The cost of vision loss in Canada. 1. Methodology

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ABSTRACT • RÉSUMÉ

Objective: This paper outlines the methodology used to estimate the cost of vision loss in Canada. The results of this study will be presented in a second paper.

Design: The cost of vision loss (VL) in Canada was estimated using a prevalence-based approach. This was done by estimating the number of people with VL in a base period (2007) and the costs associated with treating them. The cost estimates included direct health system expenditures on eye conditions that cause VL, as well as other indirect financial costs such as productivity losses. Estimates were also made of the value of the loss of healthy life, measured in Disability Adjusted Life Years or DALY's.

To estimate the number of cases of VL in the population, epidemiological data on prevalence rates were applied to population data. The number of cases of VL was stratified by gender, age, ethnicity, severity and cause.

The following sources were used for estimating prevalence: Population-based eye studies; Canadian Surveys; Canadian journal articles and research studies; and International Population Based Eye Studies.

Direct health costs were obtained primarily from Health Canada and Canadian Institute for Health Information (CIHI) sources, while costs associated with productivity losses were based on employment information compiled by Statistics Canada and on economic theory of productivity loss. Costs related to vision rehabilitation (VR) were obtained from Canadian VR organizations.

Conclusions: This study shows that it is possible to estimate the costs for VL for a country in the absence of ongoing local epidemiological studies.

Objet : Cet article décrit dans les grandes lignes la méthodologie utilisée pour estimer le coût de la perte de vision au Canada. Le résultat de cette étude fera l'objet d'un second article.

Nature : Le coût de la perte de vision (PV) au Canada a été estimé selon une approche fondée sur la prévalence.

Méthode : L'on a d'abord estimé le nombre de personnes ayant une PV dans une période de référence (2007) et les coûts associés à leur traitement. L'estimation des coûts comprenait les dépenses directes du régime de santé portant sur les affections oculaires ayant causé la PV, ainsi que les autres coûts financiers indirects comme la perte de productivité. Les estimations ont aussi porté sur la valeur de la perte de qualité de vie, mesurée selon les Années de vie pondérées par l'invalidité (AVPL).

Pour estimer le nombre de cas de PV dans la population, les données épidémiologiques sur les taux de prévalence ont été appliquées aux données de la population. Le nombre de cas de PV a été stratifié selon le genre, l'âge, l'ethnicité, la sévérité et la cause.

Les sources suivantes ont servi à l'estimation des prévalences : Études oculaires fondées sur la population; Sondages canadiens; Articles de journaux et études de recherche au Canada et Études oculaires internationales fondées sur la population.

Les frais de santé directs ont été obtenus surtout de Santé Canada et de l'Institut canadien d'information sur la santé (ICIS), alors que les coûts associés à la perte de productivité étaient fondés sur l'information sur l'emploi compilée par Statistique Canada et sur la théorie économique de la perte de productivité. Les coûts concernant la réhabilitation visuelle (RV) ont été obtenus des organisations de RV canadiennes.

Conclusion : Cette étude démontre qu'il est possible d'estimer les coûts de PV dans un pays en l'absence d'études épidémiologiques locales en cours.

The prevalence of people with vision loss (VL) is increasing dramatically as our population ages. In 2006, Statistics Canada reported that there were 836,000 Canadians who self-identified as having significant VL.[1] Statistics Canada also projects that the population over 65 will double over the next 25 years.

To plan effectively for the provision of services for people with VL, and to fully understand the economic impact of VL, it is essential to have a reasonably accurate estimate as to what the cost of VL in Canada is, and what the components of these costs are. Estimates of the cost of VL have generally been made by projections from other jurisdictions. This approach, however, ignores significant differences in health care delivery between jurisdictions, so that estimates based on a percentage of costs in the United States, for example, are almost meaningless. Although there is no major epidemiological study that has been conducted in Canada such as The Blue Mountains Eye Study[2] (Australia) or the Beaver Dam Eye Study[3] (United States), projections using these studies and applying them to Canadian demographics can be expected to yield reasonable estimates of disease prevalence.

The present study estimated the cost of VL in Canada using a prevalence-based approach. The cost estimates included direct health system expenditures on eye conditions that cause VL, as well as other indirect financial costs such as productivity losses. Estimates were also made of the

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value of the loss of healthy life, measured in disability adjusted life years (DALYs).[4]

METHODS

A prevalence-based approach to cost measurement was selected rather than an incidence-based approach because of data availability and for consistency with other studies of the cost of VL (e.g., in Australia, Japan, and the United States). This was done by measuring the number of people with VL in a base period (calendar year 2007) and the costs associated with treating them, as well as other financial and nonfinancial costs (productivity losses, care burden, loss of quality of life) in that year, due to the condition.

To estimate the number of cases of VL in the population, epidemiological data on prevalence rates were applied to population data. The number of cases of VL were stratified by sex, age, ethnicity, severity (i.e., mild VL, moderate VL, blindness), and cause (age-related macular degeneration [AMD], cataract, diabetic retinopathy [DR], glaucoma, refractive error [RE], and "other").

Age, gender, growth and ethnicity

Population projections for the whole population were compiled using data from the Statistics Canada 2006 Population Projections for Canada, Provinces and Territories 2005–2031.[5] For the purpose of this report, the total population was segmented into 2 main groups: "White" and "Aboriginal and Visual Minorities" (AVM). The projections of the AVM populations were based on Statistics Canada 2005 projections.[6,7]

Prevalence of VL

A variety of data sources were reviewed to estimate prevalence of VL stratified by age, gender, ethnicity, severity (i.e., mild VL, moderate VL, blindness) and cause (AMD, cataract, DR, glaucoma, RE, other). Because this level of detail is not available from any single Canadian epidemiological data source, various data sources were combined to ensure that Canadian aggregates were used wherever possible, with credible alternative sources used where there were found to be data gaps.

Four types of data sources were used:

1. *Population-based eye studies*. These are the gold standard, where the degree, type, and cause of VL are assessed by experts for a large sample of people over a period of years of follow-up. However, because such studies require large amounts of time, money, and equipment, they are very rare, and none have been conducted in Canada, although data from the Eye Disease Prevalence Research Group (EDPRG) eye studies[8] were used where appropriate.
2. *Canadian surveys*. Data from 3 large-scale Canadian population studies were used in this study. These studies were: the Canadian Community Health Survey (CCHS),[9] the National Population Health Survey (NPHS),[10] and the Participation and Activity Limitation Survey (PALS).[11]
3. *Canadian journal articles and research studies*. A number of small, specific, Canadian studies were obtained via literature searching and were incorporated into this study. Specifically, these studies were those by Cheng et al.[12] on the prevalence of myopia in Chinese-Canadian children; Hanley et al.[13] on complications of diabetes and diabetic retinopathy among Aboriginal Canadians; Meddings et al.[14] on the relationship between the development of cataract at a young age and socioeconomic status in British Columbia; Chang et al.[15] on AMD in Chinese-Canadians; and Iskedjian et al.[16] on the costs of treating patients with glaucoma in Canada.
4. *International population-based eye studies*. Population-based eye studies in the United States,[3] Australia,[2] and the Netherlands[17] show that the prevalence of VL and its underlying eye diseases do not vary greatly between white populations in these countries. Accordingly, data from these studies form the basis of estimates for the white Canadian population. However, these population studies also show significant differences in VL prevalence between given racial groups (e.g., East Asian and black) living in wealthy countries (such as Canada) and those living in poorer countries (e.g., China, Barbados). Accordingly, wherever possible, data for nonwhite groups were sourced from Canadian surveys and journal articles.

Cost of VL in Canada

Health system expenditures. The total cost of VL related health expenditures was estimated based on a combination of a "top down" (that is, using national expenditures on all forms of treatment for visually impairing eye conditions) and a "bottom up" approach (using known costs and quantities of specific eye care procedures). The top down estimate relies primarily on 2 sources: *The Economic Burden of Illness in Canada 1998*[18] and *National Health Expenditure Database* (NHEX) (Canadian Institute of Health Information).[19] Information from these 2 data sources was combined to provide estimates of Health System Expenditures for 2007 for the following categories of expenditures:

- Hospitals;
- Physicians;
- Pharmaceuticals;
- Vision care (optometry, ophthalmology and lenses);
- Research;
- Other institutions; and
- Other (capital, public health, administration, and professional services).

Other financial costs. In addition to health system costs, VL also imposes a number of other important financial costs on society and the economy, including the following.

1. *Productivity losses*. These costs are those incurred due to lower employment participation and higher absenteeism by people with VL, and/or premature mortality.
   (a) *Employment participation*. The PALS 2001 survey[11] indicated that the employment rate of those living with VL was 32% (about 50% of the national employment rate for Canada). This reduced employment result was combined with employment rates for each respective age-gender group[20] to calculate the number of people with VL in each age group that would be unemployed. This number was, in turn applied against the estimated average weekly earnings by age and gender.[21]
   (b) *Absenteeism.* Absenteeism costs were based on a reported figure of 4.1 additional days off work per annum incurred by people with VL.[22] This number was applied to employee costs due to lost wages, and employer costs due to increased overtime. In addition the cost of time lost from unpaid work (leisure) was assessed at 30% of paid work.[23]
   (c) *Presenteeism*. The loss in productivity due to VL (a combination of the extra costs required for additional equipment and a reduction in productivity per se) was estimated at 15.7%, based on a study by Daum et al.[24]
2. *Care costs.* These costs comprise the value of care services provided in the community primarily by informal care givers and not captured in health system costs. The calculation of care giver costs was based on a study by Cruess et al.[25] who calculated the burden of neovascular AMD in the Canadian population. In this study, the annual cost of nonmedical care of an AMD patient was estimated and compared with the general population. For the present study this value was decreased by a factor of 1.6 that was calculated by comparing the disability weight of AMD (0.235) with that of the average disability weight across all eye diseases (0.145).[25]
3. *Other costs.* These costs comprise the cost of aids, home modifications and other pertinent financial costs not captured elsewhere, and include the following costs:
   (a) *Rehabilitation and library costs*. The cost of provision of rehabilitation services for people with VL was obtained by combining the cost for these services provided by CNIB[26] with those obtained from the web sites of the other 2 major Canadian service providers, the Institut Nazareth et Louis-Braille,[27] and MAB-Mackay.[28]
   (b) *Aids and devices for people with VL*. Prices for devices were obtained from the CNIB price list (adjusted by the Consumer Price Index) and applied against the volumes of devices sold in Canada reported in the December 2003 Price Survey of Assistive Devices for Persons with Disabilities by the Department of Human Resources and Social Development.[29]
4. *Dead weight losses (DWL)*. Taxation revenue losses and welfare payments are not themselves economic costs but rather a financial transfer from taxpayers to the income support recipients. The real resource cost of these transfer payments is only the associated DWL. DWLs refer to the cost of administering welfare pensions and raising additional taxation revenues. It has been estimated[30] that the DWL of raising revenue in Canada is 20.2%.
   (a) *Lost taxation revenue.* Taxation revenue lost was estimated by calculating the total loss in earnings by people with VL, and calculating the direct taxes on these earnings that would be foregone, using the Quebec income tax rate, because its taxes were roughly mid range of all Canadian Provinces. For indirect taxes, it was assumed that all after tax income of people with VL would be spent and this number was used to calculate the provincial sales tax foregone, again using Quebec provincial sales tax rate as the basis for calculation.
   (b) *Social security payments.* It was assumed that people with VL were either employed or on a disability pension. The total disability pension for people with VL was calculated by using data from Human Resources and Social Development Canada[31] to calculate the excess number of people with VL who receive payment relative to population norms. These excess usage rates were then multiplied by the average payment rates to estimate the social security payments for people with VL.

Burden of disease

A major cost of VL is the loss of well-being and the quality of life that it entails. Loss of well-being and premature mortality—called the "burden of disease and injury"—were measured in terms of Disability Adjusted Life Years or DALYs according to the method of Murray and Lopez.[4] The Burden of disease as measured in DALYs was converted into a dollar figure using an estimate of the Value of a Statistical Life (VSL). To calculate the DALYs, disability weights for VL were based on the Dutch weights from the global burden of disease study,[4] weighting these numbers by the overall prevalence of mild, moderate and severe VL in Canada. This yielded an average disability weighting for Canadian VL of 0.093. This number was, in turn applied against the prevalence of VL in male and female Canadians

separately to get the total years of life lost due to disability (YLD). To this number was added the years of life lost due to premature death (YLL). This number was based on an Australian report by Begg et al.[32] on premature death due to VL that was applied against the number of people with VL in Canada. The overall loss of well-being due to VL (total DALYs) was a sum of YLD and YLL.

VSL was obtained from an average of 16 Canadian VSL studies, converting the findings to 2007 Canadian dollars, and using a discount rate of 3%[32] to calculate the 2007 Canadian value of a statistical life year (VSLY). Multiplying the total DALYs by the VSLY, yielded the estimated gross cost of lost well being in Canada. This number was subsequently converted to a net number by subtracting all known personal impacts such as production losses, costs borne out-of-pocket, and transfers to people with VL.

Discussion

Limitations of data sources

Data obtained from population based eye studies were based on projections from studies assembled by the EDPRG.[8] Although there are close similarities between demographics of the populations studied by the EDPRG and the Canadian population, studies using the EDPRG data are projections and have inherent limitations.

As noted above, there have not yet been any major population eye health studies conducted in Canada. Thus the choice falls to using self-diagnosed and self-reported data from the CCHS, or using data from American or Australian eye health studies. Australian data[33] is preferred for 2 reasons. First, Australian VL data for each disease is available by age cohort, which is essential for working with population projections. Second—and potentially reflecting similar ethnic mix and health systems—the Australian proportion of total VL caused by each of the major diseases is significantly closer to Canada's than the U.S. data (Table 1). As the table shows, the proportion of VL caused by cataracts in the United States is >3 times higher than in Canada, whereas the ratio between Canada and Australia is around 1.30:1.00 At the other end of the scale, the proportion of VL due to RE is >5 times smaller in the United States than it is Canada, whereas the ratio between Australia and Canada is around 1.39:1.00.

There are severe data problems in estimating the prevalence of VL among Canada's AVM populations. Although the CCHS collects the prevalence of eye diseases, by age, for the AVM population, it does not collect data on the causes of VL. Moreover, the prevalence data are not disaggregated by race, despite known differences between races.

Table 1—Causes of VL, by disease, in white populations

Disease	United States[8] (%)	Canada[34] (%)	Australia[35] (%)
Cataract	59.2	18.6	14.3
Glaucoma	3.3	7.0	2.9
DR	4.9	7.0	1.6
AMD	22.9	16.3	10.1
RE/other	9.7	51.3	71.2

Note: AMD, age-related macular degeneration; DR, diabetic retinopathy; RE, refractive error; VL, vision loss.

The approach used in this study has been to estimate from international sources the likelihood that a nonwhite person who has an eye disease will develop VL, and apply that ratio to the CCHS prevalence of that disease in Canada's AVM population.

Although available data from Canada are not sufficient to uniformly adopt a top-down approach (that is, national expenditure on all forms of treatment for visually impairing eye conditions) or bottom-up estimates (known costs and quantities of specific eye care procedures), using a combination approach enables a reasonable estimate of total health system expenditure.

The study on AMD costs by Cruess et al.[25] mentioned earlier, is an example of a bottom-up study and serves as a basis for cost comparison of the bottom-up estimates obtained in this study.

This study describes the methodology used to calculate the cost of VL in Canada. The results obtained in this study will be reported in a subsequent article. This study shows that it is possible to estimate the costs for VL for a country in the absence of ongoing local epidemiological studies. It is clear, however, that for optimal future projections it would be preferable to initiate an ongoing Canadian population eye health study to monitor incidence, prevalence and morbidity outcomes and economic impacts more robustly in the future.

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