MJ et al. Catalogue of EQ-5D scores for the United Kingdom. *Medical Decision Making*. 2011; 31(6): 800-4.

Mean QoL also decreases with increasing age, as follows:[286,287]

| Change in Mean QoL in the General US and UK Populations by Age Group | | | |
|---|---|---|---|
| **Age Group** | **United States** | **United Kingdom** | **Average US / UK** |
| 18-29 | 0.922 | 0.905 | 0.914 |
| 30-39 | 0.901 | 0.879 | 0.890 |
| 40-49 | 0.871 | 0.837 | 0.854 |
| 50-59 | 0.842 | 0.798 | 0.820 |
| 60-69 | 0.823 | 0.774 | 0.799 |
| 70-79 | 0.790 | 0.723 | 0.757 |
| ≥80 | 0.736 | 0.657 | 0.697 |
| **All Ages 18+** | **0.867** | **0.828** | **0.848** |

In assessing changes in QoL, we assume that the average QoL value for individuals living in BC is 0.85 (the mean between the US and UK values). A 0.10 reduction in QoL then is equivalent to an 11.8% (0.10 / 0.85) reduction in QoL, if the reduction is applicable to all age groups. If it is only applicable to the 60-69 year age group, then a 0.10 reduction in QoL would be equivalent to a 12.5% (0.10 / 0.80) reduction in QoL.

### Utility, Disutility and Disability Weight

Throughout this report, utility, disutility and disability weight will be used to refer to adjustments made to the quality of life. A positive utility is an improvement to the quality of life. A disutility or disability weight is a reduction in the quality of life and is equivalent to a negative utility of the same magnitude. (I.e. a disutility of 0.05, a disability weight of 0.05 and a utility of -0.05 are used interchangeably and all refer to the same thing: a reduction in the quality of life by 0.05 on a scale of 0 to 1.)

[286] Sullivan P and Ghushchyan V. Preference-based EQ-5D index scores for chronic conditions in the United States. *Medical Decision Making*. 2006; 26(4): 410-20.
[287] Sullivan PW, Slejko JF, Sculpher MJ et al. Catalogue of EQ-5D scores for the United Kingdom. *Medical Decision Making*. 2011; 31(6): 800-4.

## Major Behavioural Risk Factors

### Summary

| Summary for Major Behavioural Risk Factors (RF) | | | |
|---|---|---|---|
| | Utility | Years of Life Lost | Annual Direct Costs/Individual with the RF |
| ***Alcohol Use*** | | | |
| Low | - | - | $140 |
| Hazardous | -0.123 | - | $968 |
| Harmful | -0.235 | 3.1 | $3,038 |
| ***Excess Weight*** | | | |
| Overweight | - | 0.6 | $227 |
| Obese | -0.059 | 2.6 | $805 |
| ***Tobacco Smoking*** | | | |
| Light | -0.031 | 6.6 | $785 |
| Moderate | -0.033 | 11.9 | $1,386 |
| Heavy | -0.062 | 18.1 | $2,050 |

### Alcohol Use

- A UK study used a community-based sample ≥ 16 years of age of 14,117 to assess the *effect of alcohol use on QoL*.[288] After adjusting for age, sex, excess weight, physical activity, fruit and vegetable consumption, smoking status, ethnicity, marital status, educational attainment, and income, they found a small but statistically significant positive effect (0.011 to 0.019) on self-reported QoL associated with alcohol consumption when compared with never-drinkers.
- The GBD study found that a very mild alcohol use disorder[289] is associated with a *disutility* of 0.123 (95% CI of 0.082 to 0.177), a mild alcohol use disorder[290] is associated with a *disutility* of 0.235 (95% CI of 0.160 to 0.327), a moderate alcohol use disorder[291] is associated with a disutility of 0.373 (95% CI of 0.248 to 0.508) and a severe alcohol use disorder[292] is associated with a disutility of 0.570 (95% CI of 0.396 to 0.732).[293]

[288] Maheswaran H, Petrou S, Rees K et al. Estimating EQ-5D utility values for major health behavioural risk factors in England. *Journal of Epidemiology and Community Health*. 2013; 67(1): 172-80.
[289] **Very mild alcohol use disorder** – "Drinks alcohol daily and has difficulty controlling the urge to drink. When sober, the person functions normally."
[290] **Mild alcohol use disorder** – "Drinks a lot of alcohol and sometimes has difficulty controlling the urge to drink. While intoxicated, the person has difficulty performing daily activities."
[291] **Moderate alcohol use disorder** – "Drinks a lot, gets drunk almost every week and has great difficulty controlling the urge to drink. Drinking and recovering cause great difficulty in daily activities, sleep loss and fatigue."
[292] **Severe alcohol use disorder** – "Gets drunk almost every day and is unable to control the urge to drink. Drinking and recovering replace most daily activities. The person has difficulty thinking, remembering and communicating, and feels constant pain and fatigue."
[293] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.

- Consuming more than 4 drinks of alcohol per day *reduces an individual's longevity* by 3.1 (95% CI of 1.9 to 4.0) years.[294]
- Alcohol use is associated with higher *annual medical care costs* (e.g., hospitalization, physician, drug, etc.) than no alcohol use. Research in BC identified these costs as $62 per year for low alcohol use (less than 3 drinks per day for males and less than 1.5 drinks per day for females), $430 per year for hazardous alcohol use (3 to 4.5 drinks per day for males and 1.5 to 3 drinks per day for females) and $1,350 per year for harmful alcohol use (>4.5 drinks per day for males and >3 drinks per day for females).[295]
- In addition to direct medical care costs, alcohol use is associated with *other direct costs* such as law enforcement, fire and traffic accident damage and so on. Rehm and colleagues estimated that these other direct costs were $4.12 billion in Canada in 2002, compared to $3.31 billion for direct medical care costs that same year.[296] To take these other costs into account, we have increased the annual medical care costs noted above by 125% (4.12 / 3.31).
- For the purposes of this project, we have assumed that excess annual medical and other direct costs associated with low, hazardous and harmful alcohol use are $140 / $968 / $3,038, respectively. Harmful alcohol use is associated with 3.1 life years lost. Furthermore, hazardous alcohol use is equivalent to a very mild alcohol use disorder with a disutility of 0.123 and harmful alcohol use is equivalent to a mild alcohol use disorder with a disutility of 0.235.

### Excess Weight

- An Australian study used a community-based sample of 1,569 children (mean age of 10.4 years) to assess the *effect of excess weight on QoL*.[297] They found that QoL as identified by parents was reduced by 3.7% for overweight and 9.7% for obesity whereas QoL as identified by children was reduced by 1.5% for overweight and 8.1% for obesity.
- A further Australian study of 2,890 adolescents also assessed the effect of excess weight on QoL.[298] They found that overweight is associated with a disutility of 0.018 while obesity is associated with a disutility of 0.059. The disutility associated with overweight was only significant in girls (0.039) while the disutility associated with obesity was significant in both girls (0.084) and boys (0.041).
- A UK study used a community-based sample ≥ 16 years of age of 14,117 to assess the effect of excess weight on QoL.[299] They found a utility of -0.019 (95% CI of -0.026 to -0.011) associated with overweight (BMI of 25 to <30) compared to normal weight (BMI of 18.5 to <25) in their unadjusted model. After adjusting for age, sex, alcohol use, physical activity, fruit and vegetable consumption, smoking status,

[294] Li K, Hüsing A and Kaaks R. Lifestyle risk factors and residual life expectancy at age 40: a German cohort study. *BioMed Central Medicine*. 2014; 12(1): 59-69.
[295] H. Krueger & Associates Inc. *The Economic Burden of Risk Factors in British Columbia: Excess Weight, Tobacco Smoking, Alcohol Use, Physical Inactivity and Low Fruit and Vegetable Consumption.* 2017. Vancouver, B.C.: Provincial Health Services Authority, Population and Public Health Program.
[296] Rehm J, Gnam W, Popova S et al. The costs of alcohol, illegal drugs, and tobacco in Canada, 2002. *Journal of Studies on Alcohol and Drugs*. 2007; 68(6): 886-95.
[297] Williams J, Wake M, Hesketh K et al. Health-related quality of life of overweight and obese children. *JAMA*. 2005; 293(1): 70-6.
[298] Keating CL, Moodie ML, Richardson J et al. Utility-based quality of life of overweight and obese adolescents. *Value in Health*. 2011; 14(5): 752-8.
[299] Maheswaran H, Petrou S, Rees K et al. Estimating EQ-5D utility values for major health behavioural risk factors in England. *Journal of Epidemiology and Community Health*. 2013; 67(1): 172-80.

ethnicity, marital status, educational attainment, and income, however, this utility was no longer statistically significant (-0.005 with a 95% CI of -0.029 to 0.019). The utility associated with obesity class I & II (BMI of 30 to <40) and class III (BMI ≥40) remained significant after adjustment at -0.031 (95%CI of -0.020 to -0.041) and -0.105 (95%CI of -0.072 to -0.137) respectively.

- Excess weight also *reduces an individual's longevity*.[300,301] Research by Fontaine and colleagues suggests that the number of life years lost increases with increasing levels of excess weight, from 0.6 years for overweight, 1.9 years for obese class I, 3.8 years for obese class II and 6.8 years for obese class III.[302]
- Overweight and obesity are associated with higher *annual medical care costs* (e.g., hospitalization, physician, drug, etc.). Research in BC identified these costs as $227 per year for overweight (BMI of 25 to <30) and $805 per year for obesity (BMI of ≥30).[303]
- For the purposes of this project, we have assumed a utility of -0.059 associated with obesity (the average of -0.037[304], -0.059[305] and -0.081[306]) but no disutility associated with overweight. Overweight is associated with 0.6 life years lost and obesity is associated with 2.6 life years lost (based on the weighted average of life years lost due to class I, II and III obesity[307] using estimated proportions of the 2015 BC population in each of these categories, ((1.9 * 0.74 ) + (3.8 * 0.19) + (6.8 *0.07)). Finally, overweight and obesity are associated with excess annual medical care costs of $227 and $805.

### Tobacco Smoking

- A UK study used a community-based sample ≥ 16 years of age of 14,117 to assess the effect of tobacco smoking on QoL.[308] After adjusting for age, sex, alcohol use, physical activity, fruit and vegetable consumption, excess weight, ethnicity, marital status, educational attainment, and income, they found a utility of -0.031 (95%CI of -0.018 to -0.045) associated with light tobacco smoking (less than 10 cigarettes per day), -0.033 (95% CI of -0.019 to -0.047) for moderate tobacco smoking (10 to 19 cigarettes per day) and -0.062 (95% CI of -0.042 to -0.082) for heavy tobacco smoking (20 or more cigarettes per day).
- Tobacco smoking also *reduces an individual's longevity.* In the United States, an average of 11.5 life years are lost per tobacco smoker. An average of 10.5 of these life-years can be regained by stopping smoking at age 30, 9.5 by stopping smoking at

[300] Peeters A, Barendregt JJ, Willekens F et al. Obesity in adulthood and its consequences for life expectancy: a life-table analysis. *Annals of Internal Medicine*. 2003; 138(1): 24-32.
[301] Finkelstein EA, Brown DS, Wrage LA et al. Individual and Aggregate Years-of-life-lost Associated with Overweight and Obesity. *Obesity*. 2010; 18(2): 333-9.
[302] Fontaine KR, Redden DT, Wang C et al. Years of life lost due to obesity. *JAMA*. 2003; 289(2): 187-93.
[303] H. Krueger & Associates Inc. *The Economic Burden of Risk Factors in British Columbia: Excess Weight, Tobacco Smoking, Alcohol Use, Physical Inactivity and Low Fruit and Vegetable Consumption.* 2017. Vancouver, B.C.: Provincial Health Services Authority, Population and Public Health Program.
[304] Maheswaran H, Petrou S, Rees K et al. Estimating EQ-5D utility values for major health behavioural risk factors in England. *Journal of Epidemiology and Community Health*. 2013; 67(1): 172-80.
[305] Keating CL, Moodie ML, Richardson J et al. Utility-based quality of life of overweight and obese adolescents. *Value in Health*. 2011; 14(5): 752-8.
[306] Williams J, Wake M, Hesketh K et al. Health-related quality of life of overweight and obese children. *JAMA*. 2005; 293(1): 70-6.
[307] Fontaine KR, Redden DT, Wang C et al. Years of life lost due to obesity. *JAMA*. 2003; 289(2): 187-93.
[308] Maheswaran H, Petrou S, Rees K et al. Estimating EQ-5D utility values for major health behavioural risk factors in England. *Journal of Epidemiology and Community Health*. 2013; 67(1): 172-80.

age 40 and 6.5 by stopping smoking at age 50.[309] In Australia, an average of 10 life years are lost per tobacco smoker. Mortality for former smokers who quit prior to age 45 did not differ significantly from never-smokers.[310] Mortality increases with the duration and intensity of smoking.[311,312,313] In the US, for example, light tobacco smoking is associated with a relative risk (RR) of premature mortality of 1.98 (compared to never smokers). This RR increases to 2.7 for moderate tobacco smoking and to 3.74 for heavy tobacco smoking.[314]

- Tobacco smoking is associated with excess *annual medical care costs* (e.g., hospitalization, physician, drug, etc.). Research in BC identified these costs average $1,195 per year: $785 per year for light tobacco smoking (less than 10 cigarettes per day), $1,386 per year for moderate tobacco smoking (10 to 19 cigarettes per day) and $2,050 per year for heavy tobacco smoking (20 or more cigarettes per day).[315]
- For the purposes of this project, we have assumed light, moderate and heavy smoking are associated with utilities of -0.031, -0.033 and -0.062, respectively. On average, tobacco smoking is associated with 10 life years lost,[316] with 6.6, 11.9 and 18.1 life years lost associated with light, moderate and heavy smoking.[317] Finally, the annual medical care costs associated with light, moderate and heavy smoking are $785, $1,386 and $2,050, respectively.

[309] Jha P, Ramasundarahettige C, Landsman V et al. 21st-century hazards of smoking and benefits of cessation in the United States. *New England Journal of Medicine*. 2013; 368(4): 341-50.

[310] Banks E, Joshy G, Weber M et al. Tobacco smoking and all-cause mortality in a large Australian cohort study: findings from a mature epidemic with current low smoking prevalence. *BioMed Central Medicine*. 2015; 13(1): 38-48.

[311] Pirie K, Peto R, Reeves G et al. The 21st century hazards of smoking and benefits of stopping: a prospective study of one million women in the UK. *The Lancet*. 2013; 381(9861): 133-41.

[312] Banks E, Joshy G, Weber M et al. Tobacco smoking and all-cause mortality in a large Australian cohort study: findings from a mature epidemic with current low smoking prevalence. *BioMed Central Medicine*. 2015; 13(1): 38-48.

[313] Inoue-Choi M, Liao L, Reyes-Guzman C et al. Association of long-term, low-intensity smoking with all-cause and cause-specific mortality in the National Institutes of Health–AARP diet and health study. *Journal of American Medical Association Internal Medicine*. 2017; 177(1): 87-95.

[314] Pirie K, Peto R, Reeves G et al. The 21st century hazards of smoking and benefits of stopping: a prospective study of one million women in the UK. *The Lancet*. 2013; 381(9861): 133-41.

[315] H. Krueger & Associates Inc. *The Economic Burden of Risk Factors in British Columbia: Excess Weight, Tobacco Smoking, Alcohol Use, Physical Inactivity and Low Fruit and Vegetable Consumption.* 2017. Vancouver, B.C.: Provincial Health Services Authority, Population and Public Health Program.

[316] Banks E, Joshy G, Weber M et al. Tobacco smoking and all-cause mortality in a large Australian cohort study: findings from a mature epidemic with current low smoking prevalence. *BioMed Central Medicine*. 2015; 13(1): 38-48.

[317] In BC in 2015, 56% of tobacco smokers were light smokers, 28% were moderate smokers and 17% were heavy smokers. The estimated annual economic burden attributable to premature mortality in 2015 is $1,346 ($891 for light, $1,607 for moderate and $2,439 for heavy smokers). H. Krueger & Associates Inc. *The Economic Burden of Risk Factors in British Columbia: Excess Weight, Tobacco Smoking, Alcohol Use, Physical Inactivity and Low Fruit and Vegetable Consumption.* 2017. Vancouver, B.C.: Provincial Health Services Authority, Population and Public Health Program. We used this data to estimate life years lost by smoking intensity as follows: $891 / $1,346 * 10 life years lost = 6.6 life years lost for light smokers; $1,607 / $1,346 * 10 life years lost = 11.9 life years lost for moderate smokers; $2,439 / $1,346 * 10 life years lost = 18.1 life years lost for heavy smokers.

## Estimates for Specific Disease/Treatment/Injury States

### Summary

**Summary of Key Assumptions Regarding Life Expectancy, Quality of Life and Costs by Disease**

| | Atopic Dermatitis | Blindness / Low Vision | Breast Cancer | Cervical Cancer | Colorectal Cancer | Liver Cancer | Lung Cancer | Ovarian Cancer |
|---|---|---|---|---|---|---|---|---|
| Average Age of Occurrence (in Years) | | | 62.2 | 49.1 | 70.4 | 64.3 | 69.8 | 63.9 |
| Ratio of Nonfatal Cases per Fatal Case | | | 23.4 | 10.1 | 4.3 | 0.7 | 0.7 | 3.2 |
| Costs* for the Acute Care Phase of a Fatal Case | | | $47,230 | $46,603 | $49,197 | $30,922 | $37,046 | $51,914 |
| Life Years Lost per Survivor | | | 12.9 | 17 | 9.9 | 16.7 | 13.5 | 16.5 |
| QoL Utility for Survivors (duration in months) | -0.043 | -0.003 to -0.187 | -0.049 | -0.049 | -0.049 | -0.049 | -0.049 | -0.049 |
| Diagnosis and primary treatment (duration in months) | | | -0.288 (3) | -0.288 (4.8) | -0.288 (4) | -0.288 (4) | -0.288 (3.3) | -0.288 (3.2) |
| Metastatic phase for cancer (duration in months) | | | -0.451 (17.7) | -0.451 (9.2) | -0.451 (9.7) | -0.451 (2.5) | -0.451 (4.5) | -0.451 (25.6) |
| First Year Costs for Survivors | | | $22,695 | $20,258 | $40,080 | $36,708 | $33,523 | $33,256 |
| Ongoing Annual Costs for Survivors | $342 | $2,330 | $1,753 | $821 | $3,687 | $6,287 | $7,475 | $7,889 |
| Duration of Ongoing Annual Costs (in Years) | 10 | Ongoing | 4 | 19.2 | 6.6 | 4.7 | 3.2 | 6.5 |
| Lifetime Costs | $3,420 | | $7,012 | $15,763 | $24,334 | $29,549 | $23,920 | $51,279 |

** All costs are in 2017 Canadian dollars.*

**Summary of Key Assumptions Regarding Life Expectancy, Quality of Life and Costs by Disease** (continued)

| | Cardiovascular Disease - Myocardial Infarction | Cerebro vascular Disease - Stroke | Childhood Asthma | Dental Caries | Depression | GI Bleed | Hearing Loss | HIV / AIDS | Intellectual Disability | Spina Bifida |
|---|---|---|---|---|---|---|---|---|---|---|
| Average Age of Occurrence (in Years) | 68.0 | 72.8 | | | | 58.8 | | | | |
| Ratio of Nonfatal Cases per Fatal Case | 5.1 | 4.6 | | | | 22.2 | | | | |
| Costs* for the Acute Care Phase of a Fatal Case | $15,536 | $9,583 | | | | | | | | |
| Life Years Lost per Survivor | 6.3 | 5.5 | | | | | | | | |
| QoL Utility for Survivors (duration in months) | | -0.200 | -0.040 | -0.010 | -0.145 to -0.658 | -0.125 (12) | -0.01 to -0.215 | -0.078 to -0.381 | -0.011 to -0.200 | -0.410 |
| Diagnosis and primary treatment (duration in Metastatic phase for cancer (duration in months) | -0.100 (1) | | | | | | | | | |
| First Year Costs for Survivors | $33,934 | $21,139 | | | | $6,425 | | | | |
| Ongoing Annual Costs for Survivors | $2,278 | $6,246 | $523 | | | | | $1,889 to $10,900 | | |
| Duration of Ongoing Annual Costs (in Years) | 12.1 | 9.3 | 10 | | | | | | | |
| Lifetime Costs | $27,564 | $58,088 | $5,230 | | | | $170,000 | | $270,000 | $625,000 |

** All costs are in 2017 Canadian dollars.*

### Atopic Dermatitis / Eczema

- The mean duration of atopic dermatitis is 10 years with 45% of cases being mild in severity, 45% moderate and 10% severe. Barbeau and Lalonde describe mild atopic dermatitis as "occasional, slight itching/scratching", moderate as "constant or intermittent itching/scratching which does not disturb sleep" and severe as "bothersome itching/scratching which disturbs sleep".[318]
- The GBD study found that mild atopic dermatitis was associated with a disability weight of 0.027 (95% CI of 0.015 to 0.042).[319] Mild atopic dermatitis in the GBD study is described as follows: "has a slight, visible physical deformity that is

[318] Barbeau M and Lalonde HL. Burden of atopic dermatitis in Canada. *International Journal of Dermatology*. 2006; 45(1): 31-6.

[319] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.

sometimes sore and itchy. Others note the deformity, which causes some worry and discomfort". Moderate atopic dermatitis was associated with a disability weight of 0.188 (95% CI of 0.125 to 0.267) and is described as "has a visible physical deformity that is sore and itchy. Other people stare and comment, which causes the person to worry. The person has trouble sleeping and concentrating". We have assumed that mild atopic dermatitis in the GBD study is roughly equivalent to mild and moderate atopic dermatitis in the Barbeau and Lalonde study and that moderate atopic dermatitis in the GBD study is roughly equivalent to severe atopic dermatitis in the Barbeau and Lalonde study. Based on this assumption, we calculated an average disutility of -0.043 ((0.90 * -0.027) + (0.10 * -0.188)).

- The direct annual costs per mild, moderate and severe case are $175, $300, and $405, respectively. The average weighted cost totalled $254 (in 2001 CAD) or $342 in 2017 CAD.[320] Lifetime costs were estimated at $3,420 (10 years * $342).

### Blindness / Vision Deficits

- A community-based analysis of 38,678 individuals in the US found a utility associated with blindness and low vision (ICD-9 369) of -0.05, after adjusting for age, comorbidity, gender, race, ethnicity, income and education.[321]
- The GBD study found that mild vision impairment was associated with a disability weight of 0.003 (95% CI of 0.001 to 0.007), moderate vision impairment with 0.031 (95% CI of 0.019 to 0.049), severe vision impairment with 0.184 (95% CI of 0.125 to 0.258) and blindness with 0.187 (95% CI of 0.124 to 0.260).[322]
- In the US, blindness is associated with an annual increase in medical costs of $2,157 (in 2004 USD) or $2,330 in 2017 CAD, after adjusting for age, sex, marital status, education, income, self-reported health status, type of health insurance and family size.[323]
- A 2003 US study estimated the direct lifetime costs per individual associated with vision impairment to be $129,476.[324] The costs included physician visits, prescription medications, hospital inpatient stays, assistive devices, therapy and rehabilitation, long-term care, home and vehicle modifications and special education. We converted these costs to equivalent 2017 Canadian health care costs for a lifetime cost per individual of $143,679 with vision impairment.

### Cancer - Breast

*Average Age of Occurrence of Breast Cancer - **62.2** Years*

*Ratio of Nonfatal Breast Cancers per Fatal Breast Cancer - **23.4***

*Years of Life Lost due to Breast Cancer - **12.9** Years*

*QoL Disutility for Breast Cancer Survivors - ↓**0.049***

[320] Barbeau M and Lalonde HL. Burden of atopic dermatitis in Canada. *International Journal of Dermatology*. 2006; 45(1): 31-6.
[321] Sullivan P and Ghushchyan V. Preference-based EQ-5D index scores for chronic conditions in the United States. *Medical Decision Making*. 2006; 26(4): 410-20.
[322] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.
[323] Frick K, Gower E, Kempen J et al. Economic impact of visual impairment and blindness in the United States. *Archives of Ophthalmology*. 2007; 125(4): 544-50.
[324] Economic costs associated with mental retardation, cerebral palsy, hearing loss, and vision impairment – United States, 2003. *MMWR Weekly*. 2003; 53(03): 57-9.

*Costs for the Acute Care Phase of Fatal Breast Cancer - **$47,230***

*First Year Costs for Breast Cancer Survivors - **$22,695***

*Ongoing Annual Costs for Breast Cancer Survivors - **$1,753** (for a period of 4.0 years)*

- Based on data from BC between 2000 and 2007, female breast cancers occur at the mean age of 62.2 years.[325]
- In BC, 95.9% of breast cancer patients survive to year 1, 88.5% to year 3 and 82.5% to year 5.[326] In the first year after diagnosis there are an estimated 23.4 *nonfatal breast cancers per fatal breast cancer*.
- In BC, the *life expectancy* of a 62.2-year-old female is 24.9 years. The average survival of a female breast cancer patient, however, is approximately 12 years.[327] The average breast cancer survivor thus losses 12.9 years of life (24.9 – 12.0). International research indicates that breast cancer is associated with approximately 4 years of life lost (YLL) in Australia,[328] 6 YLL in the US,[329] 13 YLL in the UK[330] and 17 YLL in Norway.[331]
- The diagnosis and treatment phase for breast cancer lasts an average of 3 months[332] and is associated with a utility of -0.288 (95% CI of -0.193 to -0.399).[333]
- The metastatic phase for breast cancer lasts an average of 17.7 months[334] and is associated with a utility of -0.451 (95% CI of -0.307 to -0.600).[335]
- The ongoing, controlled phase (remission) for breast cancer is associated with a utility of -0.049 (95% CI of -0.031 to -0.072).[336]

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[325] Coleman MP, Forman D, Bryant, H et al. Cancer survival in Australia, Canada, Denmark, Norway, Sweden and the UK, 1995-2007 (the International Benchmarking Partnership): an analysis of population-based cancer registry data. *The Lancet*. 2011; 377: 127-38.

[326] BC Cancer Agency. *Statistics by Cancer Type - Breast.* 2014. Available at http://www.bccancer.bc.ca/statistics-and-reports-site/Documents/Cancer_Type_Breast_2014.pdf. Accessed July 2017.

[327] González-Reymúndez A, de los Campos G, Gutiérrez L et al. Prediction of years of life after diagnosis of breast cancer using omics and omic-by-treatment interactions. *European Journal of Human Genetics*. 2017; 25(5): 538-44.

[328] Baade P, Youlden D, Andersson T et al. Estimating the change in life expectancy after a diagnosis of cancer among the Australian population. *British Medical Journal Open*. 2015; 5(4): e006740-6.

[329] Liu P, Wang J and Keating N. Expected years of life lost for six potentially preventable cancers in the United States. *Preventive Medicine*. 2013; 56(5): 309-13.

[330] Burnet N, Jefferies S, Benson R et al. Years of life lost (YLL) from cancer is an important measure of population burden–and should be considered when allocating research funds. *British Journal of Cancer*. 2005; 92(2): 241-5.

[331] Brustugun O, Møller B and Helland Å. Years of life lost as a measure of cancer burden on a national level. *British Journal of Cancer*. 2014; 111(5): 1014-20.

[332] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.

[333] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.

[334] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.

[335] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.

- A *false-positive* mammography result is associated with a one-time QALY loss of -0.013 (4.7 days).[337]
- Information from the BC Cancer Agency Screening Mammography Program indicates a cost of $79.35 per screen in 2015/16.[338]
- The cost of an unnecessary biopsy associated with a false-positive result is estimated to be $396 (in 2008 USD)[339] or $386 in 2017 CAD.
- The cost of radiotherapy, breast conserving surgery and a mastectomy are $5,014, $4,937 and $6,956, respectively (in 2012 CAD)[340] or $5,233, $5,152 and $7,260 in 2017 CAD.
- Based on data from Ontario, the cost estimates for the *acute phase of a fatal breast cancer* are $35,600 (95% CI of $34,208 to $39,162) (in 2009 CAD).[341] We converted this to $39,942 in 2017 CAD. In British Columbia, the health system costs during the interval from diagnosis of first breast cancer recurrence or metastasis until death has been estimated at $36,474 (95% CI of $29,752 to $43,196) in 1995 CAD.[342] This includes all hospital costs ($19,496), BC Cancer Agency costs ($7,769), MSP costs ($3,294), home care costs ($4,661) and Pharmacare costs ($1,254). We converted this to $54,517 (95% CI $44,470 - $64,565) in 2017 CAD. For the purposes of this project, we used the midpoint between these two estimates ($47,230) in the reference case and the extremes in the sensitivity analysis.
- Based on data from Ontario, the estimated *first year costs* associated with a breast cancer survivor are $20,227 (95% CI of $19,951 to $20,503) (in 2009 CAD).[343] We converted this to $22,695 in 2017 CAD. A further Ontario-based study estimated the costs for the *two years* following diagnosis in breast cancer survivors to be $40,426 (in 2008 CAD).[344]
- Evidence from Belgium indicates that the direct medical costs attributable to breast cancer between years 2 and 5 following diagnosis/treatment were €3,496 (in 1998 Euros) and that they decreased from €1,424 in year 2 to €164 in year 5, at which

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[336] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.

[337] Schousboe JT, Kerlikowske K, Loh A, et al. Personalizing mammography by breast density and other risk factors for breast cancer: analysis of health benefits and cost-effectiveness. *Annals of Internal Medicine*. 2011; 155(1): 10-20.

[338] BC Cancer Agency. *Screening Mammography Program: 2016 Annual Report*. 2016. Available at http://www.bccancer.bc.ca/screening/Documents/SMP_Report-AnnualReport2016.pdf. Accessed August 2017.

[339] Schousboe JT, Kerlikowske K, Loh A, et al. Personalizing mammography by breast density and other risk factors for breast cancer: analysis of health benefits and cost-effectiveness. *Annals of Internal Medicine*. 2011; 155(1): 10-20.

[340] Gocgun Y, Banjevic D, Taghipour S et al. Cost-effectiveness of breast cancer screening policies using simulation. *The Breast*. 2015; 24(4): 440-8.

[341] de Oliveira C, Bremner K, Pataky R et al. Understanding the costs of cancer care before and after diagnosis for the 21 most common cancers in Ontario: a population-based descriptive study. *Canadian Medical Association Journal Open*. 2013; 1(1): E1-E8.

[342] Wai ES, Trevisan CH, Taylor SCM et al. Health system costs of metastatic breast cancer. *Breast Cancer Research and Treatment*. 2001; 65(3): 233-40.

[343] de Oliveira C, Bremner K, Pataky R et al. Understanding the costs of cancer care before and after diagnosis for the 21 most common cancers in Ontario: a population-based descriptive study. *Canadian Medical Association Journal Open*. 2013; 1(1): E1-E8.

[344] Mittmann N, Porter J, Rangrej J et al. Health system costs for stage-specific breast cancer: a population-based approach. *Current Oncology*. 2014; 21(6): 281-93.

point costs were not significantly different than matched controls.[345] For the purposes of this project, we assumed excess annual ongoing costs of €874 (€3,496 / 4) or $1,753 in 2017 CAD for years 2 through 5 following diagnosis/treatment.

### Cancer - Cervical

*Average Age of Occurrence of Cervical Cancer - **49.1** Years*

*Ratio of Nonfatal Cervical Cancer per Fatal Cervical Cancer – **10.1***

*Years of Life Lost due to Cervical Cancer – **17** Years*

*QoL Disutility for Cervical Cancer Survivors - ↓**0.049***

*Costs for the Acute Care Phase of Fatal Cervical Cancer - **$46,603***

*First Year Costs for Cervical Cancer Survivors - **$20,258***

*Ongoing Annual Costs for Cervical Cancer Survivors - **$821** (for a period of 19.2 years)*

- Based on Canadian data between 2002 and 2006, cervical cancers occur at the mean age of 49.1 years.[346]
- In BC, 91.0% of cervical cancer patients survive to year 1, 79.4% to year 3 and 73.6% to year 5.[347] In the first year after diagnosis there are an estimated 10.1 *nonfatal cervical cancer per fatal cervical cancer*.
- International research indicates that cervical cancer is associated with approximately 11 YLL in the US,[348] 17 YLL in the UK[349] and 24 YLL in Norway.[350] We used the average of this range (17 YLL) in our base case estimate and the extremes in the sensitivity analysis.
- A false-positive Pap smear result is associated with a disutility of 0.046 for a period of approximately 10 months.[351]
- Diagnosis and treatment for cervical intraepithelial neoplasia (CIN) 1-3 is associated with a disutility of 0.066 for a period of approximately 20 months.[352]
- The diagnosis and treatment phase for cervical cancer lasts an average of 4.8 months[353] and is associated with a utility of -0.288 (95% CI of -0.193 to -0.399).[354]

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[345] Broekx S, Den Hond E, Torfs R et al. The costs of breast cancer prior to and following diagnosis. *The European Journal of Health Economics*. 2011; 12(4): 311-7.

[346] Dickinson J, Stankiewicz A, Popadiuk C et al. Reduced cervical cancer incidence and mortality in Canada: national data from 1932 to 2006. *BioMed Central Public Health*. 2012; 12(1): 992.

[347] BC Cancer Agency. *Statistics by Cancer Type - Cervix*. 2014. Available at http://www.bccancer.bc.ca/statistics-and-reports-site/Documents/Cancer_Type_Cervix_2014.pdf. Accessed July 2017.

[348] Liu P, Wang J and Keating N. Expected years of life lost for six potentially preventable cancers in the United States. *Preventive Medicine*. 2013; 56(5): 309-13.

[349] Burnet N, Jefferies S, Benson R et al. Years of life lost (YLL) from cancer is an important measure of population burden–and should be considered when allocating research funds. *British Journal of Cancer*. 2005; 92(2): 241-5.

[350] Brustugun O, Møller B and Helland Å. Years of life lost as a measure of cancer burden on a national level. *British Journal of Cancer*. 2014; 111(5): 1014-20.

[351] Insinga R, Glass A, Myers E et al. Abnormal outcomes following cervical cancer screening: event duration and health utility loss. *Medical Decision Making*. 2007; 27(4): 414-22.

[352] Ibid.

[353] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.

- The metastatic phase for cervical cancer lasts an average of 9.2 months[355] and is associated with a utility of -0.451 (95% CI of -0.307 to -0.600).[356]
- The ongoing, controlled phase (remission) for cervical cancer is associated with a utility of -0.049 (95% CI of -0.031 to -0.072).[357]
- Three Canadian studies estimated the *cost of a conventional cytology screen* to be $28[358], $57[359] and $92[360] in 2005 or 2006 CAD. We updated these estimates to 2017 CAD and then used the average for the base case estimate and the extremes in the sensitivity analysis ($70 with a range from $33 to $108, in 2017 CAD).
- Cost estimates for HPV testing are based on Popadiuk et al. who estimated costs (in 2008 CAD) to be $87.70 per test, which included consultation, tray, and kit with lab interpretation fees costing $33.70, $10.99, and $43.10 respectively. [361] We updated this estimate to $96 in 2017 CAD.
- Three Canadian studies estimated the *cost of a colposcopy with biopsy* to be $148[362], $151[363] and $337[364] in 2005 or 2006 CAD. We updated these estimates to 2017 CAD and then used the average for the base case estimate and the extremes in the sensitivity analysis ($251 with a range from $176 to $392, in 2017 CAD).
- Three Canadian studies estimated the *cost per treatment for a precancerous lesion* to be $965[365], $1,032[366] and $1,071[367] in 2005 or 2006 CAD. We updated these

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[354] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.

[355] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.

[356] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.

[357] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.

[358] Kulasingam S, Rajan R, St Pierre Y et al. Human papillomavirus testing with Pap triage for cervical cancer prevention in Canada: a cost-effectiveness analysis. *BioMed Central Medicine*. 2009; 7(1): 69.

[359] Brisson M, Van de Velde N, De Wals P et al. The potential cost-effectiveness of prophylactic human papillomavirus vaccines in Canada. *Vaccine*. 2007; 25(29): 5399-408.

[360] Krahn M, McLauchlin M, Pham B et al. *Liquid-Based Techniques for Cervical Cancer Screening: Systematic Review and Cost-Effectiveness Analysis*. 2008. Available at https://www.cadth.ca/sites/default/files/pdf/333_LBC-Cervical-Cancer-Screenin_tr_e.pdf. Accessed August 2017.

[361] Popadiuk C, Gauvreau C, Bhavsar M et al. Using the Cancer Risk Management Model to evaluate the health and economic impacts of cytology compared with human papillomavirus DNA testing for primary cervical cancer screening in Canada. *Current Oncology*. 2016; 23(Supp.1): S56-S63.

[362] Brisson M, Van de Velde N, De Wals P et al. The potential cost-effectiveness of prophylactic human papillomavirus vaccines in Canada. *Vaccine*. 2007; 25(29): 5399-408.

[363] Krahn M, McLauchlin M, Pham B et al. *Liquid-Based Techniques for Cervical Cancer Screening: Systematic Review and Cost-Effectiveness Analysis*. 2008. Available at https://www.cadth.ca/sites/default/files/pdf/333_LBC-Cervical-Cancer-Screenin_tr_e.pdf. Accessed August 2017.

[364] Kulasingam S, Rajan R, St Pierre Y et al. Human papillomavirus testing with Pap triage for cervical cancer prevention in Canada: a cost-effectiveness analysis. *BioMed Central Medicine*. 2009; 7(1): 69.

[365] Ibid.

[366] Krahn M, McLauchlin M, Pham B et al. *Liquid-Based Techniques for Cervical Cancer Screening: Systematic Review and Cost-Effectiveness Analysis*. 2008. Available at https://www.cadth.ca/sites/default/files/pdf/333_LBC-Cervical-Cancer-Screenin_tr_e.pdf. Accessed August 2017.

[367] Brisson M, Van de Velde N, De Wals P et al. The potential cost-effectiveness of prophylactic human papillomavirus vaccines in Canada. *Vaccine*. 2007; 25(29): 5399-408.

estimates to 2017 CAD and then used the average for the base case estimate and the extremes in the sensitivity analysis ($1,216 with a range from $1,137 to $1,295, in 2017 CAD).

- Based on data from Ontario, the cost estimates for the *acute phase* of a fatal cervical cancer are $41,536 (95% CI of $38,642 to $44,429) in 2009 CAD.[368] We converted this to $46,603 (95% CI of $43,356 to $51,858) in 2017 CAD.
- Based on data from Ontario, the estimated *first year costs* associated with a cervical cancer survivor are $18,055 (95% CI of $17,305 to $18,804) in 2009 CAD.[369] We converted this to $20,258 (95% CI of $19,416 to $21,098) in 2017 CAD.
- Based on data from Ontario, the *ongoing annual costs* associated with a cervical cancer survivor after the first year are estimated at between $575 and $1,067 in 2017 CAD.[370] We used the midpoint of this range ($821) in our base case estimate and the extremes in the sensitivity analysis.
- Cervical cancers in BC occur at the mean age of 49.1 years (see above). A BC women 49.1 years of age has a life expectancy of 36.5 years. Cervical cancer is associated with 17.3 years of life lost (see above). Therefore, the average women in BC with cervical cancer would survive for 19.2 years (36.5 – 17.3).

### Cancer - Colorectal

*Average Age of Occurrence of colorectal cancer (CRC) - **70.4** Years*

*Ratio of Nonfatal CRC per Fatal CRC - **4.32***

*Costs for the Acute Care Phase of Fatal CRC - **$49,197***

*Years of Life Lost due to CRC – **9.9** Years*

*QoL Disutility for CRC Survivors - ↓**0.049***

*First Year Costs for CRC Survivors - **$40,080***

*Ongoing Annual Costs for CRC Survivors - **$3,687** (for a period of 6.6 years)*

- Based on data from BC between 2000 and 2007, colorectal cancers (CRC) occur at the mean age of 70.4 years.[371]
- In BC, 81.2% of CRC patients survive to year 1, 65.5% to year 3 and 56.9% to year 5.[372] In the first year after diagnosis there are an estimated 4.32 *nonfatal CRC per fatal CRC*.
- Based on data from Ontario, the cost estimates for the *acute phase of a fatal CRC* are $43,848 (95% CI of $43,070 to $44,626) (in 2009 CAD).[373] We converted this to $49,197 in 2017 CAD.

[368] de Oliveira C, Bremner K, Pataky R et al. Understanding the costs of cancer care before and after diagnosis for the 21 most common cancers in Ontario: a population-based descriptive study. *Canadian Medical Association Journal Open*. 2013; 1(1): E1-E8.
[369] Ibid.
[370] Sander B, Wong W, Yeung M et al. The cost-utility of integrated cervical cancer prevention strategies in the Ontario setting–Can we do better? *Vaccine*. 2016; 34(16): 1936-44.
[371] Coleman MP, Forman D, Bryant, H et al. Cancer survival in Australia, Canada, Denmark, Norway, Sweden and the UK, 1995-2007 (the International Benchmarking Partnership): an analysis of population-based cancer registry data. *The Lancet*. 2011; 377: 127-38.
[372] BC Cancer Agency. *Statistics by Cancer Type - Colorectal*. 2014. Available at http://www.bccancer.bc.ca/statistics-and-reports-site/Documents/Cancer_Type_Colorectal_2014.pdf. Accessed July 2017.

- In BC, the *life expectancy* of a 70.4-year-old is 16.5 years. Research from Holland suggests that the life expectancy of a CRC survivor at age 50 is 12.8 years compared to 32.0 years for the general population (or 40% of the life expectancy of the general population). Life expectancy decreases dramatically with the stage of diagnosis, with 25.3 years for survivors of Stage I cancer, 19.2 years for Stage II, 13.6 years for Stage III and 2.1 years for Stage IV.[374] In BC then, the average 70-year-old CRC survivor would have a life expectancy of 6.6 years (16.5 years times 40%), or lose 9.9 life years (16.5 – 6.6). International research indicates that colorectal cancer is associated with approximately 5 years of life lost (YLL) in Australia,[375] 7 YLL in the US,[376] 10 YLL in the UK[377] and 13 YLL in Norway.[378]
- The diagnosis and treatment phase for colorectal cancer lasts an average of 4 months[379] and is associated with a utility of -0.288 (95% CI of -0.193 to -0.399).[380]
- The metastatic phase for colorectal cancer lasts an average of 9.7 months[381] and is associated with a utility of -0.451 (95% CI of -0.307 to -0.600).[382]
- The ongoing, controlled phase (remission) for colorectal cancer is associated with a utility of -0.049 (95% CI of -0.031 to -0.072).[383]
- Based on data from Ontario, the estimated *first year costs* associated with a CRC survivor are $35,722 (95% CI of $35,158 to $36,286) (in 2009 CAD).[384] We converted this to $40,080 in 2017 CAD.

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[373] de Oliveira C, Bremner K, Pataky R et al. Understanding the costs of cancer care before and after diagnosis for the 21 most common cancers in Ontario: a population-based descriptive study. *Canadian Medical Association Journal Open*. 2013; 1(1): E1-E8.

[374] Soerjomataram I, Thong MS, Ezzati M, et al. Most colorectal cancer survivors live a large proportion of their remaining life in good health. *Cancer Causes and Control*. 2012; 23: 1421-8.

[375] Baade P, Youlden D, Andersson T et al. Estimating the change in life expectancy after a diagnosis of cancer among the Australian population. *British Medical Journal Open*. 2015; 5(4): e006740-6.

[376] Liu P, Wang J and Keating N. Expected years of life lost for six potentially preventable cancers in the United States. *Preventive Medicine*. 2013; 56(5): 309-13.

[377] Burnet N, Jefferies S, Benson R et al. Years of life lost (YLL) from cancer is an important measure of population burden–and should be considered when allocating research funds. *British Journal of Cancer*. 2005; 92(2): 241-5.

[378] Brustugun O, Møller B and Helland Å. Years of life lost as a measure of cancer burden on a national level. *British Journal of Cancer*. 2014; 111(5): 1014-20.

[379] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.

[380] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.

[381] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.

[382] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.

[383] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.

[384] de Oliveira C, Bremner K, Pataky R et al. Understanding the costs of cancer care before and after diagnosis for the 21 most common cancers in Ontario: a population-based descriptive study. *Canadian Medical Association Journal Open*. 2013; 1(1): E1-E8.

- Based on data from the US, the *ongoing annual costs* associated with a colorectal cancer survivor after the first year are estimated at $3,877 (in 2010 USD) or $3,687 in 2017 CAD.[385]

### Cancer - Liver

*Average Age of Occurrence of Liver Cancer – **64.3** Years*

*Ratio of Nonfatal Liver Cancer per Fatal Liver Cancer - **0.71***

*Costs for the Acute Care Phase of Fatal Liver Cancer - **$30,922***

*Years of Life Lost due to Liver Cancer – **16.7** Years*

*QoL Disutility for Liver Cancer Survivors - ↓**0.049***

*First Year Costs for Liver Cancer Survivors - **$36,708***

*Ongoing Annual Costs for Liver Cancer Survivors - **$6,287** (for a period of 4.7 years)*

- Based on data from the US, liver cancers occur at a mean age of 64.3 years.[386]
- In BC, 41.6% of liver cancer patients survive to year 1, 20.7% to year 3 and 12.7% to year 5.[387] In the first year after diagnosis there are an estimated 0.71 *nonfatal liver cancer per fatal liver cancer*.
- Based on data from Ontario, the cost estimates for the *acute phase of a fatal liver cancer* are $27,560 (95% CI of $25,747 to $29,373) (in 2009 CAD).[388] We converted this to $30,922 in 2017 CDN.
- In BC, the *life expectancy* of a 64.3-year-old is 21.4 years. Based on data from the US, liver cancers are associated with 16.7 YLL.[389] In BC then, the average 64.3-year-old liver cancer survivor would have a life expectancy of 4.7 years (21.4 – 16.7).
- The diagnosis and treatment phase for liver cancer lasts an average of 4 months[390] and is associated with a utility of -0.288 (95% CI of -0.193 to -0.399).[391]
- The metastatic phase for liver cancer lasts an average of 2.5 months[392] and is associated with a utility of -0.451 (95% CI of -0.307 to -0.600).[393]

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[385] Mariotto A, Robin Y, Shao Y et al. Projections of the cost of cancer care in the United States: 2010–2020. *Journal of the National Cancer Institute*. 2011; 103(2): 117-28.

[386] Liu P, Wang J and Keating N. Expected years of life lost for six potentially preventable cancers in the United States. *Preventive Medicine*. 2013; 56(5): 309-13.

[387] BC Cancer Agency. *Statistics by Cancer Type - Liver*. 2014. Available at http://www.bccancer.bc.ca/statistics-and-reports-site/Documents/Cancer_Type_Liver_2014.pdf. Accessed July 2017.

[388] de Oliveira C, Bremner K, Pataky R et al. Understanding the costs of cancer care before and after diagnosis for the 21 most common cancers in Ontario: a population-based descriptive study. *Canadian Medical Association Journal Open*. 2013; 1(1): E1-E8.

[389] Liu P, Wang J and Keating N. Expected years of life lost for six potentially preventable cancers in the United States. *Preventive Medicine*. 2013; 56(5): 309-13.

[390] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.

[391] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.

[392] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.

- The ongoing, controlled phase (remission) for liver cancer is associated with a utility of -0.049 (95% CI of -0.031 to -0.072).[394]
- Based on data from Ontario, the estimated *first year costs* associated with a liver cancer survivor are $32,717 (95% CI of $30,591 to $34,844) (in 2009 CAD).[395] We converted this to $36,708 in 2017 CAD.
- Based on data from the US, the *ongoing annual costs* associated with a liver cancer survivor after the first year are estimated at $6,611 (in 2010 USD) or $6,287 in 2017 CAD.[396]

### Cancer - Lung

*Average Age of Occurrence of Lung Cancer - **69.8** Years*

*Ratio of Nonfatal Lung Cancer per Fatal Lung Cancer - **0.72***

*Costs for the Acute Care Phase of Fatal Lung Cancer - **$37,046***

*Years of Life Lost due to Lung Cancer – **11.8** Years*

*QoL Disutility for Lung Cancer Survivors - ↓**0.049***

*First Year Costs for Lung Cancer Survivors - **$33,523***

*Ongoing Annual Costs for Lung Cancer Survivors - **$7,575** (for a period of 3.2 years)*

- Based on data from BC between 2000 and 2007, lung cancers occur at the mean age of 69.8 years.[397]
- In BC, 41.9% of lung cancer patients survive to year 1, 21.1% to year 3 and 15.8% to year 5.[398] In the first year after diagnosis there are an estimated 0.72 *nonfatal lung cancer fatal lung cancer*.
- In BC, the *life expectancy* of a 69.8-year-old is 16.7 years. International research indicates that lung cancer is associated with approximately 12 years of life lost (YLL) in the UK,[399] 13 YLL in Australia,[400] 14 YLL in the US,[401] and 15 YLL in Norway.[402]

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[393] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.

[394] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.

[395] de Oliveira C, Bremner K, Pataky R et al. Understanding the costs of cancer care before and after diagnosis for the 21 most common cancers in Ontario: a population-based descriptive study. *Canadian Medical Association Journal Open*. 2013; 1(1): E1-E8.

[396] Mariotto A, Robin Y, Shao Y et al. Projections of the cost of cancer care in the United States: 2010–2020. *Journal of the National Cancer Institute*. 2011; 103(2): 117-28. This study included the costs of care for 14 major cancers which did not include liver cancer. We used the 'other' cancer category to estimate ongoing annual costs for liver cancer.

[397] Coleman MP, Forman D, Bryant, H et al. Cancer survival in Australia, Canada, Denmark, Norway, Sweden and the UK, 1995-2007 (the International Benchmarking Partnership): an analysis of population-based cancer registry data. *The Lancet*. 2011; 377: 127-38.

[398] BC Cancer Agency. *Statistics by Cancer Type - Lung*. 2014. Available at http://www.bccancer.bc.ca/statistics-and-reports-site/Documents/Cancer_Type_Lung_2014.pdf. Accessed July 2017.

[399] Burnet N, Jefferies S, Benson R et al. Years of life lost (YLL) from cancer is an important measure of population burden–and should be considered when allocating research funds. *British Journal of Cancer*. 2005; 92(2): 241-5.

[400] Baade P, Youlden D, Andersson T et al. Estimating the change in life expectancy after a diagnosis of cancer among the Australian population. *British Medical Journal Open*. 2015; 5(4): e006740-6.

We used the average of this range (13.5 YLL) in our base case estimate and the extremes in the sensitivity analysis. Therefore, the average British Columbian with lung cancer would survive for 3.2 years (16.7 – 13.5).

- Based on data from Ontario, the cost estimates for the *acute phase of a fatal lung cancer* are $33,018 (95% CI of $32,660 to $33,376) (in 2009 CAD).[403] We converted this to $37,046 in 2017 CAD.
- The diagnosis and treatment phase for lung cancer lasts an average of 3.3 months[404] and is associated with a disutility of -0.288 (95% CI of -0.193 to -0.399).[405]
- The metastatic phase for lung cancer lasts an average of 4.5 months[406] and is associated with a utility of -0.451 (95% CI of -0.307 to -0.600).[407]
- The ongoing, controlled phase (remission) for lung cancer is associated with a utility of -0.049 (95% CI of -0.031 to -0.072).[408]
- Based on data from Ontario, the estimated *first year costs* associated with a LC survivor are $29,878 (95% CI of $29,386 to $30,371) (in 2009 CAD).[409] We converted this to $33,523 in 2017 CAD.
- Based on data from the US, the *ongoing annual costs* associated with a lung cancer survivor after the first year are estimated at $7,861 (in 2010 USD) or $7,575 in 2017 CAD.[410]

### Cancer - Ovarian

*Average Age of Occurrence of Ovarian Cancer – **63.9** Years*

*Ratio of Nonfatal Ovarian Cancer per Fatal Ovarian Cancer – **3.22***

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[401] Liu P, Wang J and Keating N. Expected years of life lost for six potentially preventable cancers in the United States. *Preventive Medicine*. 2013; 56(5): 309-13.
[402] Brustugun O, Møller B and Helland Å. Years of life lost as a measure of cancer burden on a national level. *British Journal of Cancer*. 2014; 111(5): 1014-20.
[403] de Oliveira C, Bremner K, Pataky R et al. Understanding the costs of cancer care before and after diagnosis for the 21 most common cancers in Ontario: a population-based descriptive study. *Canadian Medical Association Journal Open*. 2013; 1(1): E1-E8.
[404] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.
[405] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.
[406] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.
[407] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.
[408] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.
[409] de Oliveira C, Bremner K, Pataky R et al. Understanding the costs of cancer care before and after diagnosis for the 21 most common cancers in Ontario: a population-based descriptive study. *Canadian Medical Association Journal Open*. 2013; 1(1): E1-E8.
[410] Mariotto A, Robin Y, Shao Y et al. Projections of the cost of cancer care in the United States: 2010–2020. *Journal of the National Cancer Institute*. 2011; 103(2): 117-28.

*Costs for the Acute Care Phase of Fatal Ovarian Cancer - **$51,914***

*Years of Life Lost due to Ovarian Cancer – **16.5** Years*

*QoL Disutility for Ovarian Cancer Survivors - ↓**0.049***

*First Year Costs for Ovarian Cancer Survivors - **$33,256***

*Ongoing Annual Costs for Ovarian Cancer Survivors - **$7,889** (for a period of 6.5 years)*

- Based on data from BC between 2000 and 2007, ovarian cancers occur at the mean age of 63.9 years.[411]
- In BC, 76.3% of ovarian cancer patients survive to year 1, 55.1% to year 3 and 42.5% to year 5.[412] In the first year after diagnosis there are an estimated 3.22 *nonfatal ovarian cancer per fatal ovarian cancer*.
- In BC, the *life expectancy* of a 63.9-year-old female is 23.0 years. International research indicates that ovarian cancer is associated with approximately 16 YLL in the UK[413] and 17 YLL in Norway.[414] We used the average of this range (16.5 YLL) in our base case estimate. Therefore, the average British Columbian with ovarian cancer would survive for 6.5 years (23.0 – 16.5).
- Based on data from Ontario, the cost estimates for the *acute phase of a fatal ovarian cancer* are $46,270 (95% CI of $44,452 to $48,088) (in 2009 CAD).[415] We converted this to $51,914 in 2017 CAD.
- The diagnosis and treatment phase for ovarian cancer lasts an average of 3.2 months[416] and is associated with a utility of -0.288 (95% CI of -0.193 to -0.399).[417]
- The metastatic phase for ovarian cancer lasts an average of 25.6 months[418] and is associated with a utility of -0.451 (95% CI of -0.307 to -0.600).[419]

[411] Coleman MP, Forman D, Bryant, H et al. Cancer survival in Australia, Canada, Denmark, Norway, Sweden and the UK, 1995-2007 (the International Benchmarking Partnership): an analysis of population-based cancer registry data. *The Lancet*. 2011; 377: 127-38.

[412] BC Cancer Agency. *Statistics by Cancer Type - Ovary*. 2014. Available at http://www.bccancer.bc.ca/statistics-and-reports-site/Documents/Cancer_Type_Ovary_2014.pdf. Accessed July 2017.

[413] Burnet N, Jefferies S, Benson R et al. Years of life lost (YLL) from cancer is an important measure of population burden–and should be considered when allocating research funds. *British Journal of Cancer*. 2005; 92(2): 241-5.

[414] Brustugun O, Møller B and Helland Å. Years of life lost as a measure of cancer burden on a national level. *British Journal of Cancer*. 2014; 111(5): 1014-20.

[415] de Oliveira C, Bremner K, Pataky R et al. Understanding the costs of cancer care before and after diagnosis for the 21 most common cancers in Ontario: a population-based descriptive study. *Canadian Medical Association Journal Open*. 2013; 1(1): E1-E8.

[416] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.

[417] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.

[418] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.

[419] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.

- The ongoing, controlled phase (remission) for ovarian cancer is associated with a utility of -0.049 (95% CI of -0.031 to -0.072).[420]
- Based on data from Ontario, the estimated *first year costs* associated with an ovarian cancer survivor are $29,640 (95% CI of $28,538 to $30,743) (in 2009 CAD).[421] We converted this to $33,256 in 2017 CAD.
- Based on data from the US, the *ongoing annual costs* associated with an ovarian cancer survivor after the first year are estimated at $8,296 (in 2010 USD) or $7,889 in 2017 CAD.[422]

### Cardiovascular Disease - Myocardial Infarction

*Average Age of Myocardial Infarction (MI) Occurrence - **68.0** Years*

*Ratio of Nonfatal MI per Fatal MI - **5.09***

*Costs for the Acute Care Phase of Fatal MI - **$15,536***

*Years of Life Lost due to MI – **6.3** Years*

*QoL Disutility for MI Survivors - ↓**0.100** (for one month)*

*First Year Costs for MI Survivors - **$33,934***

*Ongoing Annual Costs for MI Survivors - **$2,278** (for a period of 12.1 years)*

- In 2014 in the US, the average age at first MI was 65.3 years for males and 71.8 years for females. Approximately 59% of MIs occur in males resulting in a weighted *mean age* of 68.0 years.[423]
- In 2014 in the US, there were an estimated 580,000 new MIs and 114,019 deaths from MI, for an estimated 5.09 *nonfatal MIs per fatal MI*.[424]
- In the US, the cost estimates for the *acute phase of a fatal MI* are $17,259 (in 2013 USD).[425] We converted this to $15,536 in 2017 CAD.
- In BC, the *life expectancy* of a 68.0-year-old is 18.4 years. Research from the US suggests that the life expectancy of a MI survivor is approximately 34% shorter than that of the general population of the same age and sex.[426] In BC then, the average 68-year-old MI survivor would have a life expectancy of 12.1 years, or would lose 6.3 years of life (18.4 – 12.1).

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[420] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.

[421] de Oliveira C, Bremner K, Pataky R et al. Understanding the costs of cancer care before and after diagnosis for the 21 most common cancers in Ontario: a population-based descriptive study. *Canadian Medical Association Journal Open*. 2013; 1(1): E1-E8.

[422] Mariotto A, Robin Y, Shao Y et al. Projections of the cost of cancer care in the United States: 2010–2020. *Journal of the National Cancer Institute*. 2011; 103(2): 117-28.

[423] Benjamin EJ, Blaha MJ, Chiuve SE et al. *Heart Disease and Stroke Statistics - 2017 Update: A Report From the American Heart Association*. 2017. Available at http://circ.ahajournals.org/content/circulationaha/early/2017/01/25/CIR.0000000000000485.full.pdf. Accessed July 2017.

[424] Ibid.

[425] Pandya A, Sy S, Cho S et al. Cost-effectiveness of 10-year risk thresholds for initiation of statin therapy for primary prevention of cardiovascular disease. *Journal of the American Medical Association*. 2015; 314(2): 142-50.

[426] Bucholz E, Normand S, Wang Y et al. Life expectancy and years of potential life lost after acute myocardial infarction by sex and race: a cohort-based study of Medicare beneficiaries. *Journal of the American College of Cardiology*. 2015; 66(6): 645-55.

- The GBD study estimated a utility of -0.432 (95% CI of -0.288 to -0.579) during days 1 and 2 following an acute myocardial infarct and a utility of -0.074 (95% CI of -0.049 to -0.105) during days 3 to 28.[427] This results in a combined disutility of 0.100 for a period of one month.
- Dehmer and colleagues estimated the *first year costs* associated with a myocardial infarct to be $37,095 (in 2012 USD).[428] We converted this to $33,934 in 2017 CAD.
- Dehmer and colleagues estimated the *ongoing annual costs* following a myocardial infarct to be $2,490 (in 2012 USD).[429] We converted this to $2,278 in 2017 CAD.

### Cerebrovascular Disease - Stroke

*Average Age of Stroke Occurrence - **72.8** Years*

*Ratio of Nonfatal Strokes per Fatal Stroke - **4.58***

*Costs for the Acute Care Phase of Fatal Stroke - **$9,583***

*Years of Life Lost due to Stroke – **5.5** Years*

*QoL Disutility for Stroke Survivors - ↓**0.200***

*First Year Costs for Stroke Survivors - **$21,139***

*Ongoing Annual Costs for Stroke Survivors - **$6,246** (for a period of 9.3 years)*

- In Canada, hospitalization for an ischemic stroke occurs at a mean age of 73.9 years (71.5 for males and 76.4 for females) while hospitalization for a haemorrhagic stroke occurs at a mean age of 67.5 years (66.2 for males and 68.8 for females).[430] The majority of strokes (82.7%) are ischemic.[431] The average weighted *mean age* is 72.8 years (70.6 for males and 75.1 for females).
- In 2014 in the US, there were an estimated 610,000 new strokes and 133,103 deaths from stroke, for an estimated 4.58 *nonfatal strokes per fatal stroke* in the US.[432]
- In the US, the cost estimates for the *acute phase of a fatal stroke* are $10,647 (in 2013 USD).[433] We converted this to $9,583 in 2017 CAD.
- In BC, the *life expectancy* of a 72.8-year-old is 14.8 years. Research from Denmark suggests that the life expectancy of a stroke survivor is approximately 37% shorter than that of the general population of the same age and sex.[434] In BC then, the

[427] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.
[428] Dehmer S, Maciosek M, LaFrance A et al. Health benefits and cost-effectiveness of asymptomatic screening for hypertension and high cholesterol and aspirin counseling for primary prevention. *The Annals of Family Medicine*. 2017; 15(1): 23-36.
[429] Dehmer S, Maciosek M, LaFrance A et al. Health benefits and cost-effectiveness of asymptomatic screening for hypertension and high cholesterol and aspirin counseling for primary prevention. *The Annals of Family Medicine*. 2017; 15(1): 23-36.
[430] Krueger H, Lindsay P, Cote R et al. Cost avoidance associated with optimal stroke care in Canada. *Stroke*. 2012; 43(8): 2198-206.
[431] Ibid.
[432] Benjamin EJ, Blaha MJ, Chiuve SE et al. *Heart Disease and Stroke Statistics - 2017 Update: A Report from the American Heart Association*. 2017. Available at http://circ.ahajournals.org/content/circulationaha/early/2017/01/25/CIR.0000000000000485.full.pdf. Accessed July 2017.
[433] Pandya A, Sy S, Cho S et al. Cost-effectiveness of 10-year risk thresholds for initiation of statin therapy for primary prevention of cardiovascular disease. *Journal of the American Medical Association*. 2015; 314(2): 142-50.
[434] Hannerz H and Nielsen M. Life expectancies among survivors of acute cerebrovascular disease. *Stroke*. 2001; 32(8): 1739-44.

average 72.8-year-old stroke survivor would have a life expectancy of 9.3 years, or would lose 5.5 years of life (14.8 – 9.3).

- The GBD study groups the long term consequences following a stroke into five levels of severity.[435] Level 1 ("has some difficulty in moving around and some weakness in one hand, but is able to walk without help") is associated with a utility of -0.019 (95% CI of -0.010 to -0.032). Level 2 ("has some difficulty in moving around, and in using the hands for lifting and holding things, dressing and grooming") is associated with a utility of -0.070 (95% CI of -0.046 to -0.099). Level 3 ("has some difficulty in moving around, in using the hands for lifting and holding things, dressing and grooming, and in speaking. The person is often forgetful and confused") is associated with a utility of -0.316 (95% CI of -0.206 to -0.437). Level 4 ("is confined to a bed or a wheelchair, has difficulty speaking and depends on others for feeding, toileting and dressing") is associated with a utility of -0.552 (95% CI of -0.377 to -0.707). Level 5 ("is confined to a bed or a wheelchair, depends on others for feeding, toileting and dressing, and has difficulty speaking, thinking clearly and remembering things") is associated with a utility of -0.588 (95% CI of -0.411 to -0.744).
- We have assumed that the five severity levels identified by the GBD are approximately comparable to Modified Rankin scale scores of 1 through 5. Furthermore, an estimated 25.5% of stroke survivors have a Rankin score of 0, 21.5% a 1, 11.3% a 2, 18.5% a 3, 18.6% a 4 and 4.6% a 5.[436] The average utility associated with a stroke would therefore be -0.200 (95% CI of -0.134 to -0.265) ((0.255*0) + (0.215*-0.019) + (0.113*-0.070) + (0.185*-0.316) + (0.186*-0.552) + (0.046*-0.588)).
- Gloede and coauthors in Australia estimated the *first year costs* associated with an ischemic stroke to be $30,110 (in 2010 AUD) while costs associated with a haemorrhagic stroke were $17,767.[437] Based on a mix of 85% ischemic strokes,[438] the weighted cost would be $28,258. We converted this to $25,635 in 2017 CAD. Dehmer and colleagues estimated the first year costs associated with a stroke to be $18,192 (in 2012 USD).[439] We converted this to $16,642 in 2017 CAD. For modelling purposes, we use the midpoint between $16,642 and $25,635 ($21,139) in the reference case and the extremes in the sensitivity analysis.
- Gloede and coauthors in Australia estimated the ongoing annual costs (including informal care and out-of-pocket costs) associated with an ischemic stroke to be $7,996 (in 2010 AUD) while costs associated with a haemorrhagic stroke were $10,251.[440] Based on a mix of 85% ischemic strokes in Canada,[441] the weighted cost would be $8,335. We converted this to $7,562 in 2017 CAD. Dehmer and colleagues

[435] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.
[436] Krueger H, Lindsay P, Cote R et al. Cost avoidance associated with optimal stroke care in Canada. *Stroke.* 2012; 43(8): 2198-206.
[437] Gloede T, Halbach S, Thrift A et al. Long-term costs of stroke using 10-year longitudinal data from the North East Melbourne Stroke Incidence Study. *Stroke*. 2014: 1-8.
[438] Krueger H, Lindsay P, Cote R et al. Cost avoidance associated with optimal stroke care in Canada. *Stroke.* 2012; 43(8): 2198-206.
[439] Dehmer S, Maciosek M, LaFrance A et al. Health benefits and cost-effectiveness of asymptomatic screening for hypertension and high cholesterol and aspirin counseling for primary prevention. *The Annals of Family Medicine*. 2017; 15(1): 23-36.
[440] Gloede T, Halbach S, Thrift A et al. Long-term costs of stroke using 10-year longitudinal data from the North East Melbourne Stroke Incidence Study. *Stroke*. 2014: 1-8.
[441] Krueger H, Lindsay P, Cote R et al. Cost avoidance associated with optimal stroke care in Canada. *Stroke.* 2012; 43(8): 2198-206.

estimated the ongoing annual costs following a stroke to be $5,389 (in 2012 USD).[442] We converted this to $4,930 in 2017 CAD. For modelling purposes, we use the midpoint between $4,930 and $7,562 ($6,246) in the reference case and the extremes in the sensitivity analysis.

### Childhood Asthma

- The Global Burden of Disease Study found that controlled asthma is associated with a disability weight of -0.015 (95% CI of 0.007 – 0.026) while partially controlled asthma is associated with a disability weight of 0.036 (95% CI of 0.022 to 0.055) and uncontrolled asthma is associated with a disability weight of 0.133 (95% CI of 0.086 to 0.192). [443] We assumed that asthma is controlled in 24% of children, partially controlled in 67% of children and uncontrolled in 9% of children[444] and estimated a weighted utility of -0.040 ((0.24 * -0.015) + (0.67 * -0.036) + (0.09 * -0.133)).
- A BC study estimated the annual direct costs attributable to asthma at $444 per person year (in 2006 CAD)[445] or $523 in 2017 CAD. Based on an average treatment duration of 10 years,[446] the total costs attributable to childhood asthma would be $5,230 per case.

### Childhood Leukemia

- The lifetime cost per case in the US has been estimated at $136,444 (in 2007 USD)[447] or $134,920 in 2017 CAD.

### Chronic Pelvic Pain

- The GBD study found that moderate pelvic pain is associated a disability weight of 0.114 (95% CI of 0.078 to 0.159).[448] We have assumed that this pain would last for a period of five years.[449]

### Dental Caries

- The Global Burden of Disease Study found that symptomatic dental caries ("has a toothache, which causes some difficulty in eating") is associated with a disability weight of 0.01 (95% CI of 0.005 to 0.019). Severe tooth loss ("has lost more than 20 teeth including front and back, and has great difficulty eating meat, fruits and

[442] Dehmer S, Maciosek M, LaFrance A et al. Health benefits and cost-effectiveness of asymptomatic screening for hypertension and high cholesterol and aspirin counseling for primary prevention. *The Annals of Family Medicine*. 2017; 15(1): 23-36.
[443] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.
[444] Chapman K, Ernst P, Grenville A et al. Control of asthma in Canada: failure to achieve guideline targets. *Canadian Respiratory Journal*. 2001; 8(Suppl A): 35A-40A.
[445] Sadatsafavi M, Lynd L, Marra C et al. Direct health care costs associated with asthma in British Columbia. *Canadian Respiratory Journal*. 2010; 17(2): 74-80.
[446] Bartick M and Reinhold A. The burden of suboptimal breastfeeding in the United States: a pediatric cost analysis. *Pediatrics*. 2010; 125(5): e1048-e56.
[447] Ibid
[448] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed January 2018.
[449] Hu D, Hook EW and Goldie SJ. Screening for Chlamydia trachomatis in women 15 to 29 years of age: a cost-effectiveness analysis. *Annals of Internal Medicine*. 2004; 141(7): 501-13.

vegetables") is associated with a disability weight of 0.067 (95% CI of 0.045 to 0.095).[450]

- A topical fluoride application costs $10.61.[451]
- A pit and fissure sealant application costs $19.74 for the first tooth in a quadrant and $10.83 for each additional tooth in the quadrant.[452]
- An amalgam restoration costs between $83.10 and $102.40 depending on whether or not the restoration is bonded and to which teeth the restoration is applied.[453] We used the mid-point ($92.75) for the base case and the extremes in the sensitivity analysis.
- The cost per day surgery for dental cavities in BC is estimated at $1,782 which includes $1,515 for hospital and $267 for anaesthesia costs in 2011[454] or $1,884 in 2017 dollars.

### Depression

- Depression has an important influence on a person's QoL. Studies have shown that individuals with current or treated depression report lower preference scores for depression health states than the general population.[455,456] Pyne and colleagues suggest that "public stigma may result in the general population being less sympathetic to the suffering of individuals with depression and less willing to validate the impact of depression symptoms."[457] Revicki and Wood, based on input from patients with depression who had completed at least eight weeks of antidepressant medication (ADM), identified the following health state utilities (or quality of life): severe depression = 0.30, moderate depression = 0.55 to 0.63, mild depression = 0.64 to 0.73 and antidepressant maintenance therapy = 0.72 to 0.83.[458] Whiteford and colleagues[459] suggest the following health utilities:
    - Severe depression, QoL = 0.35 (95% CI of 0.18 to 0.53)
    - Moderate depression, QoL = 0.59 (95% CI of 0.45 to 0.72)
    - Mild depression, QoL = 0.84 (95% CI of 0.78 to 0.89)

[450] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.
[451] BC Ministry of Social Development and Poverty Reduction. *Dental Supplement*. September 1, 2017. Available online at https://www2.gov.bc.ca/assets/gov/family-and-social-supports/income-assistance/on-assistance/schedule-dentist.pdf. Accessed January 2018.
[452] BC Ministry of Social Development and Poverty Reduction. *Dental Supplement*. September 1, 2017. Available online at https://www2.gov.bc.ca/assets/gov/family-and-social-supports/income-assistance/on-assistance/schedule-dentist.pdf. Accessed January 2018.
[453] Ibid.
[454] Canadian Institute for Health Information. *Treatment of Preventable Dental Cavities in Preschoolers: A Focus on Day Surgery Under General Anesthesia*. 2013. Available at https://secure.cihi.ca/free_products/Dental_Caries_Report_en_web.pdf. Accessed January 2018.
[455] Pyne JM, Fortney JC, Tripathi S et al. How bad is depression? Preference score estimates from depressed patients and the general population. *Health Services Research*. 2009; 44(4): 1406-23.
[456] Gerhards SA, Evers SM, Sabel PW et al. Discrepancy in rating health-related quality of life of depression between patient and general population. *Quality of Life Research*. 2011; 20(2): 273-9.
[457] Pyne JM, Fortney JC, Tripathi S et al. How bad is depression? Preference score estimates from depressed patients and the general population. *Health Services Research*. 2009; 44(4): 1406-23.
[458] Revicki DA and Wood M. Patient-assigned health state utilities for depression-related outcomes: differences by depression severity and antidepressant medications. *Journal of Affective Disorders*. 1998; 48(1): 25-36.
[459] Whiteford HA, Degenhardt L, Rehm J et al. Global burden of disease attributable to mental and substance use disorders: findings from the Global Burden of Disease Study 2010. *The Lancet*. 2013; 382(9904): 1575-86.

For modelling purposes we assumed an equal proportion of individuals with mild, moderate and severe depression and used the average quality of life provided by Whiteford and colleagues of 0.59 (95% CI of 0.47 to 0.72).

- The GBD study found that mild depression was associated with a disability weight of 0.145 (95% CI of 0.099 to 0.209), moderate depression was associated with a disability weight of 0.396 (95% CI of 0.267 to 0.531) and severe depression was associated with a disability weight of 0.658 (95% CI of 0.477 to 0.807).[460] The results by Whiteford et al. were generated for the GBD.[461]
- The cost/day for antidepressant prescriptions in BC ranges from $1.00 for prescriptions paid by the provincial government to $1.19 for prescription paid for by uninsured patients and $1.27 paid for by private insurers (in 2012 CAD)[462] or $1.04 / $1.24 / $1.33 respectively in 2017 CAD. The weighted average is $1.20/day or $438/year.

### Diabetes – Type 1

- The lifetime cost per case in the US has been estimated at $77,463 (in 2007 USD)[463] or $76,598 in 2017 CAD.

### Diabetes – Type 2

- The GBD study found that diabetic neuropathy ("person has pain, tingling and numbness in the arms, legs, hands and feet. The person sometimes gets cramps and muscle weakness") is associated with a disability weight of 0.133 (95% CI of 0.089 to 0.187).[464]
- Uncomplicated diabetes mellitus is associated with a disability weight of 0.049 (95% CI of 0.031 to 0.072).[465] In this situation, the person has "a chronic disease that requires medication every day and causes some worry but minimal interference with daily activities".

### Ectopic Pregnancy

- The GBD study found that an ectopic pregnancy is associated a disability weight of 0.114 (95% CI of 0.078 to 0.159).[466] We have assumed that the disability would last for a period of four weeks.[467]

[460] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed January 2018.
[461] Whiteford HA, Degenhardt L, Rehm J et al. Global burden of disease attributable to mental and substance use disorders: findings from the Global Burden of Disease Study 2010. *The Lancet*. 2013; 382(9904): 1575-86.
[462] Morgan S, Smolina K, Mooney D et al. *The Canadian Rx Atlas, Third Edition*. 2013. UBC Centre for Health Services and Policy Research. Available at http://www.chspr.ubc.ca/sites/default/files/file_upload/publications/2013/RxAtlas/canadianrxatlas2013.pdf. Accessed January 2018.
[463] Bartick M and Reinhold A. The burden of suboptimal breastfeeding in the United States: a pediatric cost analysis. *Pediatrics*. 2010; 125(5): e1048-e56.
[464] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed January 2018.
[465] Ibid.
[466] Ibid.
[467] Hu D, Hook EW and Goldie SJ. Screening for Chlamydia trachomatis in women 15 to 29 years of age: a cost-effectiveness analysis. *Annals of Internal Medicine*. 2004; 141(7): 501-13.

### End-Stage Renal Disease

- The GBD study found that chronic kidney disease (stage IV) is associated with a disability weight of 0.104 (95% CI of 0.07 to 0.147).[468]
- The GBD study found that being on dialysis because of end-stage renal disease caused by diabetes is associated with a disability weight of 0.571 (95% CI of 0.398 to 0.725).[469]
- The annual costs for end-stage renal disease are $63,045 (in 2000 CAD)[470] or $86,278 in 2017 CAD.

### Gastrointestinal Bleeding

- In a Canadian study of 124 patients (mean age of 58.8 years) with acute lower gastrointestinal hemorrhage, the mean hospital stay was 7.5 days at a cost of $4,832 per stay (in 2002 CAD) or $6,425 (in 2017 CAD).
- In a study of 936 patients with acute upper gastrointestinal bleeding (AUGIB) in the UK (mean age of 59.4 years), 42 (4.5%) had died by day 28 following the bleeding episode. The mean QoL score at 28 days for surviving patients was 0.735 compared to 0.86 for the general UK population, a disutility of 0.125 (or 14.5%). We have assumed that this disutility lasts for a one-year period.[471]
- In the same UK study, the mean hospital stay was 5.34 days with total hospital costs of £2,458 (in 2012/13 £). Mean post hospital discharge costs to day 28 were £391.[472] We converted the total cost of £2,849 to $5,269 2017CAD.

### Gastrointestinal Infection

- A US study suggests the direct costs for gastrointestinal infections and lower respiratory tract infections are $331 per case (in 1995 USD)[473] or $462 in 2017 CAD.

### Hearing Deficits

- The GBD study found that a mild hearing loss was associated with a utility of -0.01 (95% CI of -0.004 to -0.019), a moderate hearing loss with -0.027 (95% CI of -0.015 to -0.042), a severe hearing loss with -0.158 (95% CI of -0.105 to -0.227), a profound hearing loss with -0.204 (95% CI of -0.134 to -0.288) and a complete hearing loss with -0.215 (95% CI of -0.144 to -0.307).[474]
- A 2003 US study estimated the direct lifetime costs per individual associated with hearing loss to be $153,151 USD.[475] The costs included physician visits, prescription

[468] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed January 2018.
[469] Ibid.
[470] O'Brien JA, Patrick AR and Caro JJ. Cost of managing complications resulting from type 2 diabetes mellitus in Canada. *BMC Health Services Research*. 2003; 3(1): 7.
[471] Campbell H, Stokes E, Bargo D et al. Costs and quality of life associated with acute upper gastrointestinal bleeding in the UK: cohort analysis of patients in a cluster randomised trial. *British Medical Journal Open*. 2015; 5(4): e007230.
[472] Ibid.
[473] Ball TM and Wright AL. Health care costs of formula-feeding in the first year of life. *Pediatrics*. 1999; 103(Suppl. 1): 870-6.
[474] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed January 2018.
[475] Economic costs associated with mental retardation, cerebral palsy, hearing loss, and vision impairment – United States, 2003. *MMWR Weekly*. 2003; 53(03): 57-9.

medications, hospital inpatient stays, assistive devices, therapy and rehabilitation, long-term care, home and vehicle modifications and special education. We converted these costs to equivalent 2017 Canadian health care costs for a lifetime cost per individual of $169,952 CAD associated with hearing loss.

### HIV/AIDS

- The GBD study found that symptomatic HIV without anemia is associated with a disability weight of 0.274 (95% CI of 0.184 to 0.377), symptomatic HIV with mild anemia is associated with a disability weight of 0.277 (95% CI of 0.189 to 0.379), symptomatic HIV with moderate anemia is associated with a disability weight of 0.312 (95% CI of 0.217 to 0.418) and symptomatic HIV without severe anemia is associated with a disability weight of 0.381 (95% CI of 0.269 to 0.505).[476]
- The GBD study found that AIDS with antiretroviral treatment (ART) without anemia is associated with a disability weight of 0.078 (95% CI of 0.052 to 0.111), AIDS with antiretroviral treatment with mild anemia is associated with a disability weight of 0.081 (95% CI of 0.054 to 0.116), AIDS with antiretroviral treatment with moderate anemia is associated with a disability weight of 0.125 (95% CI of 0.085 to 0.176) and AIDS with antiretroviral treatment with severe anemia is associated with a disability weight of 0.215 (95% CI of 0.148 to 0.295).[477]
- Long and colleagues estimated the gain in quality of life associated with early detection and treatment of an HIV infection to be is 0.11 and the difference in quality of life between avoided infection and symptomatic HIV treated with ART to be 0.17.[478]
- The annual direct medical costs (excluding medications) associated with HIV/AIDS in Canada have been estimated by stage of infection at $1,684 for asymptomatic HIV, $2,534 for symptomatic HIV and $9,715 for AIDS (in 2009 CAD)[479] or $1,889, $2,843 and $10,900 respectively in 2017 CAD.

### Infertility

- The GBD study found that primary infertility ("wants to have a child and has a fertile partner but the couple cannot conceive") is associated with a disability weight of -0.008 (95% CI of -0.003 to -0.015) while secondary infertility ("has at least one child, and wants to have more children. The person has a fertile partner but the couple cannot conceive") is associated with a disability weight of 0.005 (95% CI of 0.002 to 0.011).[480]

### Intellectual Disability

- The GBD study found that borderline intellectual functioning is associated with a utility of -0.011 (95% CI of -0.005 to -0.02), mild intellectual disability is associated with a utility of -0.043 (95% CI of -0.026 to -0.064), moderate intellectual disability

[476] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed January 2018.
[477] Ibid.
[478] Long EF, Brandeau ML and Owens DK. The cost-effectiveness and population outcomes of expanded HIV screening and antiretroviral treatment in the United States. *Annals of Internal Medicine*. 2010; 153(12): 778-89.
[479] Kingston-Riechers, J. *The Economic Cost of HIV/AIDS in Canada*. Canadian AIDS Society, 2011. Available online at http://www.cdnaids.ca/files.nsf/pages/economiccostofhiv-aidsincanada/$file/Economic%20Cost%20of%20HIV-AIDS%20in%20Canada.pdf. Accessed July, 2014.
[480] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed January 2018.

is associated with a utility of -0.1 (95% CI of -0.066 to -0.142) and profound intellectual disability is associated with a utility of -0.2 (95% CI of -0.133 to -0.283).[481]

- A 2003 US study estimated the direct lifetime costs per individual associated with intellectual disability to be $243,620 USD.[482] The costs included physician visits, prescription medications, hospital inpatient stays, assistive devices, therapy and rehabilitation, long-term care, home and vehicle modifications and special education. We converted these costs to equivalent 2017 Canadian health care costs for a lifetime cost per individual of $270,345 CAD associated with intellectual disability.

### Lower Extremity Amputation

- The typical event cost for a lower extremity amputation is $24,583 with annual costs thereafter of $1,020 (in 2000 CAD)[483] or $33,642 and $1,396 respectively in 2017 CAD.

### Lower Respiratory Tract Infections

- A US study suggests the direct costs for gastrointestinal infections and lower respiratory tract infections are $331 per case (in 1995 USD)[484] or $462 in 2017 CAD.

### Otitis Media

- Two estimates from the US suggest a direct cost (ambulatory care and antibiotics) per case of $156 (2007 USD)[485] and $106 (2004 USD).[486] A Canadian study suggested additional hospital costs over and above physician and drug costs of 15.6%.[487] We have converted the $156 to 2017 CAD and then added 15.6% to account for hospital costs for a total cost per case of $251 CAD.

### Sexually Transmitted Infection

- The GBD study found that a mild chlamydial or gonococcal infection is associated with a utility of -0.006 (95% CI of -0.002 to -0.012).[488]

### Spina Bifida

- Based on a consecutive cohort of 117 children with spina bifida in the UK, 33.9% presented with a sacral lesion, 28.6% with a lower lumbar lesion and 37.5% with an upper lumbar lesion.[489]

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[481] Ibid.
[482] Economic costs associated with mental retardation, cerebral palsy, hearing loss, and vision impairment – United States, 2003. *MMWR Weekly*. 2003; 53(03): 57-9.
[483] O'Brien JA, Patrick AR and Caro JJ. Cost of managing complications resulting from type 2 diabetes mellitus in Canada. *BMC Health Services Research*. 2003; 3(1): 7.
[484] Ball TM and Wright AL. Health care costs of formula-feeding in the first year of life. *Pediatrics*. 1999; 103(Suppl. 1): 870-6.
[485] Bartick M and Reinhold A. The burden of suboptimal breastfeeding in the United States: a pediatric cost analysis. *Pediatrics*. 2010; 125(5): e1048-e56.
[486] Zhou F, Shefer A, Kong Y et al. Trends in acute otitis media-related health care utilization by privately insured young children in the United States, 1997–2004. *Pediatrics*. 2008; 121(2): 253-60.
[487] Coyte PC, Asche CV and Elden LM. The economic cost of otitis media in Canada. *International Journal of Pediatric Otorhinolaryngology*. 1999; 49(1): 27-36.
[488] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed January 2018.
[489] Oakeshott P, Hunt G, Poulton A et al. Expectation of life and unexpected death in open spina bifida: a 40-year complete, non-selective, longitudinal cohort study. *Developmental Medicine & Child Neurology*. 2009; 52(8): 749-53.

- Based on a study of 98 children with spina bifida in Arkansas, the average loss in QoL associated with spina bifida was 41%, ranging from 34% (6% to 62%) for the sacral lesion, 42% (22% to 62%) for the lower lumbar lesion and 52% (25% to 78%) for the upper lumbar lesion.
- The GBD study found the following utilities associated with spina bifida.

| Health State | Utility Weight | 95% CI | |
|---|---|---|---|
| Mild motor impairment due to spina bifida | -0.010 | -0.005 | -0.019 |
| Mild motor impairment and mild intellectual disability due to spina bifida | -0.031 | -0.018 | -0.050 |
| Moderate motor impairment due to spina bifida | -0.061 | -0.040 | -0.089 |
| Moderate motor impairment and borderline intellectual disability due to spina bifida | -0.071 | -0.045 | -0.106 |
| Moderate motor impairment and mild intellectual disability due to spina bifida | -0.101 | -0.066 | -0.146 |
| Moderate motor impairment and incontinence due to spina bifida | -0.191 | -0.132 | -0.263 |
| Moderate motor impairment, borderline intellectual disability and incontinence due to spina bifida | -0.200 | -0.139 | -0.273 |
| Moderate motor impairment and moderate intellectual disability due to spina bifida | -0.203 | -0.134 | -0.290 |
| Moderate motor impairment and severe intellectual disability due to spina bifida | -0.211 | -0.145 | -0.293 |
| Moderate motor impairment and profound intellectual disability due to spina bifida | -0.249 | -0.174 | -0.338 |
| Moderate motor impairment, mild intellectual disability and incontinence due to spina bifida | -0.272 | -0.191 | -0.364 |
| Moderate motor impairment, moderate intellectual disability and incontinence due to spina bifida | -0.272 | -0.191 | -0.364 |
| Moderate motor impairment, severe intellectual disability and incontinence due to spina bifida | -0.320 | -0.228 | -0.429 |
| Moderate motor impairment, profound intellectual disability and incontinence due to spina bifida | -0.352 | -0.254 | -0.465 |
| Severe motor impairment due to spina bifida | -0.402 | -0.268 | -0.545 |

- Grosse and co-authors estimated the lifetime costs associated with spina bifida to be $791,900 (in 2014 USD). This includes $513,500 in medical costs, $63,500 in special education and developmental service costs and $214,900 in parental time costs.[490] We converted these costs to $454,745 in medical costs, $79,203 in special education and developmental service costs and $268,043 in parental time costs in 2017 CAD.

[490] Grosse S, Berry R, Tilford J et al. Retrospective assessment of cost savings from prevention: folic acid fortification and spina bifida in the US. *American Journal of Preventive Medicine*. 2016; 50(5S1): S74-S80.