Title:

The Economic Burden of Cancer Care in Canada: Revised and Recent Cost-of-Illness Estimates

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None declared.

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Abstract

Background: Resource and cost issues are a growing concern in healthcare. Thus, it is important to have an accurate estimate of the economic burden of care. Previous work has estimated the economic burden of cancer care for Canada; however, there is some concern this estimate is too low. The objective of this analysis was to provide a comprehensive, revised estimate of this burden.

Methods: We undertook a case-control prevalence-based direct cost approach and estimated cancer costs for each year from 2005 to 2012 to compare with and update previous work. Patient-level administrative healthcare data from Ontario were used to correctly attribute healthcare costs to cancer. We employed the net cost method to account for costs directly and indirectly related to cancer and its sequelae. Using average patient-level cost estimates from Ontario, we applied proportions from national health expenditures data to obtain the economic burden of cancer care for Canada. All costs were adjusted to 2015 Canadian dollars.

Results: Our cost estimates were generally larger than those previously published, due to the inclusion of costs of chemotherapy, radiation therapy and other costs. Costs of cancer care rose steadily over our analysis period, from $2.9 billion in 2005 to roughly $7.5 billion in 2012, mostly due to the increase in costs of hospital-based care.

Interpretation: The existing estimates of the economic burden of cancer care for Canada are too low. Our revised cost estimates provide decision makers with a more accurate understanding of the total economic burden of cancer care in Canada.

Background

Cancer and related costs are rising at a fast pace.[1] Those who fund and organize cancer care struggle to provide patients with the latest therapies, given limited financial resources. Due to the large economic burden of cancer, it is important to have accurate cost estimates.[2] Cost-of-illness studies can help translate the adverse effects of diseases into dollars, a useful metric for decision makers. These estimates can be used to help set priorities for treatments and aid in the allocation of scarce resources within the healthcare sector. However, few studies have attempted to estimate the cost of cancer for Canada.

The Economic Burden of Illness in Canada (EBIC) 2005–2008 report is the only comprehensive Canadian cost-of-illness study,[3] which provides comparable estimates for direct (e.g., medical expenditures) and indirect (e.g., lost productivity) costs for all major illness categories, including cancer. This analysis attributed healthcare expenditures to particular conditions by applying estimates of utilization patterns from various sources to aggregate healthcare spending data by expenditure category: hospital care, physician care, and public and private drugs. Other direct healthcare expenditures (e.g., other professionals, capital, public health and other health spending) were also included but could not be attributed to diagnostic and demographic categories. While all expenditures directly associated with cancer were captured, expenditures that were indirectly related were not assigned to the disease. As such, the EBIC report underestimates the actual burden of cancer care. The purpose of this study was to both revise the estimates of the EBIC report and provide more recent estimates of the burden of cancer care for Canada using a more comprehensive approach, which better captures the direct costs of cancer care.

Methods

Setting

We undertook a comprehensive approach to estimate the economic burden of cancer care for Canada using existing cancer prevalence rates, Ontario patient-level cost data and national expenditure data. For comparability with prior work, we examined two analysis periods: 2005-2008 (to provide more accurate revised estimates) and 2009-2012 (to provide more recent estimates).

Study design

We employed a case-control prevalence-based direct cost approach to estimate costs for each year of our analysis periods. We undertook a 10-year person-based prevalence approach to define our cohort, which was roughly in line with Statistics Canada's cancer prevalence reports.[4] We estimated total and per patient net costs of cancer care for Ontario, and extrapolated these to the rest of Canada using relative provincial/territorial expenditures obtained from the National Health Expenditure Database (NHEX).[5]

Data sources

Cancer prevalence rates were obtained from Statistics Canada and the Canadian Cancer Society. We used patient-level data from Ontario, Canada's largest province (~ 14 million people), to estimate direct costs, from the perspective of the third-party payer (ministry of health), for each year of our analysis. These data were accessed through the Institute for Clinical Evaluative Sciences (ICES), which houses comprehensive, linkable healthcare records for Ontario. Table 1

provides a list of the datasets used in this study. A full description of each dataset can be found elsewhere.[6] In addition, we used the NHEX to obtain provincial/territorial expenditures by healthcare category.[5]

Cancer prevalence in Canada

Person-based cancer prevalence rates were not available by province/territory; rates by sex were available for Canada for 2005, 2007 and 2009 only.[7-9] Based on existing data, we used linear interpolation and extrapolation to obtain prevalence rates by sex for 2006 and 2008, and 2010-2012, respectively. We used existing 10-year tumour-based prevalence by sex and age groups[9] to infer the corresponding person-based cancer prevalence rates. To estimate the number of people living with cancer across the country, we applied the Canadian prevalence rate in each province/territory and multiplied our sex and age group prevalence estimates by the respective population groups of each province/territory obtained from the NHEX.[5] (Further details can be found in the Appendix).

Patients

We used the Ontario Cancer Registry to select all patients with cancer and in remission (cases) who were diagnosed in the 10 years up to and including the year of analysis (see Table A2 in the Appendix for the list of neoplasm codes included). We selected non-cancer patients (controls) from the Registered Persons Database, a population-based registry in Ontario. We matched cases to controls on age +/- 1 year; sex; and comorbidity (measured by Aggregated Diagnosis Groups from the Johns Hopkins Adjusted Clinical Groups software,[10] excluding the malignant neoplasm cluster) at the start of each analysis period (2005 and 2009). This ensured that controls remained

representative of cases throughout each analysis period. Cases that died at any time during each analysis period were matched to controls that also died during the same year.

Patient-level cost estimation

We estimated all costs related to initial treatment, ongoing treatment, remission and palliative care for cancer patients. Patient-level costs were obtained using a cost algorithm available at ICES,[6] which includes the cost of inpatient hospitalizations (acute and psychiatric); emergency department visits, same-day surgery and other ambulatory care; other institution-based care, such as rehabilitation, complex continuing care and long-term care; physician-related visits; outpatient prescription drugs (covered under the public provincial drug plan);[11] non-physician billings covered under the Ontario Health Insurance Plan (e.g. physiotherapists, optometrists, chiropractors, etc.); diagnostic tests; home care, and assistive devices. For comparability with prior work,[3] we assigned these costs to three categories: hospital care (which included hospital and other institution-based care), physician care, and drugs. We created a fourth category, 'other care', not included in prior work, which included the remaining healthcare services (non-physician billings, diagnostic tests, home care and assistive devices).

Chemotherapy and radiation therapy costs were also not included in previous work. We estimated these costs and reported them separately and jointly with hospital care. To estimate the cost of parenteral and oral chemotherapy, we used the number of doses and unit costs available in the New Drug Funding Program database, from Cancer Care Ontario, and the Ontario Drug Benefit claims database, respectively. For radiation therapy, we used the unit measure provided by the National Hospital Productivity Improvement Program codes in the Activity Level

Reporting database, from Cancer Care Ontario, and multiplied each unit by a unit cost estimate obtained from the literature.[12]

Data on some health services were missing for some months/years of our analysis, namely for psychiatric inpatient hospitalizations for the first 9 months of 2005; other ambulatory care (cancer clinic and dialysis visits) for 2005; and assistive devices from August 2010 onwards. To address this, we extrapolated missing cost estimates for other ambulatory care and estimated annualized cost estimates for psychiatric inpatient hospitalizations and assistive devices based on existing data.

Statistical analyses

All analyses were undertaken by sex (male and female) and age groups (0–14 years; 15–34 years; 35–54 years; 55–64 years; 65–74 years; and 75 years and older), as defined in previous work.

Patient-level net costs

We calculated gross per patient costs for each cost category, sex and age group. To estimate the "true" costs due to cancer, we employed a 'net cost' approach,[13-14] which has been employed and validated in previous work.[15-17] This method consists of estimating the total gross cost of all healthcare used to treat cases and controls by matching them on variables believed to influence healthcare utilization. Mathematically, $NC = C^P - C^C$, where NC is net cost, C is gross cost, and superscripts *P* and *C* denote patients (cases) and controls, respectively. The corresponding variance was defined as $Var\ (NC) = Var(C^P) + Var(C^C)$, where the covariance of costs for

patients (cases) and controls was assumed to be independent, given the conditional independence of the demographic variables and comorbidity after matching. In addition, 95% confidence intervals (CIs) were produced for each cost estimate.

National-level extrapolated costs

Data from the NHEX were used to create extrapolation factors to reflect differences between Ontario and each province/territory in terms of relative expenditures for each cost category. (Further details on the methodology can be found in the Appendix.) Extrapolation factors for 'other care' were based on expenditure data for 'other professionals', as this was the category that best matched the mix of healthcare services included in the 'other expenditures' category. We used hospital care extrapolation factors for chemotherapy and radiation therapy. Missing data for some provinces and analysis periods were replaced with similar regional provincial data for the same year and cost category, where required.

All cost estimates were expressed in constant 2015 dollars using the provincial healthcare component of the Consumer Price Index produced by Statistics Canada.[18]

Ethics approval

This study was approved by the Research Ethics Board at Sunnybrook Health Sciences Centre, Toronto.

Results

Patients

We found non-cancer matches for 96% of our cases, overall, in both analysis periods. Over 99% of patients who were alive during each period were matched; for deaths, just over 80% were matched. There were no significant differences post-matching between cases and controls on age, sex or comorbidity in either analysis period or cohort. (See Tables A3-A5 in the Appendix for details.)

Patient-level net costs

Tables 2 and 3 provide total net cost estimates in constant 2015 dollars (million) by cost category, and respective confidence intervals, for 2005–2008 and 2009–2012, respectively. (Corresponding total gross cost estimates can be found in Tables A6 and A7 in the Appendix.) Total net costs increased over both analysis periods from $1,024.5 million (95% CI [$997.2, $1,051.9]) in 2005 to $2,073.0 million (95% CI [$2,034.3, $2,111.7]) in 2008 and from $1,825.4 million (95% CI [$1,785.9, $1,864.9]) in 2009 to $2,610.4 million (95% CI [$2,568.5, $2,652.2]) in 2012. Subcategories of net costs, and respective confidence intervals, were negative for some years due to higher costs among matched controls.

National-level extrapolated costs

Figure 1 depicts total (net) public expenditures on cancer care by cost category and year for Canada, in constant 2015 dollars (millions). Total net expenditures rose substantively over each study period, from $2.9 billion in 2005 to roughly $7.5 billion in 2012, mainly driven by hospital-based care. (See Table A8 in the Appendix for total (net) public expenditures by cost category, sex and year for Canada.) Chemotherapy and radiation therapy expenditures saw the

largest increases over the study period (by a factor of 3 and almost 4 times, respectively, from 2005 to 2012) (Figure 2).

Table 4 provides our revised estimates for each expenditure category (including our revised hospital care and other care expenditures), from 2005 to 2008, alongside the EBIC report estimates, in constant 2015 dollars. Figure 2 illustrates these comparisons for 2008. The estimate in the EBIC report in 2008 was higher ($4.2 billion) than our net expenditure estimate ($3.6 billion), excluding chemotherapy, radiation therapy and other care); however, our estimate of hospital care was slightly higher than that in the EBIC report ($2.6 billion versus $2.5 billion). When we included chemotherapy and radiation therapy, our total estimate increased to $4.5 billion; it increased further to $4.9 billion when we included other care.

Interpretation

We found that the economic burden of cancer care in Canada more than doubled over our entire analysis period, rising from $2.9 billion in 2005 to $7.5 billion in 2012. Hospital care expenditures made up the largest portion, followed by physician care and drug expenditures; other expenditures were of similar magnitude to that of drugs and thus not negligible.

Our estimates were only comparable with those reported in the EBIC report for our first analysis period, 2005-2008. With the exception of 2005 and 2006, we found higher total expenditures in our analysis by 9% and 18% in 2007 and 2008, respectively. Our estimates of hospital care expenditures were lower than those in the EBIC report, with the exception of 2008. However, when hospital care was expanded to include chemotherapy and radiation therapy, our estimate

was higher for all years except 2005. Our findings suggest that the figures in the EBIC report are likely underestimates of the actual expenditures of hospital care for cancer patients.

Our physician care expenditures were lower than those in the EBIC report for all years. The EBIC report attributed physician care expenditures to specific conditions by applying patterns from Manitoba's publicly available fee-for-service data to the total physician expenditure data in the NHEX. Costs may have been misattributed to cancer if patterns found in Manitoba's fee-for-service system did not apply to other provinces and payment systems. Our revised estimates of physician care were based on costs observed in Ontario, where the share of physicians paid fee-for-service is lower than in Québec and the western provinces for most years of the full study period.[19] Hence, our estimates of physician care expenditures may be biased downward.

We could not compare our drug expenditures with those from the EBIC report. Our estimates included costs of outpatient prescription drugs and dispensing fees covered under public provincial/territorial drug plans only; those in the EBIC report included costs of outpatient prescription drugs covered under both public *and* private insurance plans and fees. Thus, our estimates are a portion of those included in the EBIC report.

When we included *all* relevant costs, such as costs of home care and other health services (likely non-attributable and thus not explicitly included in the EBIC report), our total cost estimates were larger than those in the EBIC report for every year, except 2005 and 2006. Thus, when all relevant costs are considered, the true cost of caring for cancer patients is likely higher than the estimates currently available.

Our analysis made use of rich administrative healthcare data and a large population-based prevalence sample of children and adults in Ontario. This enabled us to attribute all direct costs to patients and cost categories, in contrast with previous work. Our case-control methodology enabled us to estimate costs directly *and* indirectly related to cancer and its sequelae, a more accurate measure of all relevant costs of cancer care. It is vital to have accurate cost estimates. This information is important to stakeholders, such as ministries/departments of health and the Canadian Partnership Against Cancer, for example, who are interested in understanding the cost of treating patients with cancer. These estimates may be used to inform decisions regarding healthcare resource allocation and to set future healthcare budgets. In particular, chemotherapy cost estimates will be of interest to members of the Canadian Association of Provincial Cancer Agencies and provincial ministries/departments of health as the provision of cancer-related drugs has direct impact on their budgets. These data may also be useful to the pan-Canadian Pharmaceutical Alliance to inform future drug price negotiations.

Limitations

Our method to calculate 10-year person-based prevalence differed slightly from the one used by Statistics Canada. Prevalence rates were missing for some years of our study, which required extrapolation. Prevalence estimates by province/territory were not available for any year of our analysis; thus, we assumed the same prevalence rate across all jurisdictions. We also made several assumptions to extrapolate person-based prevalence from tumour-based prevalence for each sex/age group.

Our patient-level data were limited to costs paid by the Ontario Ministry of Health and Long-term Care, which includes roughly 92% of government-related costs of health services.[20] We were only able to capture third-party *public* costs for outpatient *prescription* drugs and dispensing fees; in Ontario this includes patients 65 and older and special cases (e.g. individuals on social assistance).[11] Data on outpatient prescription drugs paid by private health insurance plans, non-prescription drugs, markups and taxes were not available. There were also a few instances where cost data were missing, which required imputation.

We were not able to find a match for all cancer cases; this reduced the sample of the net cost analysis and may have biased our estimates. Along with age and sex, we matched on comorbidity, which may have excluded the higher risk of developing comorbid conditions among cancer patients. Thus, our estimates are likely conservative.

To extrapolate the Ontario cost to other Canadian provinces/territories, we assumed that relative spending for cancer patients (in each province/territory versus Ontario) reflected the relative total spending by provincial/territorial government payers for each healthcare cost category. Given the lack of spending estimates for chemotherapy and radiation therapy, we used relative hospital care spending. Data from the NHEX were missing for some categories and years for some jurisdictions, which required making some assumptions to obtain imputed values. Furthermore, we were not able to find an equivalent cost category in the NHEX for "other expenditures".

Finally, unlike the EBIC report, we estimated the direct costs incurred by the public third-party payer only; we did not have the data required to estimate indirect costs, such as lost productivity associated with cancer.

Conclusion

Our analysis suggests that the economic burden of cancer care in Canada is larger than the existing estimate. Hospital care made up the largest and fastest growing share of the overall burden. In particular, chemotherapy and radiation therapy expenditures grew the most. Nevertheless, given our assumptions and data limitations, our results are likely an underestimate of the true economic burden. Future work is required to estimate the full cost of both prescription and non-prescription drugs covered by public and private third-party payers. Given that this analysis was based on cost estimates for Ontario only, the accuracy of national estimates would be improved by using province-specific cost data where possible. Further research is also required to understand how the economic burden of cancer compares to that of other diseases.

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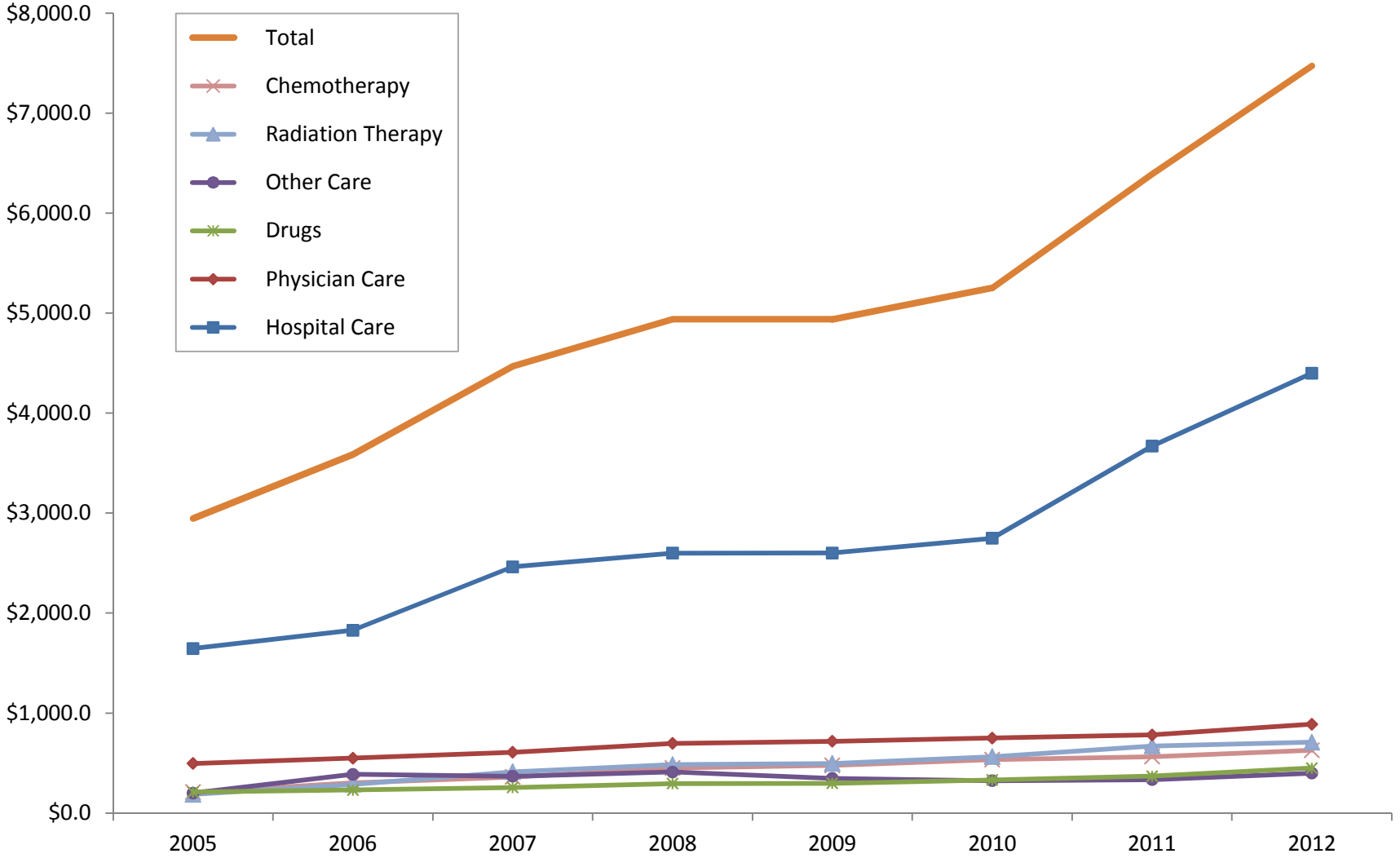
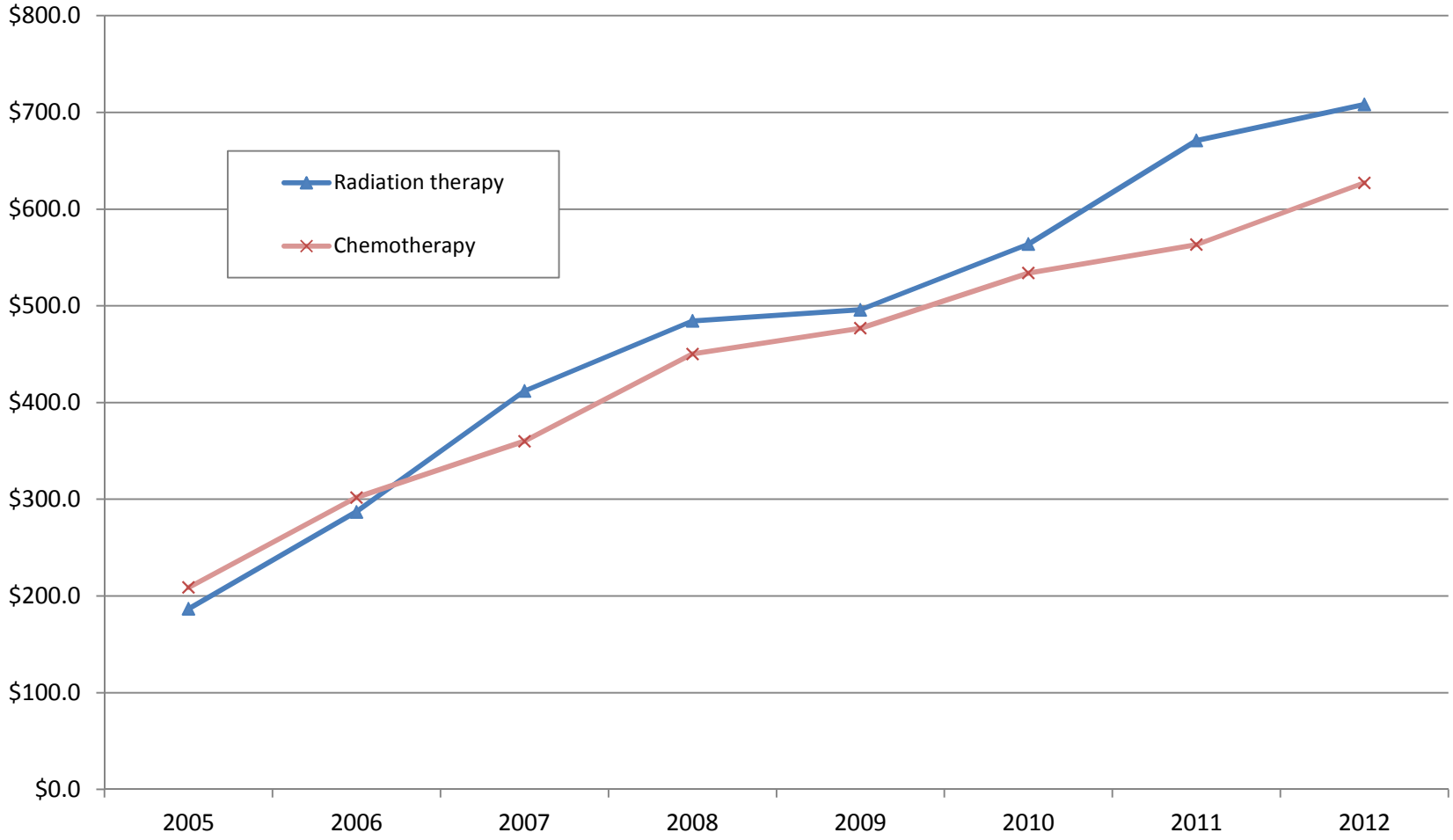
Figure 1 – Total (net) public expenditures on cancer care by cost category and year (2005-2008 and 2009-2012), Canada (constant 2015 $000,000)



Note: Cases were matched to controls in 2005 and 2009; hence, there is a discontinuity in net costs between 2008 and 2009. 'Other Care' includes non-physician care (including other professional services performed outside the hospital setting), diagnostic testing, home care, and assistive devices.
Source: Costs for Canada were estimated using a combination of purpose-derived estimates of mean net costs of cancer care in Ontario, National Health Expenditures (NHEX) data on relative expenditures by cost category for each province versus Ontario (Table E)[5] and prevalence figures for each province/territory, which were estimated based on data from the Canadian Cancer Society (CCS) and Statistics Canada,[7-9] and NHEX data on population by age, sex and province/territory for 2005–2012.[5]

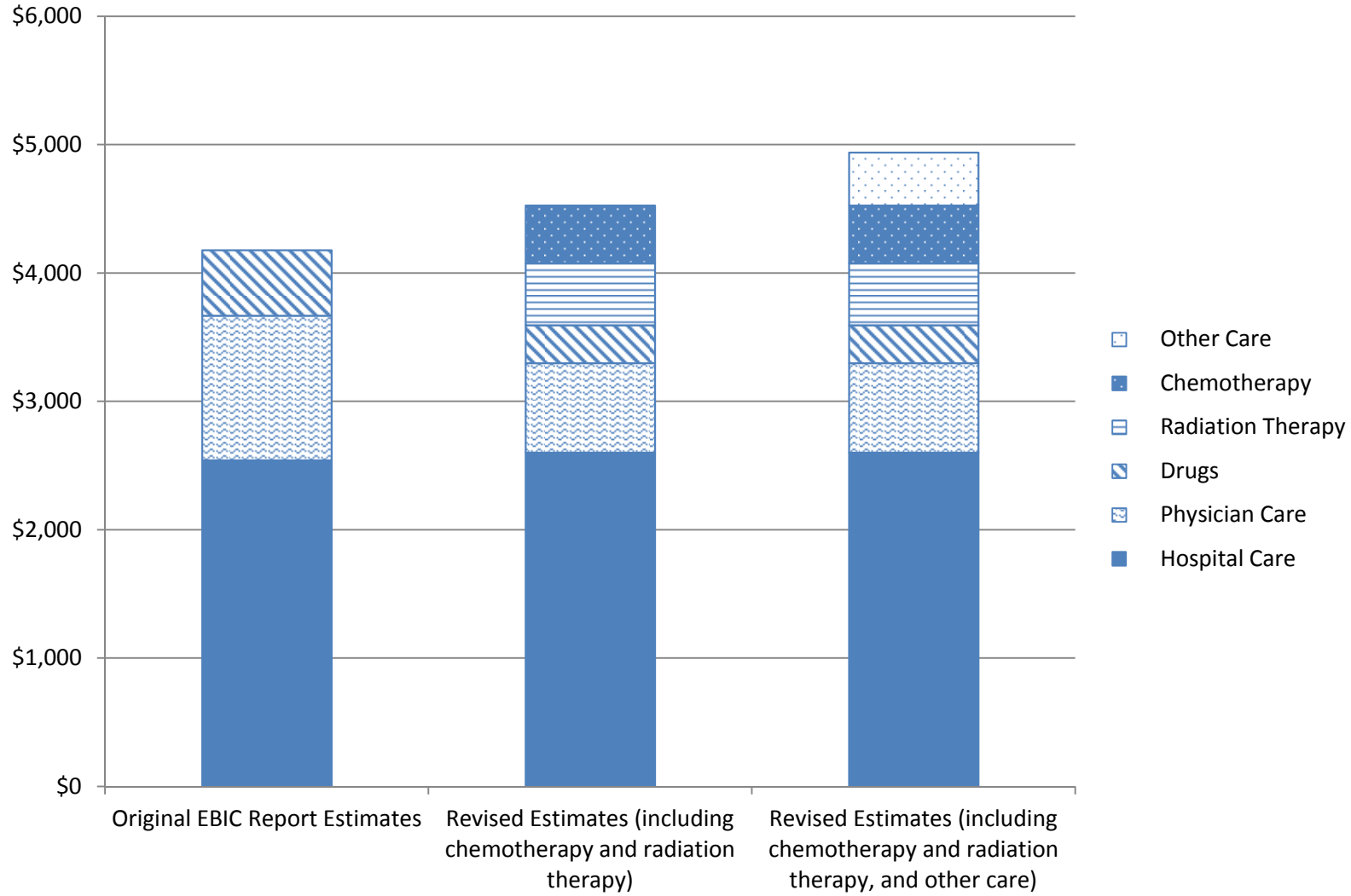
Figure 2 – Total (net) public expenditures on radiation therapy and chemotherapy by year (2005-2008 and 2009-2012), Canada (constant 2015 $000,000)



Note:

Note: Cases were matched to controls in 2005 and 2009; hence, there is a discontinuity in net costs between 2008 and 2009.
Source: Costs for Canada were estimated using a combination of purpose-derived estimates of mean net costs of cancer care in Ontario, National Health Expenditures (NHEX) data on relative expenditures by cost category for each province versus Ontario (Table E),[5] and prevalence figures for each province/territory, which were estimated based on data from the Canadian Cancer Society (CCS) and Statistics Canada,[7-9] and NHEX data on population by age, sex and province/territory for 2005–2012.[5]

Figure 3 – Total public expenditures on cancer care in Canada, by cost category, 2008 (constant 2015 $'000,000)



Note: 'Drugs' includes expenditures by both public and private insurance plans in the Original EBIC report estimates but includes only public expenditures in the revised estimates. 'Other Care' includes home care, non-physician care (including other professional services performed outside the hospital setting), diagnostic testing, and assistive devices.

Source: Economic Burden of Illness in Canada (EBIC) 2005–2008 report;[3] costs for Canada were estimated using a combination of purpose-derived estimates of mean net costs of cancer in Ontario, National Health Expenditures (NHEX) data on relative expenditures by cost category for each province versus Ontario (Table E),[5] and prevalence figures for each province/territory, which we estimated based on data from the Canadian Cancer Society (CCS) and Statistics Canada,[7-9] and NHEX data on population by age, sex and province/territory for 2005–2012.[5]

Table 1 – Databases available at the Institute for Clinical Evaluative Sciences

Databases	Years
Cancer-specific Databases	
Activity Level Reporting Database	Jan 2007-Dec 2012
New Drug Funding Program Database	Jan 2005-Dec 2012
Ontario Cancer Registry	Jan 2005-Dec 2012
Health Services Databases	
Assistive Devices Program Database	Jan 2005-Aug 2010
Canadian Institute for Health Information-Discharge Abstract Database	Jan 2005-Dec 2012
Canadian Institute for Health Information-National Ambulatory Care Reporting System	Jan 2005-Dec 2012
Continuing Care Reporting System	Jan 2005-Dec 2012
Home Care Database	Apr 2005-Dec 2012
National Rehabilitation Reporting System	Jan 2005-Dec 2012
Ontario Drug Benefit Claims Database	Jan 2005-Dec 2012
Ontario Health Insurance Plan Claims Database	Jan 2005-Dec 2012
Ontario Home Care Administrative System	Jan 2005-Mar 2005
Ontario Mental Health Reporting System	Oct 2005-Dec 2012
Population Registry	
Ontario Registered Persons Database	Jan 2005-Dec 2012

Table 2 – Total net cost[1] and 95% confidence intervals (CI), by cost category for patients with malignant neoplasms diagnosed in the past 10 years in Ontario, 2005–2008 (constant 2015 $000,000)

	2005			2006			2007			2008		
Cost Category:	**Net Cost**	**Lower 95% CI**	**Upper 95% CI**	**Net Cost**	**Lower 95% CI**	**Upper 95% CI**	**Net Cost**	**Lower 95% CI**	**Upper 95% CI**	**Net Cost**	**Lower 95% CI**	**Upper 95% CI**
Hospital Care												
Acute inpatient hospital care	$500.5	$484.2	$516.8	$550.3	$532.1	$568.5	$630.3	$607.5	$653.0	$665.5	$642.6	$688.5
Ambulatory hospital care												
Day surgery	$39.2	$38.1	$40.3	$39.5	$38.3	$40.7	$43.6	$42.3	$45.0	$46.0	$44.6	$47.4
Emergency department visits	$7.7	$6.9	$8.6	$9.2	$8.3	$10.1	$10.2	$9.2	$11.1	$13.2	$12.3	$14.2
Cancer clinics[2]	n/a	n/a	n/a	$357.3	$353.0	$361.6	$517.3	$511.9	$522.8	$498.4	$492.9	$503.8
Dialysis clinics[2]	n/a	n/a	n/a	-$12.7	-$16.7	-$8.7	-$16.9	-$23.4	-$10.4	-$13.1	-$21.5	-$4.8
Psychiatric inpatient hospital care[3]	-$7.8	-$9.8	-$5.8	-$24.7	-$29.5	-$19.8	-$26.4	-$32.4	-$20.5	-$26.3	-$32.5	-$20.1
Chronic and rehabilitation care												
Complex continuing care	-$7.8	-$17.2	$1.7	-$12.8	-$22.5	-$3.1	-$0.8	-$10.5	$8.8	$5.5	-$4.1	$15.1
Long-term care	-$116.8	-$124.1	-$109.5	-$128.3	-$135.8	-$120.7	-$132.5	-$140.2	-$124.8	-$124.3	-$132.2	-$116.5
Rehabilitation	$4.4	$0.2	$8.5	$7.4	$3.2	$11.6	$4.5	$0.1	$8.8	$7.2	$2.4	$12.0
Other hospital care												
Chemotherapy	$91.7	$89.4	$94.1	$128.6	$125.2	$132.0	$149.9	$146.4	$153.5	$187.3	$183.3	$191.2
Radiation therapy	$82.3	$80.6	$84.0	$123.7	$121.5	$125.9	$173.4	$169.8	$177.0	$201.5	$197.5	$205.5
Physician Care												
Fee-for-service	$202.0	$198.1	$205.9	$219.6	$215.6	$223.6	$242.0	$237.1	$246.9	$273.7	$268.2	$279.1
Non-fee-for-service	$43.2	$42.4	$43.9	$53.0	$52.1	$53.9	$58.5	$57.5	$59.5	$70.0	$68.9	$71.1
Drugs[4]	$106.1	$102.0	$110.1	$114.4	$110.0	$118.9	$122.1	$117.8	$126.5	$139.7	$135.2	$144.2
Other Care												
Assistive devices	-$1.6	-$2.6	-$0.6	-$2.4	-$3.4	-$1.4	-$2.4	-$3.3	-$1.4	-$0.3	-$1.2	$0.6
Home care	$77.4	$73.5	$81.3	$100.5	$95.9	$105.0	$103.6	$99.5	$107.7	$125.0	$120.7	$129.2
Diagnostic tests	$5.9	$5.6	$6.2	$5.7	$5.5	$6.0	$6.1	$5.8	$6.4	$7.0	$6.7	$7.3
Non-physician care[5]	-$1.9	-$2.2	-$1.7	-$2.2	-$2.5	-$2.0	-$2.6	-$2.9	-$2.3	-$2.8	-$3.1	-$2.5
Total Direct Cost	$1,024.5	$997.2	$1,051.9	$1,526.2	$1,494.1	$1,558.3	$1,879.9	$1,842.7	$1,917.0	$2,073.0	$2,034.3	$2,111.7

[1] Costs are presented for matched cancer patients (cases) only.
[2] Data for cancer and dialysis clinics were missing for 2005.
[3] Data for psychiatric hospitalizations were missing from January 2005 to September 2005.
[4] 'Drugs' includes outpatient prescription drugs covered by the provincial government payer.
[5] 'Non-physician care' includes care provided by other professionals outside the hospital setting.
Source: Data housed at Institute for Clinical Evaluative Sciences.

Table 3 – Total net cost[1] and 95% confidence intervals (CI), by cost category for patients with malignant neoplasms diagnosed in the past 10 years in Ontario, 2009–2012 (constant 2015 $000,000)

	2009			2010			2011			2012		
COST COMPONENT:	**Net Cost**	**Lower 95% CI**	**Upper 95% CI**	**Net Cost**	**Lower 95% CI**	**Upper 95% CI**	**Net Cost**	**Lower 95% CI**	**Upper 95% CI**	**Net Cost**	**Lower 95% CI**	**Upper 95% CI**
Hospital Care												
Acute inpatient hospital care	$571.3	$547.2	$595.3	$566.5	$542.6	$590.3	$597.3	$573.4	$621.2	$724.4	$700.4	$748.5
Ambulatory hospital care												
Day surgery	$48.3	$46.9	$49.7	$48.5	$47.1	$49.9	$55.1	$53.7	$56.5	$61.7	$60.2	$63.2
Emergency department visits	$9.5	$8.5	$10.4	$8.8	$7.8	$9.7	$11.2	$10.2	$12.2	$16.8	$15.7	$17.8
Cancer clinics	$474.1	$468.5	$479.8	$497.6	$491.6	$503.7	$753.3	$744.5	$762.2	$783.2	$774.4	$791.9
Dialysis clinics	-$25.1	-$33.4	-$16.9	-$30.3	-$39.2	-$21.4	-$15.7	-$21.8	-$9.7	-$4.2	-$10.5	$2.2
Psychiatric inpatient hospital care	-$22.0	-$27.9	-$16.1	-$26.5	-$32.7	-$20.3	-$27.3	-$33.7	-$20.9	-$25.7	-$32.5	-$18.9
Chronic and rehabilitation care												
Complex continuing care	-$14.2	-$24.1	-$4.2	-$1.1	-$11.2	$9.0	-$0.5	-$10.4	$9.4	$14.3	$4.3	$24.2
Long-term care	-$139.9	-$147.7	-$132.0	-$148.9	-$157.7	-$140.1	-$149.4	-$158.5	-$140.4	-$121.8	-$130.8	-$112.8
Rehabilitation	$5.8	$1.4	$10.2	$4.9	-$0.8	$10.7	$6.0	$1.3	$10.7	$13.4	$8.2	$18.6
Other hospital care												
Chemotherapy	$172.0	$168.2	$175.8	$186.4	$182.3	$190.5	$194.3	$190.1	$198.6	$212.5	$208.0	$217.1
Radiation therapy	$185.0	$181.2	$188.7	$201.0	$197.1	$205.0	$234.1	$229.9	$238.4	$240.8	$236.4	$245.2
Physician Care												
Fee-for-service	$242.6	$237.9	$247.3	$260.8	$256.7	$264.8	$287.5	$283.5	$291.6	$314.8	$310.7	$318.9
Non-fee-for-service	$71.9	$68.4	$75.5	$60.7	$59.8	$61.7	$41.8	$41.1	$42.4	$50.0	$49.3	$50.8
Drugs[2]	$136.8	$132.0	$141.6	$147.6	$141.9	$153.3	$159.0	$152.9	$165.1	$190.6	$184.0	$197.3
Other Care												
Assistive devices[3]	-$2.8	-$3.6	-$2.0	-$0.8	-$1.1	-$0.4	n/a	n/a	n/a	n/a	n/a	n/a
Home care	$108.3	$103.8	$112.8	$107.8	$103.1	$112.5	$118.9	$113.7	$124.0	$136.3	$131.3	$141.3
Diagnostic tests	$6.8	$6.5	$7.1	$6.4	$6.2	$6.7	$6.3	$6.0	$6.5	$6.8	$6.5	$7.0
Non-physician care[4]	-$3.0	-$3.3	-$2.6	-$3.7	-$4.1	-$3.4	-$3.9	-$4.2	-$3.5	-$3.6	-$4.0	-$3.2
Total Direct Cost	$1,825.4	$1,785.9	$1,864.9	$1,885.7	$1,845.4	$1,926.0	$2,268.1	$2,227.0	$2,309.2	$2,610.4	$2,568.5	$2,652.2

[1] Costs are presented for matched cancer patients (cases) only.
[2] 'Drugs' includes outpatient prescription drugs covered by the provincial government payer.
[3] Data for assistive devices were missing from September 2010 onwards.
[4] 'Non-physician care' includes care provided by other professionals outside the hospital setting.
Source: Data housed at Institute for Clinical Evaluative Sciences.

Table 4 – Total public expenditures on cancer care in Canada, by cost category and year (2005–2008) (constant 2015 $'000,000)

	2005	2006	2007	2008
Original EBIC Report Estimates				
Hospital Care	$2,267.5	$2,345.7	$2,504.9	$2,542.1
Physician Care	$847.1	$894.1	$1,027.2	$1,125.9
Drugs[1]	$408.5	$625.2	$560.7	$509.8
Other Care[2]				
Total Expenditures	**$3,523.2**	**$3,865.0**	**$4,092.9**	**$4,177.8**
Revised Estimates				
Hospital Care	$1,645.7	$1,828.7	$2,463.1	$2,600.1
Radiation Therapy	$186.7	$286.9	$412.0	$484.4
Chemotherapy	$208.8	$301.7	$360.0	$450.3
Physician Care	$496.4	$549.5	$608.3	$697.4
Drugs[1]	$209.9	$230.4	$255.5	$295.0
Other Care[2]	$199.5	$387.0	$368.0	$410.9
Total Expenditures (excluding chemotherapy, radiation therapy, and other care)	**$2,351.9**	**$2,608.7**	**$3,326.9**	**$3,592.5**
Total Expenditures (including chemotherapy and radiation therapy)	**$2,747.5**	**$3,197.4**	**$4,098.8**	**$4,527.2**
Total Expenditures (including chemotherapy, radiation therapy and other care)	**$2,947.0**	**$3,584.4**	**$4,466.8**	**$4,938.1**
Difference: Revised Estimates versus Original EBIC Report Estimates				
Revised estimates excluding chemotherapy, radiation therapy, and other care	-$1,171.2	-$1,256.3	-$766.0	-$585.2
Revised estimates including chemotherapy and radiation therapy but excluding other care	-$775.7	-$667.7	$5.9	$349.4
Revised estimates including chemotherapy, radiation therapy and other care	-$576.2	-$280.6	$374.0	$760.3

[1] 'Drugs' includes expenditures by both public and private insurance plans in the Original EBIC report estimates but includes only public expenditures in the revised estimates.
[2] 'Other Care' includes non-physician care (including other professional services performed outside the hospital setting), diagnostic testing, home care, and assistive devices.
Source: Economic Burden of Illness in Canada (EBIC) 2005–2008 report;[3] costs for Canada were estimated using a combination of purpose-derived estimates of mean net costs of cancer in Ontario, National Health Expenditures (NHEX) data on relative expenditures by cost category for each province versus Ontario (Table E),[5] and prevalence figures for each province/territory, which were estimated based on data from the Canadian Cancer Society (CCS) and Statistics Canada,[7-9] and NHEX data on population by age, sex and province/territory for 2005–2012.[5]

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
Objectives	3	State specific objectives, including any prespecified hypotheses
Methods		
Study design	4	Present key elements of study design early in the paper
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	Describe any efforts to address potential sources of bias
Study size	10	Explain how the study size was arrived at
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses

Continued on next page

Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	Discuss the generalisability (external validity) of the study results
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Note from authors: all items have been checked.

Appendix

I. Cancer prevalence in Canada

We obtained 10-year person-based cancer prevalence rates for all of Canada for some years of our study period from data published by Statistics Canada in conjunction with the Canadian Cancer Society. Data on cancer prevalence broken down by province and territory were not available. However, 10-year person-based prevalence rates by sex were available for 2005, 2007 and 2009 only.[1-3] Based on the available data, we used linear interpolation to extrapolate prevalence rates by sex for the remaining years (2006, 2008, and 2010-2012).

The Canadian Cancer Statistics 2014 publication included tumour-based 10-year prevalence by sex and age group (ages 0-19, 20-29, 30-39, 40-49, 50-59, 60-69, 70-79, and 80+) (Table 6.2).[3] These data show that tumour prevalence rises with age, peaking for those 60-79 years of age. Mariotto and colleagues show that the likelihood of having more than one primary tumour rises with age.[4] Hence, rather than apply the sex and age distribution of tumour-based prevalence directly to person-based prevalence, we redistributed the sex and age weights to reflect the likelihood of finding fewer tumours per person among younger people and more tumours per person among older people. We then calculated the numbers of people living with cancer as of January 1st, 2009, by multiplying the sex/age group weights by the total number of males and females in each age group in the population. Finally, we divided the total population by the estimated numbers of people with cancer as of January 1st, 2009, in each sex/age group, to obtain the prevalence expressed as "1 in n" members of the Canadian population. We extrapolated the sex and age group distributed prevalence estimates from 2009 to all other years in our study based on the overall total prevalence estimates by sex for each year (described above).

To estimate the number of people living with cancer, we assumed the same prevalence rate in each province/territory (the prevalence rate for Canada) and multiplied our sex and age group prevalence estimates by the population (broken down by the corresponding sex and age groups) of each province/territory obtained from NHEX data (Appendix tables C.11 to C.18).[5] For comparability with the EBIC report, we redistributed the total prevalence estimates from the Canadian Cancer Statistics 2014 groupings (provided above) to those used in the EBIC report (ages 0-14, 15-34, 35-54, 55-64, 65-74, and 75+) assuming equal allocations across age groups. For example, half of those ages 70-79 were allocated to the 65-74 year old group and half to the 75 and older group.

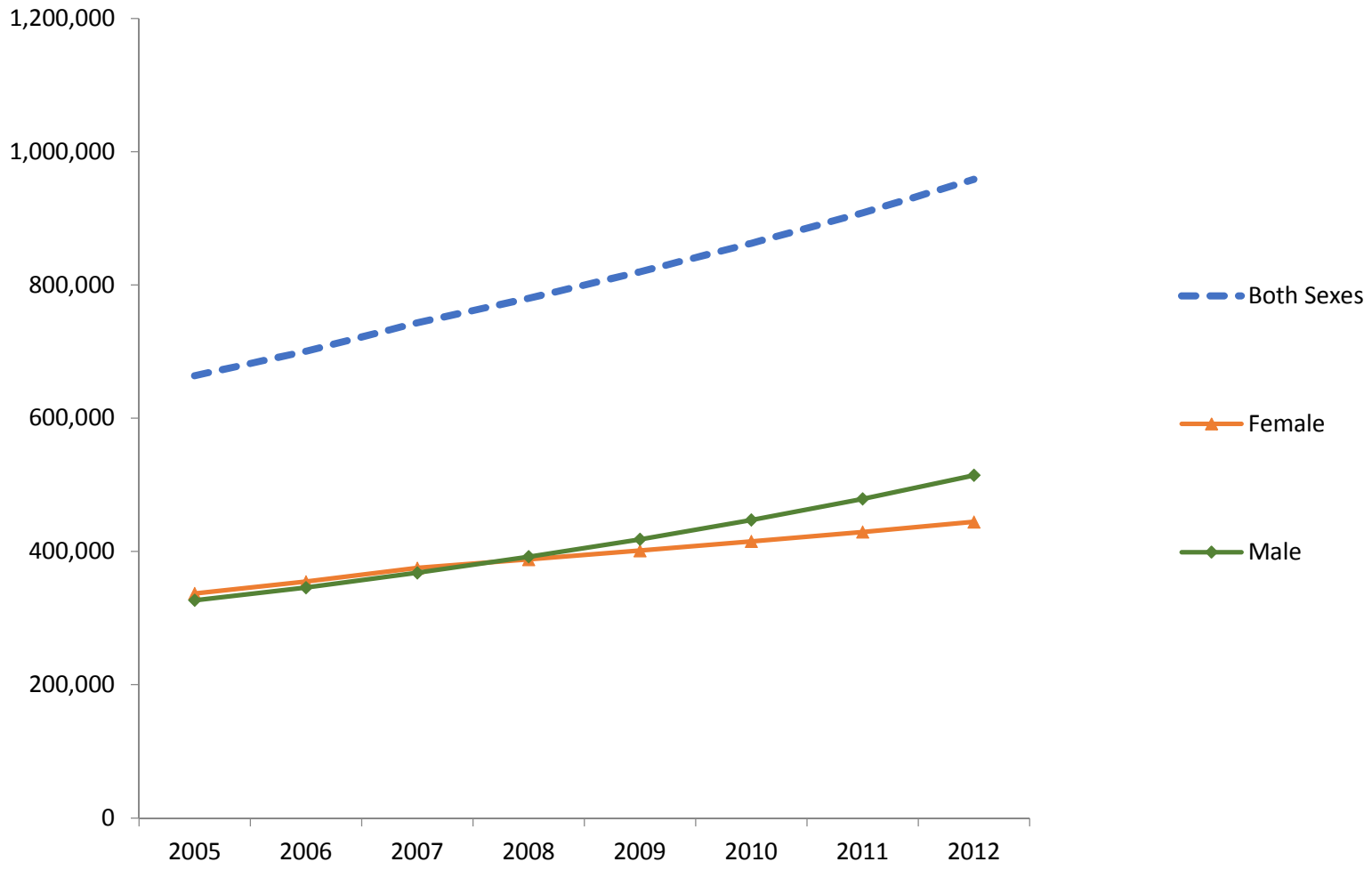
Table 2 includes estimates of cancer prevalence in Canada by sex for each year of our analysis. Our results suggest that prevalence in Canada has been increasing over time for both sexes, from 663,827 in 2005 to 958,632 in 2012 (an increase of 44.4% or 5.6% per annum). Between 2005 and 2007, we estimate that there were slightly more females than males with cancer in Canada; from 2008 onward the trend reverses (Figure 1). Prevalence increased in a linear fashion with age across the study period. The number of children (0-14) and young people (15-34) with cancer was low and rose slowly over the period. The number of patients with cancer between the ages of 35 and 54 was higher but remained relatively flat over the time period. By contrast, prevalence increased steadily from 2005 to 2012 among older patients (ages 55-64, 65-74 and 75 and older).

Table A1 – Estimated 10-year cancer prevalence* by year (2005-2008 and 2009-2012), age and sex, for Canada

	2005	2006	2007	2008	2009	2010	2011	2012
Both Sexes								
0-14	4,917	5,065	5,235	5,373	5,516	5,659	5,810	5,972
15-34	21,474	22,172	23,039	23,707	24,476	25,304	26,115	27,162
35-54	128,510	134,437	140,006	143,795	147,877	152,117	156,457	161,027
55-64	135,868	145,395	156,809	166,814	177,177	188,269	199,681	211,507
65-74	169,779	179,373	191,518	202,451	214,193	226,805	240,538	255,661
75+	203,278	214,122	226,584	237,943	250,283	264,151	279,562	297,303
Total	663,827	700,565	743,192	780,083	819,522	862,304	908,163	958,632
Female								
0-14	2,209	2,276	2,355	2,388	2,419	2,446	2,472	2,498
15-34	12,471	12,877	13,398	13,669	13,982	14,317	14,623	15,022
35-54	83,926	87,694	91,199	92,746	94,390	96,043	97,653	99,338
55-64	72,127	77,123	82,921	86,994	91,091	95,325	99,493	103,735
65-74	74,324	78,397	83,720	87,315	91,039	94,887	98,885	103,202
75+	91,960	96,446	101,692	104,931	108,359	112,165	116,167	120,608
Total	337,017	354,814	375,285	388,044	401,280	415,182	429,294	444,404
Male								
0-14	2,708	2,789	2,879	2,984	3,097	3,213	3,338	3,474
15-34	9,004	9,295	9,640	10,038	10,495	10,986	11,492	12,140
35-54	44,584	46,743	48,807	51,049	53,486	56,074	58,803	61,689
55-64	63,741	68,272	73,889	79,820	86,086	92,944	100,189	107,772
65-74	95,455	100,976	107,799	115,136	123,154	131,918	141,653	152,458
75+	111,318	117,676	124,892	133,012	141,924	151,986	163,395	176,695
Total	326,809	345,751	367,906	392,039	418,241	447,122	478,869	514,228

Source: 10-year cancer prevalence was estimated using a combination of published 10-year prevalence figures for Canada as a whole for selected years (2005, 2007 and 2009) from the Canadian Cancer Society (CCS) and Statistics Canada[1-3] and National Health Expenditure data on population by age, sex and province/territory for 2005–2012.[5]

Figure A1 – Estimated 10-year cancer prevalence by sex and year (2005-2008 and 2009-2012), Canada



Source: 10-year cancer prevalence was estimated using a combination of published 10-year prevalence figures for Canada as a whole for selected years (2005, 2007 and 2009) from the Canadian Cancer Society (CCS) and Statistics Canada[1-3] and National Health Expenditure data on population by age, sex and province/territory for 2005–2012.[5]

Table A2 - Neoplasm codes

EBIC CODE	EBIC DIAGNOSTIC CATEGORIES	ICD-9 CODE	ICD-10 CODE
E06	**Malignant Neoplasms**	**140-208, 238.6**	**C00-C97**
E06.1	Oral Cancers	140-149	C00-C14
E06.2	Esophagus Cancer	150	C15
E06.3	Stomach Cancer	151	C16
E06.4	Colorectal Cancer	153,154,159.0	C18-C21,C26.0
E06.5	Liver Cancer	155 (minus 155.1,155.2)	C22.0,C22.2-C22.7
E06.6	Pancreas Cancer	157	C25
E06.7	Larynx Cancer	161	C32
E06.8	Trachea Cancer	162.0	C33
E06.9	Bronchus and Lung Cancers	162.2-162.9	C34
E06.10	Melanoma	172	C43
E06.11	Other Skin Cancers	173	C44
E06.12	Breast Cancer	174,175	C50
E06.13	Cervix Cancer	180	C53
E06.14	Body of Uterus Cancer	179,182	C54-C55
E06.15	Ovary Cancer	183	C56
E06.16	Prostate Cancer	185	C61
E06.17	Testis Cancer	186	C62
E06.18	Bladder Cancer (including in situ)	188	C67
E06.19	Kidney Cancer	189.0,189.1	C64-C65
E06.20	Brain Cancer	191,192	C70-C72
E06.21	Thyroid Cancer	193	C73
E06.22	Hodgkin Lymphoma	201	C81
E06.23	Non-Hodgkin Lymphoma	200,202 (minus 202.4)	C82-C85,C96.3
E06.24	Multiple Myeloma	203.0	C90.0,C90.2
E06.25	Leukemia	202.4,203.1,204-208	C90.1,C91-C95
E06.26	Other Malignant Neoplasms	152, 155.1, 155.2, 156, 158-160, 163-171, 176, 81, 184, 187, 189.2-190, 194-199, 203.8, 238.6	C17, C22.1, C22.9, C23, C24, C26-C31, C37-C41, C45-C49, C51, C52, C57-C60, C63, C66, C68-C69, C74-C80, C86, C88, C90.3,C96, C97

Legend:
EBIC – Economic Burden of Illness in Canada
ICD – International Classification of Diseases

II. Cost extrapolation to other provinces/territories and Canada

Data from the NHEX were used to create extrapolation factors to reflect differences between Ontario and each province/territory, *j*, in terms of relative expenditures by category *k* (where *k* = hospital care, physician care and provincial/territorial government-funded outpatient prescription drugs). This calculation consisted of three steps:

(1) Estimate the mean net cost of category *k*, for each sex/age group in a given province, *j*, by multiplying the estimate of the mean net cost of category *k* for patients in that sex/age group in Ontario by the ratio of total expenditures in category *k* for each sex/age group in province *j* to total expenditures in category *k* by sex/age group in Ontario, as follows

Estimated using ICES data

Estimated using NHEX data

$$NC_k^j = NC_k^{ON} * \left(\frac{CPP_{TOTk}^j}{CPP_{TOTk}^{ON}} \right),$$

where NC_k^j is the mean net cost of category *k* in a given sex/age group and province *j*, NC_k^{ON} is the mean net cost of category *k* per patient in a given sex/age group in Ontario, CPP_{TOTk}^j is the mean cost per person of total expenditures in category *k* for that sex/age group in province *j*, and CPP_{TOTk}^{ON} is the mean cost per patient of total expenditures in category *k* for that sex/age group in Ontario.

(2) Estimate total net cost of category *k* for cancer patients in province *j* by multiplying the mean net estimated cost of category *k* for cancer in each sex/age group by the estimated number of patients diagnosed with cancer in the past 10 years in that sex/age group and then sum over the totals for each sex/age group to obtain the total net cost of category *k* for cancer patients in province *j* as follows

$$TC_k^j = \sum_i (NC * POP)_i ,$$

where TC_k^j is the total net cost of category *k* for cancer patients in province *j* over all sex/age groups, NC is the mean net cost of category *k* for cancer per patient in a given sex/age group in province *j*, POP is the total number of patients diagnosed with cancer in the prior 10 years in a given sex/age group in province *j*, and *i* denotes a member in the set of sex/age groups.

(3) Estimate the total net cost of category *k* for cancer patients across Canada by summing total net cost estimates of category *k* across each province/territory *j*.

III. Quality of control match

Table A3 – Summary of case-control match, 2005 and 2009

Study Period		Eligible Cases (N)	Matched Cases (N)	Matched Cases (%)	Unique Controls (N)	Controls Re-Used (%)
2005 -2008	**Alive during study period**	472,468	470,620	99.6%		
	Died during study period	138,611	114,354	82.5%		
	Total	611,079	584,974	95.7%	549,124	6.1%
2009 -2012	**Alive during study period**	557,878	556,349	99.7%		
	Died during study period	149,636	121,977	81.5%		
	Total	707,514	678,326	95.9%	646,694	4.7%

Source: Data housed at Institute for Clinical Evaluative Sciences.

Table A4 – Details of case-control match, 2005

Variable		2005 Alive Cohort			2005 Death Cohort		
		Cases (N=470,620)	Controls (N=470,620)	Standardized Difference in the Mean	Cases (N=114,354)	Controls (N=114,354)	Standardized Difference in the Mean
Age, years	Mean ± SD	62.47 ± 15.37	62.15 ± 15.41	0.02	74.40 ± 12.83	74.70 ± 13.16	0.02
	Median (IQR)	64 (53-74)	64 (52-74)	0.02	77 (67-83)	76 (68-84)	0.02
CADG 1	Number (%)	267,655 (56.9%)	267,655 (56.9%)	0	45,409 (39.7%)	45,409 (39.7%)	0
CADG 2	Number (%)	330,598 (70.2%)	330,598 (70.2%)	0	57,745 (50.5%)	57,745 (50.5%)	0
CADG 3	Number (%)	219,650 (46.7%)	219,650 (46.7%)	0	29,863 (26.1%)	29,863 (26.1%)	0
CADG 4	Number (%)	9,117 (1.9%)	9,117 (1.9%)	0	533 (0.5%)	533 (0.5%)	0
CADG 5	Number (%)	130,854 (27.8%)	130,854 (27.8%)	0	35,000 (30.6%)	35,000 (30.6%)	0
CADG 6	Number (%)	205,013 (43.6%)	205,013 (43.6%)	0	29,685 (26.0%)	29,685 (26.0%)	0
CADG 7	Number (%)	17,457 (3.7%)	17,457 (3.7%)	0	850 (0.7%)	850 (0.7%)	0
CADG 8	Number (%)	74,047 (15.7%)	74,047 (15.7%)	0	8,292 (7.3%)	8,292 (7.3%)	0
CADG 9	Number (%)	20,604 (4.4%)	20,604 (4.4%)	0	1,483 (1.3%)	1,483 (1.3%)	0
CADG 10	Number (%)	45,174 (9.6%)	45,174 (9.6%)	0	11,399 (10.0%)	11,399 (10.0%)	0
CADG 11	Number (%)	249,970 (53.1%)	249,970 (53.1%)	0	30,446 (26.6%)	30,446 (26.6%)	0
CADG 12	Number (%)	5,020 (1.1%)	5,020 (1.1%)	0	28 (0.0%)	28 (0.0%)	0

Legend: SD – standard deviation; IQR – interquartile range; CADG – Collapsed Adjusted Diagnosis Groups

Note: The cohort was matched on age+/-2 years, sex (hard match, not shown) and CADG from the Johns Hopkins Adjusted Clinical Groups (ACG) software.

Source: Data housed at Institute for Clinical Evaluative Sciences.

Table A5 – Details of case-control match, 2009

Variable		2009 Alive Cohort			2009 Death Cohort		
		Cases (N=556,349)	Controls (N=556,349)	Standardized Difference in the Mean	Cases (N=121,977)	Controls (N=121,977)	Standardized Difference in the Mean
Age, years	Mean ± SD	63.01 ± 15.28	62.69 ± 15.27	0.02	75.29 ± 12.88	75.58 ± 13.22	0.02
	Median (IQR)	64 (54-74)	64 (53-74)	0.02	78 (68-85)	78 (68-85)	0.02
CADG 1	Number (%)	313,355 (56.3%)	313,355 (56.3%)	0	46,470 (38.1%)	46,470 (38.1%)	0
CADG 2	Number (%)	387,581 (69.7%)	387,581 (69.7%)	0	59,709 (49.0%)	59,709 (49.0%)	0
CADG 3	Number (%)	264,207 (47.5%)	264,207 (47.5%)	0	33,183 (27.2%)	33,183 (27.2%)	0
CADG 4	Number (%)	9,636 (1.7%)	9,636 (1.7%)	0	398 (0.3%)	398 (0.3%)	0
CADG 5	Number (%)	162,609 (29.2%)	162,609 (29.2%)	0	40,814 (33.5%)	40,814 (33.5%)	0
CADG 6	Number (%)	262,161 (47.1%)	262,161 (47.1%)	0	37,822 (31.0%)	37,822 (31.0%)	0
CADG 7	Number (%)	20,560 (3.7%)	20,560 (3.7%)	0	854 (0.7%)	854 (0.7%)	0
CADG 8	Number (%)	84,432 (15.2%)	84,432 (15.2%)	0	7,781 (6.4%)	7,781 (6.4%)	0
CADG 9	Number (%)	24,693 (4.4%)	24,693 (4.4%)	0	1,660 (1.4%)	1,660 (1.4%)	0
CADG 10	Number (%)	53,887 (9.7%)	53,887 (9.7%)	0	12,627 (10.4%)	12,627 (10.4%)	0
CADG 11	Number (%)	318,355 (57.2%)	318,355 (57.2%)	0	36,181 (29.7%)	36,181 (29.7%)	0
CADG 12	Number (%)	5,843 (1.1%)	5,843 (1.1%)	0	31 (0.0%)	31 (0.0%)	0

Legend: SD – standard deviation; IQR – interquartile range; CADG – Collapsed Adjusted Diagnosis Groups

Note: The cohort was matched on age+/-2 years, sex (hard match, not shown) and CADG from the Johns Hopkins Adjusted Clinical Groups (ACG) software.

Source: Data housed at Institute for Clinical Evaluative Sciences.

IV. Ontario patient-level costs

Table A6 – Total gross cost, and 95% confidence intervals (CI), by cost component for patients with malignant neoplasms diagnosed in the past 10 years in Ontario, 2005–2008 (constant 2015 $000,000)

COST COMPONENT:	2005			2006			2007			2008		
	Gross Cost	Lower 95% CI	Upper 95% CI	Gross Cost	Lower 95% CI	Upper 95% CI	Gross Cost	Lower 95% CI	Upper 95% CI	Gross Cost	Lower 95% CI	Upper 95% CI
Hospital Care												
Acute inpatient hospital care	$1,116.6	$1,104.2	$1,129.0	$1,248.7	$1,234.8	$1,262.6	$1,408.9	$1,391.0	$1,426.7	$1,471.4	$1,453.9	$1,489.0
Ambulatory hospital care												
Day surgery	$89.0	$88.2	$89.9	$96.4	$95.5	$97.3	$109.0	$108.0	$110.1	$117.5	$116.4	$118.5
Emergency department visits	$73.0	$72.4	$73.6	$76.8	$76.1	$77.4	$83.0	$82.3	$83.7	$89.1	$88.4	$89.8
Cancer clinics	n/a	n/a	n/a	$360.2	$355.9	$364.5	$521.3	$515.9	$526.7	$501.2	$495.8	$506.7
Dialysis clinics	n/a	n/a	n/a	$38.4	$35.8	$41.1	$66.2	$61.8	$70.5	$87.7	$82.0	$93.4
Psychiatric inpatient hospital care	$18.1	$16.8	$19.4	$28.3	$25.7	$30.9	$37.2	$33.9	$40.5	$39.2	$35.5	$42.9
Chronic and rehabilitation care												
Complex continuing care	$125.6	$119.5	$131.7	$123.3	$117.2	$129.4	$127.9	$121.6	$134.2	$132.2	$125.7	$138.7
Long-term care	$182.9	$178.3	$187.4	$189.6	$184.9	$194.3	$193.6	$188.8	$198.3	$198.9	$194.1	$203.8
Rehabilitation	$54.6	$51.6	$57.6	$62.1	$59.0	$65.3	$62.4	$59.1	$65.6	$68.6	$65.3	$71.9
Other hospital care												
Chemotherapy	$92.3	$89.9	$94.6	$129.2	$125.7	$132.6	$150.6	$147.0	$154.1	$187.8	$183.9	$191.8
Radiation therapy	$82.7	$81.0	$84.4	$124.4	$122.2	$126.6	$174.3	$170.8	$177.9	$202.5	$198.5	$206.5
Physician Care												
Fee-for-service	$487.1	$483.9	$490.4	$538.4	$535.2	$541.5	$581.3	$577.2	$585.3	$629.4	$624.6	$634.1
Non-fee-for-service	$54.3	$53.5	$55.0	$69.4	$68.5	$70.3	$82.8	$81.8	$83.7	$101.8	$100.7	$102.9
Drugs*	$391.5	$388.0	$395.0	$424.3	$420.5	$428.2	$442.6	$438.9	$446.4	$474.5	$470.6	$478.3
Other Care												
Assistive devices	$17.6	$16.9	$18.3	$17.4	$16.7	$18.0	$18.5	$17.9	$19.2	$19.6	$19.0	$20.2
Home care	$188.6	$185.8	$191.4	$241.7	$238.4	$245.0	$237.3	$234.4	$240.3	$260.0	$256.8	$263.1
Diagnostic tests	$35.6	$35.4	$35.8	$37.3	$37.1	$37.5	$39.8	$39.6	$40.0	$44.3	$44.1	$44.5
Non-physician care**	$9.7	$9.5	$9.9	$10.5	$10.4	$10.7	$11.8	$11.6	$12.0	$13.7	$13.5	$13.9
Total Direct Cost	**$3,019.3**	**$2,999.1**	**$3,039.5**	**$3,816.2**	**$3,792.0**	**$3,840.5**	**$4,348.4**	**$4,319.6**	**$4,377.2**	**$4,639.4**	**$4,609.4**	**$4,669.4**

Note: Data for assistive devices were missing from September 2010 onwards, data for cancer and dialysis clinics were missing for 2005, and data for psychiatric hospitalizations were missing from January 2005 to September 2005. Costs are presented for matched cancer patients (cases) only.

* 'Drugs' includes outpatient prescription drugs covered by the provincial government payer.

** 'Non-physician care' includes care provided by other professionals outside the hospital setting.

Source: Data housed at Institute for Clinical Evaluative Sciences.

Table A7 – Total gross cost, and 95% confidence intervals (CI), by cost component for patients with malignant neoplasms diagnosed in the past 10 years in Ontario, 2009–2012 (constant 2015 $000,000)

COST COMPONENT:	2009			2010			2011			2012		
	Gross Cost	Lower 95% CI	Upper 95% CI	Gross Cost	Lower 95% CI	Upper 95% CI	Gross Cost	Lower 95% CI	Upper 95% CI	Gross Cost	Lower 95% CI	Upper 95% CI
Hospital Care												
Acute inpatient hospital care	$1,413.0	$1,395.2	$1,430.8	$1,412.6	$1,395.3	$1,429.9	$1,450.2	$1,432.5	$1,467.8	$1,564.0	$1,545.3	$1,582.6
Ambulatory hospital care												
Day surgery	$116.6	$115.5	$117.6	$120.6	$119.6	$121.7	$129.9	$128.8	$131.0	$144.4	$143.2	$145.6
Emergency department visits	$84.7	$84.0	$85.4	$86.2	$85.5	$86.8	$94.4	$93.7	$95.1	$104.4	$103.6	$105.1
Cancer clinics	$477.1	$471.4	$482.7	$500.8	$494.8	$506.9	$758.0	$749.1	$766.8	$788.4	$779.7	$797.1
Dialysis clinics	$82.4	$76.9	$87.9	$89.0	$83.1	$94.9	$62.9	$58.9	$67.0	$72.5	$68.0	$77.0
Psychiatric inpatient hospital care	$38.9	$35.4	$42.5	$41.3	$37.6	$44.9	$43.1	$39.2	$47.0	$48.9	$44.9	$52.9
Chronic and rehabilitation care												
Complex continuing care	$127.3	$121.0	$133.6	$135.7	$129.1	$142.3	$136.4	$129.9	$143.0	$145.2	$138.3	$152.0
Long-term care	$183.6	$178.8	$188.3	$208.6	$203.3	$213.9	$215.1	$209.5	$220.6	$223.3	$217.6	$228.9
Rehabilitation	$63.7	$60.6	$66.9	$67.7	$64.3	$71.1	$73.8	$70.4	$77.2	$82.8	$79.0	$86.6
Other hospital care												
Chemotherapy	$172.6	$168.8	$176.4	$187.3	$183.2	$191.3	$195.3	$191.0	$199.5	$213.6	$209.0	$218.1
Radiation therapy	$186.0	$182.2	$189.8	$202.6	$198.6	$206.5	$235.7	$231.5	$240.0	$242.6	$238.1	$247.0
Physician Care												
Fee-for-service	$595.3	$591.8	$598.9	$639.8	$636.7	$642.9	$694.8	$691.6	$698.1	$725.7	$722.4	$728.9
Non-fee-for-service	$112.8	$109.2	$116.3	$111.3	$110.4	$112.2	$102.5	$101.9	$103.1	$122.3	$121.6	$123.0
Drugs*	$474.2	$470.0	$478.4	$478.2	$473.0	$483.3	$485.4	$479.8	$490.9	$516.8	$510.8	$522.9
Other Care												
Assistive devices	$18.6	$18.1	$19.2	$4.1	$3.8	$4.3	n/a	n/a	n/a	n/a	n/a	n/a
Home care	$257.3	$254.0	$260.7	$264.6	$261.2	$268.0	$289.1	$285.4	$292.7	$301.3	$297.6	$305.0
Diagnostic tests	$46.1	$45.9	$46.3	$46.2	$46.0	$46.4	$46.2	$46.0	$46.4	$47.5	$47.3	$47.7
Non-physician care**	$15.1	$14.9	$15.4	$17.2	$16.9	$17.4	$19.0	$18.7	$19.2	$20.7	$20.5	$21.0
Total Direct Cost	**$4,465.5**	**$4,435.7**	**$4,495.3**	**$4,613.5**	**$4,583.3**	**$4,643.7**	**$5,031.7**	**$4,999.8**	**$5,063.6**	**$5,364.2**	**$5,330.7**	**$5,397.6**

Note: Data for assistive devices were missing from September 2010 onwards, data for cancer and dialysis clinics were missing for 2005, and data for psychiatric hospitalizations were missing from January 2005 to September 2005. Costs are presented for matched cancer patients (cases) only.

* 'Drugs' includes outpatient prescription drugs covered by the provincial government payer.

** 'Non-physician care' includes care provided by other professionals outside the hospital setting.

Source: Data housed at Institute for Clinical Evaluative Sciences.

V. Costs in Canada

Table A8 – Total (net) public expenditures on cancer care by provincial/territorial governments in Canada, by cost component, sex and year (constant 2015 $000,000)

	2005	2006	2007	2008	2009	2010	2011	2012
Both Sexes								
Hospital Care	$1,645.7	$1,828.7	$2,463.1	$2,600.1	$2,600.6	$2,748.8	$3,669.2	$4,399.2
Chemotherapy	$186.7	$286.9	$412.0	$484.4	$495.9	$563.8	$670.9	$708.2
Radiation Therapy	$208.8	$301.7	$360.0	$450.3	$476.9	$533.9	$563.2	$627.2
Physician Care	$496.4	$549.5	$608.3	$697.4	$717.6	$750.3	$782.3	$888.4
Drugs	$209.9	$230.4	$255.5	$295.0	$298.0	$331.7	$368.8	$449.9
Other Care	$199.5	$387.0	$368.0	$410.9	$347.6	$323.4	$333.5	$398.9
Total	$2,947.0	$3,584.4	$4,466.8	$4,938.1	$4,936.6	$5,252.0	$6,387.9	$7,472.0
Female								
Hospital Care	$778.1	$861.2	$1,198.1	$1,308.3	$1,239.3	$1,300.8	$1,743.1	$2,027.3
Chemotherapy	$87.8	$135.6	$196.1	$218.5	$204.1	$226.5	$324.9	$389.4
Radiation Therapy	$119.2	$207.8	$243.4	$281.1	$286.9	$314.9	$316.9	$333.8
Physician Care	$245.2	$276.0	$302.5	$347.3	$351.6	$369.4	$382.0	$426.8
Drugs	$70.8	$86.9	$102.3	$124.1	$125.8	$135.2	$151.3	$183.4
Other Care*	$117.1	$224.1	$222.7	$244.3	$194.3	$176.7	$179.9	$210.1
Total	$1,418.2	$1,791.6	$2,265.1	$2,523.5	$2,402.1	$2,523.4	$3,098.1	$3,570.7
Male								
Hospital Care	$867.5	$967.6	$1,265.0	$1,291.8	$1,361.3	$1,448.1	$1,926.1	$2,372.0
Chemotherapy	$98.9	$151.3	$215.9	$265.9	$291.8	$337.4	$346.0	$318.9
Radiation Therapy	$89.6	$93.9	$116.5	$169.2	$190.0	$219.0	$246.4	$293.4
Physician Care	$251.1	$273.5	$305.8	$350.1	$366.0	$380.8	$400.3	$461.6
Drugs	$139.1	$143.6	$153.2	$170.9	$172.2	$196.5	$217.5	$266.6
Other Care*	$82.4	$162.9	$145.3	$166.6	$153.3	$146.8	$153.6	$188.8
Total	$1,528.8	$1,792.8	$2,201.7	$2,414.6	$2,534.6	$2,728.5	$3,289.8	$3,901.3

*'Other Care' includes home care, non-physician care (including other professional services), diagnostic testing, and assistive devices.

Source: Costs for Canada were estimated using a combination of purpose-derived estimates of mean net cost of cancer in Ontario, National Health Expenditures (NHEX) data on relative expenditures by cost category for each province versus Ontario (Table E),[5] and prevalence figures for each province/territory, which we estimated based on data from the Canadian Cancer Society (CCS) and Statistics Canada[1-3] and NHEX data on population by age, sex and province/territory for 2005–2012.[5]

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