Technical appendix

Data sources

CANCER DATA

The Ontario Cancer Registry (OCR), maintained by Cancer Care Ontario, is the main data source for this report. Its goals are to collect, analyze and disseminate timely and high-quality information describing cases of cancer diagnosed among Ontario residents.

The OCR is a dynamic database: new case information and updates to past cases may be added throughout the year. Consequently, the results of analyses will vary based on the date that data are extracted from the OCR. The data used in this report were extracted from the OCR between November 2016 and March 2017.

OCR records are created using data collected for purposes other than cancer registration. This information comes from various administrative databases, laboratory reports and clinical records. Four primary sources are used to generate case records in the OCR:

- pathology reports;
- activity-level reporting (ALR) from regional cancer centres (RCCs);
- surgery and discharge data (e.g., Discharge Abstract Database [DAD] and National Ambulatory Care Reporting System [NACRS]) from the Canadian Institute for Health Information (CIHI); and
- death certificates from the Office of the Registrar General for Ontario.

Safeguarding confidential information is a guiding principle for Cancer Care Ontario. All activities—from the initial registration of a new cancer case in the OCR, through to research and reporting—are governed by the Personal Health Information Protection Act (PHIPA), 2004.[1] This Ontario law governs the collection and use of data and the disclosure of personal health information. PHIPA designates Cancer Care Ontario as a prescribed entity and authorizes Cancer Care Ontario to collect, use and disclose personal health information for the purposes of managing and planning Ontario's health system.

DATA QUALITY

Death certificate only and microscopically confirmed cases

Table TA.1 presents the percentage of cases in the OCR that were diagnosed based on a death certificate only (DCO) and the percentage that were microscopically confirmed.

Overall, 1.8% of cases diagnosed in 2013 were DCOs. The percentage ranged from a low of zero for testicular cancer to a high of 4.9% for liver cancer.

For all cancer types, 89.8% of cases were microscopically confirmed. This falls below the Surveillance, Epidemiology and End Results (SEER) Program's recommendation of having at least 93% of cases be microscopically confirmed.[2] The percentage microscopically confirmed varied from a low of 56.8% for liver cancer to a high of 99.3% for thyroid cancer.

Table TA.1 Percentage death certificate only and microscopically confirmed cases by cancer type, Ontario Cancer Registry, 2013

Cancer type	DCO		Microscopically confirmed	
	Number of cases	% of cases	Number of cases	% of cases
All cancers	**1,367**	**1.8%**	**69,234**	**89.8%**
Bladder	36	0.8%	4,624	97.6%
Brain	21	1.9%	897	83.1%
Breast	74	0.7%	10,044	97.8%
Cervix	6	1.1%	507	96.9%
Colorectal	171	2.0%	8,071	92.1%
Esophagus	16	2.0%	749	93.6%
Hodgkin lymphoma	**	**	363	94.0%
Kidney	46	2.1%	1,998	89.2%
Larynx	**	**	404	95.7%
Leukemia	22	0.9%	1,897	78.6%
Liver	61	4.9%	706	56.8%
Lung	319	3.3%	7,817	80.1%
Melanoma	24	0.7%	3,324	97.5%
Myeloma	20	1.6%	896	72.6%
Non-Hodgkin lymphoma	47	1.1%	3,453	84.5%
Oral cavity & pharynx	32	1.7%	1,832	94.5%
Ovary	29	2.4%	1,051	88.2%
Pancreas	75	4.0%	1,238	65.9%
Prostate	68	0.9%	7,354	96.2%
Stomach	23	1.5%	1,407	94.0%
Testis	0	0.0%	399	98.0%
Thyroid	**	**	3,198	99.3%
Uterus	18	0.7%	2,343	97.3%

**Suppressed due to small cell count (n<6)
DCO=Death certificate only
Analysis by: Ontario Cancer Registry, Analytics and Informatics, CCO
Data source: Ontario Cancer Registry (November 2016), CCO

Incidence to mortality ratio

The age-standardized incidence to mortality (I:M) ratio is used to identify areas of undercoverage within a registry. The I:M ratio for malignant cases in the OCR for 2013 was 2.9:1 (Table TA.2). This ratio meets the Canadian Partnership Against Cancer's recommended ratio of at least 2.3:1.[2] Almost all the public health units (PHUs) in Ontario met that recommended ratio. The exception was the Eastern Ontario Health Unit with an I:M ratio of 2.2:1, which is just below the recommended ratio. An I:M ratio below the recommended level may indicate incomplete registration of cases.[2] The mostly similar I:M ratios among the province's PHUs indicate that case registration is fairly complete across Ontario, with no obvious areas of undercoverage.

Table TA.2 **Age-standardized incidence to mortality ratio by public health unit for all cancers combined, Ontario Cancer Registry, 2013**

PHU†	I:M ratio
Algoma	3.4
Brant County	2.4
Chatham-Kent	2.3
Durham Region	2.9
Eastern Ontario	2.2
Elgin-St. Thomas	2.4
Grey Bruce	2.6
Haldimand-Norfolk	2.7
Haliburton, Kawartha, Pine Ridge District	2.7
Halton Region	2.9
Hamilton	2.6
Hastings and Prince Edward Counties	2.6
Huron County	3.1
Kingston, Frontenac and Lennox & Addington	2.3
Lambton	2.6
Leeds, Grenville and Lanark District	2.4
Middlesex-London	2.7
Niagara Region	2.6
North Bay Parry Sound District	2.6
Northwestern	2.3
Ottawa	2.8
Oxford County	2.5
Peel	3.1
Perth District	2.5
Peterborough County-City	2.5
Porcupine	2.3
Region of Waterloo	2.8
Renfrew County and District	2.5
Simcoe Muskoka District	2.7
Sudbury and District	2.6
Thunder Bay District	2.7
Timiskaming	2.4
Toronto	3.2
Wellington-Dufferin-Guelph	2.7
Windsor-Essex County	2.8
York Region	3.3

I:M ratio=Incidence to mortality ratio
PHU=Public health unit
†For all cancers combined
Note: I:M ratio is the ratio of the age-standardized incidence rate to the age-standardized mortality rate.
Analysis by: Surveillance, Analytics and Informatics, CCO
Data source: Ontario Cancer Registry (March 2017), CCO

Further data quality measures are presented in Table TA.3.

Table TA.3 **Data element completeness estimates, Ontario Cancer Registry, 2013**

Measure	Value
Average number of sources/notification per case	12
Percent of cases with unknown primary site of cancer	0%
Percent of cases with unknown morphology	0%
Percent of cases staged*	90%
Completeness of CS data collection*	91%
Synoptic pathology completeness	87%
Percent of cases missing "age at diagnosis/death"	0.003%

Measure	Value
Percent of cases missing "sex"	0%
Percent of cases missing "postal code" at diagnosis	3.7%
Percent of patients listed as "alive" with current age >100	0%
Percent of patients listed as "dead" missing death date	0%

*For lung, female breast, colorectal, cervix and prostate cancers only
Notes: 1. For all malignant cases and *in situ* bladder.
2. Total number of cases: 79,549; total number of patients: 75,662.
Analysis by: Ontario Cancer Registry, Analytics and Informatics, CCO
Data source: Ontario Cancer Registry (March 2017), CCO

POPULATION DATA

Except where otherwise noted, population data are from the Ontario Ministry of Finance (Fall 2016 release). These population figures are based on the 2011 census, conducted by Statistics Canada. Population figures by PHU are provided in Table TA.4.

Table TA.4 **Population estimates by sex and public health unit, Ontario, 2013**

PHU	Both sexes	Males	Females
Algoma	116,829	57,319	59,510
Brant County	143,323	70,335	72,988
Chatham-Kent	105,998	51,835	54,163
Durham Region	645,055	316,765	328,290
Eastern Ontario	204,166	101,184	102,982
Elgin St. Thomas	90,367	44,791	45,576
Grey Bruce	163,186	80,894	82,292
Haldimand-Norfolk	110,349	55,305	55,044
Haliburton, Kawartha, Pine Ridge District	178,678	88,531	90,147
Halton Region	539,958	264,380	275,578
Hamilton	546,600	269,018	277,582
Hastings and Prince Edward Counties	163,921	80,545	83,376
Huron County	59,258	29,391	29,867
Kingston, Frontenac and Lennox & Addington	199,618	98,632	100,986
Lambton	130,490	64,014	66,476
Leeds, Grenville and Lanark District	169,130	82,944	86,186
Middlesex-London	461,783	225,616	236,167
Niagara Region	445,495	217,217	228,278
North Bay Parry Sound District	128,032	63,318	64,714
Northwestern	81,645	41,115	40,530
Ottawa	935,810	457,514	478,296
Oxford County	110,155	54,733	55,422
Peel	1,391,479	688,432	703,047
Perth District	77,815	38,459	39,356
Peterborough County-City	139,337	67,471	71,866
Porcupine	87,084	43,723	43,361
Region of Waterloo	534,132	265,110	269,022
Renfrew County and District	105,514	53,101	52,413
Simcoe Muskoka District	534,540	265,001	269,539
Sudbury and District	199,854	98,936	100,918
Thunder Bay District	155,047	76,860	78,187
Timiskaming	34,613	17,307	17,306
Toronto	2,777,211	1,345,590	1,431,621
Wellington-Dufferin-Guelph	278,361	137,678	140,683
Windsor-Essex County	401,742	199,170	202,572
York Region	1,104,429	543,592	560,837

PHU=Public health unit
Data source: Ontario Ministry of Finance population estimates (Fall 2016)

DISEASE SITE GROUPING

The OCR uses disease site groupings based on the third edition of the International Classification of Diseases for Oncology (ICD-O-3).[3] These disease site groupings are recoded based on the SEER groups.[4]

Cancer deaths are classified according to the 10th edition of the International Classification of Diseases and Related Health Problems (ICD-10).[5]

The primary cancer groupings used in this report are found in Table TA.5.

Table TA.5 **Cancer definitions by coding methodology**

Cancer type: short form	Cancer type: full name	Incidence	Mortality
		ICD-O-3 definition	ICD-10 definition
All cancers		C00.0–C80.9	C00–C97
Bladder	Urinary bladder	C67	C67
Brain	Brain and other nervous system	C70–C72	C70–C72
Breast (female)		C50	C50
Cervix	Cervix uteri	C53	C53
Colorectal	Colon and rectum	C18–C20, C26.0	C18–C20, C26
Esophagus		C15	C15
Hodgkin lymphoma		All sites with histologies 9650–9667	C81
Kidney	Kidney and renal pelvis	C64.9, C65.9	C64–C65
Larynx		C32	C32
Leukemia		C42.0, C42.1, C42.4 with histologies 9811–9818, 9837,9823. Histologies 9826, 9835–9836, 9820, 9832–9834, 9940, 9840, 9861, 9865–9867, 9869, 9871–9874, 9895–9897, 9898, 9910–9911, 9920, 9891, 9863, 9875–9876, 9945–9946, 9860, 9930, 9801, 9805–9809, 9931, 9733, 9742, 9800, 9831, 9870, 9948, 9963–9964, 9827	C90.1, C91.0–C91.5, C91.7, C91.9, C92.0–C92.1, C92.4–C92.5, C92.7, C92.9, C93.0–C93.2, C93.7, C93.9, C94.0–C94.2, C94.4–C94.5, C94.7, C95.0–C95.2, C95.7, C95.9
Liver	Liver and intrahepatic bile duct	C22.0, C22.1	C22.0, C22.2–C22.4, C22.7, C22.9
Lung	Lung and bronchus	C34	C34

Table TA.5 *(Cont'd)* **Cancer definitions by coding methodology**

Cancer type: short form	Cancer type: full name	Incidence	Mortality
		ICD-O-3 definition	ICD-10 definition
Melanoma	Melanoma of skin	C44 with histologies 8720–8790	C43
Myeloma	Multiple myeloma	Histologies 9731–9732, 9734	C90.0, C90.2
Non-Hodgkin lymphoma		Histologies 9590–9596, 9670–9671, 9673, 9675, 9678–9680, 9684, 9687, 9689–9691, 9695, 9698–9702, 9705, 9708–9709, 9714–9719, 9727–9729; All sites other than C42.0, C42.1, C42.4 with histologies 9823, 9827	C82–C85, C96.3
Oral cavity & pharynx		C00–C00.9, C01.9-C02.9, C03-C11, C12.9, C13, C14.0, C14.2, C14.8	C00–C14
Ovary		C56.9	C56
Pancreas		C25	C25
Prostate		C61.9	C61
Stomach		C16	C16
Testis		C62	C62
Thyroid		C73.9	C73
Uterus	Corpus and uterus NOS	C54, C55.9	C54–55

ICD-O-3=International Classification of Disease for Oncology, Third Edition
ICD-10=International Statistical Classification of Diseases and Related Health Problems, Tenth Revision
Notes: 1. All cancer types exclude basal cell and squamous cell skin cancers
2. Histology types 9590-9989 (leukemias, lymphomas and hematopoietic diseases), 9050-9055 (mesothelioma) and 9140 (Kaposi sarcoma) are excluded from other specific organ sites.

NON-MELANOMA SKIN CANCER

Data presented in this document exclude cases of basal cell and squamous cell carcinoma of the skin, which are the most common types of non-melanoma skin cancer. Although approximately 30% of the malignant cancers diagnosed among Ontarians each year are basal cell and squamous cell carcinomas of the skin, these tumours are generally not life-threatening and are treated in out-patient settings. As a result, they are too inconsistently reported to the OCR to allow meaningful analysis

CANCER STAGE AT DIAGNOSIS

Cancer staging is viewed as an essential element for quality care. Stage data are vital for evaluating the effectiveness of screening and treatment programs, analysis of survival, research into new treatments and resource planning for healthcare management.

The tumour-node-metastasis (TNM) system is the most widely used classification system for stage at diagnosis and it is recognized as the international standard for describing the anatomic extent of various cancers. TNM definitions are maintained by the Union for International Cancer Control (UICC) and the American Joint Committee on Cancer (AJCC).[6]

Collaborative Staging (CS) is a staging approach used by central cancer registries. CS brings together the principles of the National Cancer Institute (NCI)/SEER Summary Stage, the TNM categories and stage groupings and the SEER Extent of Disease coding structure. Most of the CS data items have traditionally been collected by some cancer registries, including tumour size, extension, lymph node status and metastatic status. Other data such as site/histology-specific factors (e.g., Gleason score and receptor status) are specific to CS. The data is used to derive the "best stage" grouping consistent with the AJCC Cancer Staging Manual (currently in its seventh edition).[7]

CS values for invasive cancer range from stage I, which means the disease is in the early phase, to stage IV, which means the cancer has spread (or metastasized) to other organs or places in the body. An unknown stage is the result of limited stage work-up, limited documentation in the person's health record or both. Cases that are defined as "not staged" are cases where no attempt at staging has yet occurred.

Starting with cases diagnosed on January 1, 2005, the OCR implemented various versions of CS in a phased approach by reporting hospital (see Table TA.6 for a list of contributing hospitals and regional cancer centres) and selected cancer type. More specifically, full implementation of CS was achieved for breast, lung, colorectal and prostate cancers in 2010; for ovarian, uterine and cervical cancers and melanoma in 2011; and for thyroid cancer in 2013. Stage data included in this report are for the diagnosis years 2010 to 2013.

Table TA.6 Contributing facilities to activity-level reporting data used for population-level staging, Ontario Cancer Registry

Regional cancer centres
Grand River Regional Cancer Centre
Juravinski Cancer Centre
Cancer Centre of Southeastern Ontario
R.S. McLaughlin Durham Regional Cancer Centre
London Regional Cancer Program
Simcoe Muskoka Regional Cancer Centre
Stronach Regional Cancer Centre at Southlake
Northeast Cancer Centre
Odette Cancer Centre
The Ottawa Hospital Regional Cancer Centre
Regional Cancer Care North West – Northwest
Carlo Fidani Peel Regional Cancer Centre
Princess Margaret Hospital
Windsor Regional Cancer Centre

Hospitals
Grand River Hospital
Hamilton Health Sciences
Kingston Health Sciences Centre
Lakeridge Health
London Health Sciences Centre
Royal Victoria Hospital
Southlake Regional Health Centre
Health Sciences North Sudbury
Sunnybrook Health Sciences Centre
The Ottawa Hospital
Thunder Bay Regional Health Sciences Centre
Trillium Health Partners
University Health Network
Windsor Regional Hospital
Bluewater Health
Cambridge Memorial Hospital
Grey Bruce Health Services
Halton Healthcare Services
Headwaters Health Centre
Humber River Regional Hospital
Mackenzie Health (formerly York Central Hospital)
Markham-Stouffville Hospital
The Scarborough Hospital
Sinai Health System
North York General Hospital
Quinte Healthcare Corporation
Rouge Valley Health System
Sault Area Hospital
St. Joseph's Health Centre
St. Michael's Hospital
Toronto East Health Network
William Osler Health Centre

CODING RULES FOR MULTIPLE PRIMARY CANCERS

Different rules exist to determine if a cancer is a new primary cancer or an extension of a previous cancer. Following a recent rebuild, the OCR adopted the SEER program's rules for counting multiple primaries and assigning histology,[8] similar to other North American cancer registries. To identify multiple primary cancers the SEER counting rules take into account histology, site, laterality and time since the initial diagnosis. The SEER rules are more liberal than the rules previously used in the OCR for counting multiple primaries in their consideration of what constitutes a new primary case. The SEER rules for multiple primary cancers have been applied to cases in the OCR that were diagnosed on or after January 1, 2010.

Cases from the years prior to SEER adoption (i.e., 1964 to 2009) have been imported into the new OCR from the Ontario Cancer Registry Information System (OCRIS) to allow for continued analytic use. OCRIS applied a modified version of the International Agency for Research on Cancer/International Association of Cancer Registries (IARC/IACR) rules,9 which are more conservative than the SEER rules. Under the IARC/IACR rules, only one tumour is registered for an organ irrespective of time unless there are histological differences. In this report, data were converted using the IARC/IACR rules for all trend analyses that span both the OCR (2010 onward) and OCRIS (1983 to 2009) eras and whenever comparisons are made between data from the two registry systems. When data are presented only from 2010 onward, the SEER rules were applied.

Given that the SEER rules are less conservative than the IARC/IACR rules, applying the SEER rules results in an increase in the number of cases included in incidence counts. This is simply a result of using a different methodology and does not reflect an actual increase in the number of people being diagnosed with cancer. The impact of applying the SEER versus IARC/IACR rules on new cases differed by cancer type. For example, the largest increases in new cases due to the adoption of the SEER rules were observed for melanoma (15.9% higher when based on SEER rules), breast cancer (14.0% higher) and testicular cancer (9.8% higher) for 2011–2012 data; the smallest changes were for Hodgkin lymphoma (0.5% higher), pancreatic cancer (0.5% higher) and prostate cancer (0.8% higher).

Analysis

CANCER INCIDENCE AND MORTALITY

Counts

Incidence counts are the number of new cancer cases diagnosed in a population during a specific time period. In this report, this refers to the number of new cancer diagnoses in a calendar year in Ontario. Complete death-cleared incidence data were available up to 2013 at the time of writing.

Mortality counts describe the number of deaths attributed to cancer during a specific period of time in a specific population. In this report, mortality refers to the number of deaths due to cancer in a calendar year in Ontario. For consistency, this report uses data for the same range of years for incidence and mortality (i.e., 1983 to 2013).

Rates

Incidence and mortality rates are the number of new cancer cases or deaths per 100,000 people in a population during a specific time period. This is sometimes called the crude rate since it does not adjust for the age distribution of the population. Rates were calculated using CCO SEER*Stat v.8.3.2.[10]

Age-standardized rates

Age-standardized rates are weighted averages of age-specific rates using a standard population. Age-standardized incidence rates (ASIR) and age-standardized mortality rates (ASMR) are adjusted for differences in the age structure of different populations, which permits comparisons of cancer incidence or mortality between different populations. These may be different segments of a population (e.g., different geography) or the same population at different periods of time. Age-standardized rates give the rate that would have occurred if the population of Ontario had the same age distribution as the standard population. This report uses direct standardization, which produces artificial rates for the purpose of comparison only.

The standard population used in this report is the 2011 Canadian census population (Table TA.7). Surveillance reports published by Cancer Care Ontario prior to 2016 used the 1991 Canadian census population. The 1991 standard population is no longer appropriate because the population age structure has changed considerably since then. Using the 2011 standard population results in age-standardized rates that are closer to the crude rate (e.g., the 2012 ASIR for prostate cancer using the 1991 population was 47.8 per 100,000 compared to 63.1 per 100,000 using the 2011 standard population, while the crude rate was 63.4 per 100,000). Given the change in standard population, the age-standardized rates in this report should not be compared to previously published rates that used the 1991 population for standardization.

Table TA.7 **Canada 2011 reference population used for calculating age-standardized rates**

Age group (years)	Population
0–4	1,899,064
5–9	1,810,433
10–14	1,918,164
15–19	2,238,952
20–24	2,354,354
25–29	2,369,841
30–34	2,327,955
35–39	2,273,087
40–44	2,385,918
45–49	2,719,909
50–54	2,691,260
55–59	2,353,090
60–64	2,050,443
65–69	1,532,940
70–74	1,153,822
75–79	919,338
80–84	701,140
85+	643,070

Note: Postcensal estimates are based on the 2011 census counts adjusted for census net undercoverage (CNU) (including adjustment for incompletely enumerated Indian reserves [IEIR]) and the components of demographic growth that occurred since that census. Intercensal estimates are produced using counts from two consecutive censuses adjusted for CNU (including IEIR and postcensal estimates).
Data source: Statistics Canada. Table 051-0001 - Estimates of population, by age group and sex for July 1, Canada, provinces and territories, annual (persons unless otherwise noted), CANSIM (database).

Trends in age-standardized rates

Incidence and mortality trends were determined using annual percent change (APC) and average annual percent change (AAPC), which were calculated using age-standardized rates. APCs were used when examining short term changes in trend. AAPCs are summary measures that describe the change in trend over a longer period of time with a single statistic.

APCs and AAPCs were determined using Joinpoint regression software (version 4.2.0.2).[11] Joinpoint regression uses piecewise regression to model the change in rates on the log scale. A statistical algorithm finds the optimal number and points in a trend (the joinpoints) where the trend changes.

In general, the model that Joinpoint software found to be the best fit was used. However, for some types of cancer, models other than what the Joinpoint software suggested were used to best describe the changes in trend for the data. A maximum of five joinpoints was allowed. If the Joinpoint software found a best-fit model with a joinpoint three or less observations from the end of the data, the model was rerun using five as the minimum number of observations from a joinpoint to the end of the data.

Projections

Incidence and mortality projections for the years 2014 to 2018 were calculated using the Nordpred package in R software.[12]

For incidence projections, cases meeting the IARC/IACR multiple primary rules from 1984 to 2012 were grouped by five-year age groups and time periods. Population data was similarly aggregated (with the exception of bladder cancer for which cases were grouped from 1994 to 2012 due to the classification changes since 1989). To obtain projections for all cancers combined, projections were calculated separately for female breast, prostate, colorectal, lung, thyroid and bladder cancers and for all other cancers by sex, and then summed.

Projections were performed using a Nordpred Power 5 age-period-cohort model (with the exception of prostate cancer incidence):

$$Case_{ap} \sim Poisson\left(\mu_{ap}\right),$$
$$R_{ap} = \frac{\mu_{ap}}{n_{ap}} = (A_a + P_p + C_c + Dp)^5$$

where R_ap is the incidence rate in age group a in calendar period p, which is the mean count μ_ap of case divided by the corresponding population size n_ap, A_a is the age component for age group a, D is the common linear drift parameter of period and cohort, P_p is the non-linear period component of period p and C_c is the non-linear cohort component of cohort c. Cohorts were calculated as c=A+p-a, with A = total number of age groups (=18).

Nordpred is based on an age-period-cohort Poisson regression model. It has enhancements that overcome difficulties in the standard Poisson model and improve projection accuracy.[13] Further details of Nordpred's background methods can be found elsewhere.[14] Projections were produced in five-year periods and linear interpolation was used to create annual counts. An inflation factor was applied based on the age-specific increase in multiple primary cancers due to the application of the SEER counting rules in 2010 to 2013.

Due to the major drop in the prostate cancer incidence rate in the past few years, the age-period-cohort models do not fit for prostate incidence. Instead, an age-only model based on DCO-corrected data from 2013 to 2014 was used. This method is more appropriate when there has been a recent change in the trend.

Mortality projections were also performed using a Nordpred Power 5 age-period-cohort model using cancer deaths from 1984 to 2012 divided into five-year age groups and time periods. To obtain mortality projections for all cancers combined, projections were calculated separately for female breast, prostate, colorectal and lung cancers and for all other cancers by sex, and then summed.

Geospatial analysis

Geospatial analysis for the ASIR and ASMR by PHU shown in the maps in *Chapter 8: Cancer statistics by public health unit* was performed by obtaining digital boundary files for the PHUs from Statistics Canada.[15] Using the Geographic Information System software ArcGIS®, the age-standardized rates were linked to the geographic boundary files and mapped to display the rates for each PHU.

PROBABILITY OF DEVELOPING OR DYING FROM CANCER

The probability of developing or dying from cancer refers to the probability of a newborn child developing or dying from cancer at some point during his or her lifetime. Lifetime risk calculations are based on current incidence and mortality rates and are therefore calculated under the assumption that the current rates, within each age group, will remain constant during the life of the newborn child.

The probability of developing or dying from cancer was calculated using DevCan software.[16] The DevCan software program uses life-table methods based on cross-sectional incidence, mortality and population data for 18 age groups to compute the lifetime and age-conditional probabilities of developing or dying from cancer.

SIGNIFICANCE TESTING

Throughout this report, the word significant refers to statistical significance at an alpha level of 0.05 for changes in trend or when comparing differences in rates or ratios. Non-significant changes in trend are described in this report as "stable."

COMORBIDITY

Data on comorbidity were extracted from the DAD[17] and the NACRS.[18] Data was linked to the OCR by health insurance card number (HIN). The analysis cohort was restricted to first primary malignant cases of bladder, female breast, colorectal, kidney, lung and pancreatic cancer as well as melanoma, diagnosed from 2011 to 2015 with valid HIN numbers. DCO and autopsy only cases were excluded.

The comorbidity time span was defined as one year prior to diagnosis to one month post diagnosis. Comorbidity was measured using the Charlson Comorbidity Index (CCI).[19] There is no "gold standard" for measuring comorbidity in the context of cancer, so the most commonly used index was selected.[20] The CCI index was developed to predict three-year mortality in medical inpatients and was subsequently validated in people with cancer.[21, 22] Comorbid conditions are assigned weights based on the ratio of the mortality risk for patients with the comorbidity of interest versus the mortality risk for those without. The sum of the weights for all of the conditions is calculated to create a comorbidity index for each patient. We modified the CCI index to exclude metastatic carcinomas because it was not possible to distinguish between metastases for other cancers and metastases for the cancer of interest, the latter not being considered comorbidity.

Survival analysis were done in SAS v 9.2 using a publicly available algorithm,[23] with some minor adaptations. Expected survival proportions were derived using the Ederer II approach,[24] from provincial life tables produced by Statistics Canada. Relative survival ratios (RSRs) were estimated by the period method.

WAIT TIME

Data on wait time to treatment were extracted from CCO's Wait Time Information System (WTIS). The analysis focused on "Wait 2" — the time from the decision to treat with surgery to the first therapeutic surgery. Once the decision to treat the cancer with surgery is made, the patient is assigned a priority level. Priority level is based on the invasiveness of the cancer.[25] There are four priority levels: one (surgery recommended within 24 hours); two (highly aggressive malignancies, surgery recommended within 14 days); three (invasive malignancies that do not meet the criteria for priority two or four, surgery recommended with 28 days); and four (slow-growing malignancies, surgery recommended within 84 days). Wait caused by the patient being unavailable for the procedure due to patient-related reasons were excluded from the final wait time. These delays are known as Dates Affecting Readiness to Treat (DART) and do not include system-related delays such as surgeon unavailability or lack of hospital resources.

The analysis cohort was restricted to adult first primary malignant cases of female breast, colorectal, esophageal, lung, oral cavity & pharynx, ovarian and pancreatic cancers, diagnosed from 2011 to 2015 with a valid HIN number and for which the primary method of treatment was surgical. WTIS data was linked to OCR data through HIN number. DCO and autopsy only cases were excluded. In addition, cases were the surgeon and patient decide to take a "watchful waiting" approach to care were excluded. The analysis cohort was then further narrowed to cases for which the cancer diagnosis and first therapeutic surgery type matched.

The same survival methodology that was used for the comorbidity analysis was used for the wait time analysis. The one exception is that the wait time analysis reports observed survival, rather than relative survival. This is because this analysis is restricted to patients who received surgical treatment. Existing life tables do not accurately reflect this population. As a result, we decided to only report observed survival estimates.

SURVIVAL

RSRs are estimated by comparing the survival of people with cancer to the expected survival for the general population of Ontarians of the same age and sex during the same time period. Relative survival shows the extent to which a diagnosis of cancer shortens a life span. The RSR is usually expressed as a percent. The closer the value is to 100%, the more similar the survival pattern is to the general population.

Survival analyses were based on first primary cancers. RSRs are provided for cases diagnosed in people between 15 and 99 years of age. Cases were excluded from the survival analyses if the age of the person was unknown, they were diagnosed on the basis of an autopsy only, or when the date of diagnosis and date of death were the same (i.e., DCO cases where the diagnosis happened at or following death). (See Table TA.1 for details on DCO cases.)

Relative and conditional survival analyses were performed using CCO SEER*Stat software (version 8.3.2). Expected survival proportions were derived using the Ederer II approach[24] from provincial life tables produced by Statistics Canada. It should be noted that life tables currently available for calculating expected survival may not completely reflect all factors contributing to variation in all-cause mortality, such as smoking. This should be taken into account when interpreting the estimates.

RSRs were estimated by the cohort method when complete follow-up data after diagnosis (e.g., at least five years of follow-up to estimate a five-year ratio) were available. For recently diagnosed cases whose complete follow-up data were not available, the estimates were computed using the period method. Period analysis uses the survival experience of people in a recent time interval to estimate survival.[26] The period method, modeled after period life tables, allows for more up to date estimates because it means analysis does not have wait for data on the full follow-up period (e.g., five years for a five-year ratio). Comparisons between cohort and period RSRs should be interpreted with caution because of the two different methods used to derive the respective ratios.

RSRs were age-standardized by weighting with the International Cancer Survival Standard (ICSS) weights.[27] (See Table TA.8 for details on weightings).

Table TA.8 International cancer survival standards used for standardizing relative survival ratios, by cancer type and age group

Age groups (years)	Weightings	Cancer types
15–44, 45–54, 55–64, 65–74, 75–100	60, 10, 10, 10, 10	Testis, Hodgkin lymphoma, acute lymphatic leukemia
15–44, 45–54, 55–64, 65–74, 75–100	28, 17, 21, 20,14	Nasopharynx, soft tissues, melanoma, cervix uteri, brain, thyroid gland, bone
15–44, 45–54, 55–64, 65–74, 75–100	7, 12, 23, 29, 29	All other cancer types except prostate
15–54, 55–64, 65–74, 75–84, 85–100	19, 23, 29, 23, 6	Prostate

Data Source: Corazziari I, Quinn M, Capocaccia R. Standard cancer patient population for age standardizing survival ratios. Eur J Cancer. 2004;40(15):2307-16.

PREVALENCE

Prevalence analyses were performed using CCO SEER*Stat software (version 8.3.2). This report provides person-based limited duration prevalence; that is, the number of people diagnosed with malignant cancer over a specific time period (e.g., two years, five years or 10 years) who were still alive on the index date. The chosen index date was January 1, 2014.

Multiple primary cancers were treated as follows: only the first primary was included in the prevalence count for all cancers combined, but for individual cancer types, each individual could contribute a case for each cancer. For example, a person with a first primary of prostate cancer and a second primary of colorectal cancer would be included once in the prevalence count for all cancers but twice in the individual cancer type counts (i.e., once in the prostate prevalence count and once in the colorectal prevalence count).

This appendix presented an overview of the methodologies used in this report. For more information or further details please contact us at: **surveillance@cancercare.on.ca.**

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Data appendix

Table DA.1 Incidence counts and age-standardized rates by public health unit for males and all cancers combined, Ontario, 2013

PHU	Count	ASIR	95% CI
Ontario	**38,453**	**605.1**	**599.0–611.2**
Algoma	624	842.2*	776.2–912.7
Brant County	424	618.4	560.7–680.4
Chatham-Kent	369	635.6	571.8–704.8
Durham Region	1,731	637.5*	607.3–668.8
Eastern Ontario	695	620.6	574.7–669.2
Elgin-St. Thomas	301	669.2	594.7–750.5
Grey Bruce	667	636.4	588.1–687.9
Haldimand-Norfolk	447	713.1*	647.5–783.7
Haliburton, Kawartha, Pine Ridge District	791	636.9	592.1–684.5
Halton Region	1,300	569.7*	538.8–601.8
Hamilton	1,695	640.4*	610.2–671.6
Hastings and Prince Edward Counties	726	738.7*	685.3–795.5
Huron County	254	708.5*	622.4–803.7
Kingston, Frontenac and Lennox & Addington	608	579.9	534.3–628.4
Lambton	462	617.8	562.1–677.8
Leeds, Grenville and Lanark District	620	612.3	564.2–663.7
Middlesex-London	1,347	631.2	597.8–665.9
Niagara Region	1,626	643.5*	612.4–675.9
North Bay Parry Sound District	504	651.4	594.7–712.3
Northwestern	176	451.2*	386.3–523.7
Ottawa	2,431	601.0	577.1–625.6
Oxford County	369	648.5	583.8–718.4
Peel	2,901	542.1*	521.9–562.8
Perth District	207	526.5*	457.0–603.5
Peterborough County-City	508	611.3	558.7–667.8
Porcupine	282	650.5	575.0–733.1
Region of Waterloo	1,297	579.8	548.4–612.5
Renfrew County and District	370	619.0	557.1–686.2
Simcoe Muskoka District	1,791	640.1*	610.5–670.7
Sudbury and District	717	679.8*	630.3–732.2
Thunder Bay District	522	635.4	581.6–692.9
Timiskaming	163	765.9*	650.7–896.9
Toronto	6,942	570.0*	556.7–583.6
Wellington-Dufferin-Guelph	700	559.6*	518.5–603.1
Windsor-Essex County	1,262	642.9*	607.7–679.6
York Region	2,565	550.4*	528.8–572.6

ASIR=Age-standardized incidence rate
CI=Confidence interval
PHU=Public health unit
*Significantly different compared to the rate for Ontario
Note: Rates are per 100,000 and age-standardized to the 2011 Canadian population.
Analysis by: Surveillance, Analytics and Informatics, CCO
Data source: Ontario Cancer Registry (November 2016), CCO

Table DA.2 Incidence counts and age-standardized rates by public health unit for females and all cancers combined, Ontario, 2013

PHU	Count	ASIR	95% CI
Ontario	**38,635**	**523.3**	**518.1–528.6**
Algoma	535	680.5*	622.2–743.1
Brant County	397	492.2	444.6–543.6
Chatham-Kent	376	564.4	507.4–626.2
Durham Region	1,723	532.2	507.4–558.0
Eastern Ontario	710	571.1*	529.4–615.3
Elgin-St. Thomas	234	460.2	402.6–523.8
Grey Bruce	603	540.4	496.5–587.4
Haldimand-Norfolk	393	570.2	514.0–631.2
Haliburton, Kawartha, Pine Ridge District	701	557.4	514.8–603.0
Halton Region	1,401	506.7	480.4–534.0
Hamilton	1,582	512.1	486.8–538.3
Hastings and Prince Edward Counties	605	566.5	521.1–615.0
Huron County	221	554.7	481.7–636.3
Kingston, Frontenac and Lennox & Addington	589	489.9	450.5–531.9
Lambton	430	514.6	465.9–567.2
Leeds, Grenville and Lanark District	672	581.2*	537.1–628.2
Middlesex-London	1,305	506.7	479.3–535.3
Niagara Region	1,541	539.9	512.6–568.3
North Bay Parry Sound District	428	515.0	466.3–567.8
Northwestern	187	449.1*	386.8–518.7
Ottawa	2,454	506.4	486.5–527.0
Oxford County	355	559.2	501.7–621.6
Peel	2,999	476.2*	459.2–493.7
Perth District	244	541.7	474.7–615.7
Peterborough County-City	467	495.0	449.7–544.0
Porcupine	278	590.2	522.6–664.4
Region of Waterloo	1,359	517.6	490.4–546.0
Renfrew County and District	349	537.4	481.1–598.8
Simcoe Muskoka District	1,793	574.2*	547.7–601.8
Sudbury and District	691	583.9*	540.8–629.7
Thunder Bay District	499	548.7	501.0–599.8
Timiskaming	120	542.3	447.7–652.3
Toronto	7,688	516.0	504.4–527.8
Wellington-Dufferin-Guelph	768	529.0	492.2–567.9
Windsor-Essex County	1,211	539.5	509.3–571.1
York Region	2,678	489.8*	471.4–508.7

ASIR=Age-standardized incidence rate
CI=Confidence interval
PHU=Public health unit
*Significantly different compared to the rate for Ontario
Note: Rates are per 100,000 and age-standardized to the 2011 Canadian population.
Analysis by: Surveillance, Analytics and Informatics, CCO
Data source: Ontario Cancer Registry (November 2016), CCO

Table DA.3 Mortality counts and age-standardized rates by public health unit for males and all cancers combined, Ontario, 2013

PHU	Count	ASMR	95% CI
Ontario	**14,465**	**236.7**	**232.8–240.6**
Algoma	187	253.1	217.5–293.3
Brant County	181	274.3	235.6–317.4
Chatham-Kent	158	277.5	235.5–324.9
Durham Region	587	232.5	213.7–252.5
Eastern Ontario	328	300.2*	268.1–335.1
Elgin-St. Thomas	117	272.2	224.2–327.3
Grey Bruce	286	278.5*	246.6–313.6
Haldimand-Norfolk	184	297.3*	255.3–344.5
Haliburton, Kawartha, Pine Ridge District	326	263.7	235.2–295.0
Halton Region	482	224.7	204.8–245.8
Hamilton	684	261.7*	242.4–282.1
Hastings and Prince Edward Counties	275	286.2*	252.9–322.8
Huron County	80	217.0	171.5–271.6
Kingston, Frontenac and Lennox & Addington	287	282.9*	250.7–318.1
Lambton	187	255.2	219.6–295.3
Leeds, Grenville and Lanark District	298	307.3*	272.8–345.1
Middlesex-London	529	256.7	235.2–279.6
Niagara Region	672	266.3*	246.4–287.4
North Bay Parry Sound District	208	277.4*	240.2–319.0
Northwestern	83	224.1	177.9–278.4
Ottawa	894	234.1	218.9–250.1
Oxford County	158	280.0*	237.9–327.4
Peel	923	193.9*	181.1–207.3
Perth District	103	265.2	216.4–321.7
Peterborough County-City	232	275.7*	241.1–314.2
Porcupine	142	338.5*	283.5–400.8
Region of Waterloo	499	234.1	213.8–255.6
Renfrew County and District	175	300.9*	257.6–349.6
Simcoe Muskoka District	684	254.2	235.3–274.2
Sudbury and District	317	311.1*	277.2–348
Thunder Bay District	217	265.9	231.4–304.1
Timiskaming	76	356.5*	279.6–449.5
Toronto	2,386	199.5*	191.6–207.7
Wellington-Dufferin-Guelph	255	217.6	191.3–246.4
Windsor-Essex County	474	247.7	225.7–271.1
York Region	791	188.6*	175.3–202.6

ASMR=Age-standardized mortality rate
CI=Confidence interval
PHU=Public health unit
*Significantly different compared to the rate for Ontario
Note: Rates are per 100,000 and age-standardized to the 2011 Canadian population.
Analysis by: Surveillance, Analytics and Informatics, CCO
Data source: Ontario Cancer Registry (November 2016), CCO

Table DA.4 Mortality counts and age-standardized rates by public health unit for females and all cancers combined, Ontario, 2013

PHU	Count	ASMR	95% CI
Ontario	**13,169**	**169.5**	**166.6–172.5**
Algoma	174	200.9*	171.6–234.3
Brant County	174	205.0*	175.5–238.3
Chatham-Kent	177	240.0*	205.2–279.6
Durham Region	572	176.2	162.0–191.3
Eastern Ontario	323	251.1*	224.2–280.6
Elgin-St. Thomas	111	208.8*	171.5–252.1
Grey Bruce	224	184.8	160.8–211.8
Haldimand-Norfolk	142	192.8	162.0–228.2
Haliburton, Kawartha, Pine Ridge District	267	189.8	167.1–215.3
Halton Region	446	155.2	141.0–170.4
Hamilton	598	177.1	163.0–192.3
Hastings and Prince Edward Counties	243	212.8*	186.3–242.3
Huron County	79	192.2	151.0–242.1
Kingston, Frontenac and Lennox & Addington	229	181.2	158.2–206.8
Lambton	175	186.3	159.3–217.0
Leeds, Grenville and Lanark District	263	211.7*	186.4–239.9
Middlesex-London	486	178.1	162.4–194.9
Niagara Region	602	191.0*	175.7–207.4
North Bay Parry Sound District	154	169.2	143.2–199.0
Northwestern	71	162.8	126.9–205.8
Ottawa	855	171.0	159.6–182.9
Oxford County	134	198.1	165.5–235.6
Peel	845	141.9*	132.4–151.8
Perth District	89	175.2	140.0–217.1
Peterborough County-City	189	176.0	151.0–204.4
Porcupine	102	208.5*	169.9–253.5
Region of Waterloo	446	165.7	150.6–181.9
Renfrew County and District	132	183.0	152.5–218.3
Simcoe Muskoka District	641	195.1*	180.2–211.0
Sudbury and District	236	187.2	163.9–213.0
Thunder Bay District	174	179.4	153.4–208.7
Timiskaming	45	182.4	132.5–247.3
Toronto	2,351	146.7*	140.8–152.9
Wellington-Dufferin-Guelph	293	194.5*	172.8–218.2
Windsor-Essex County	432	182.6	165.6–200.9
York Region	695	130.4*	120.8–140.4

ASMR=Age-standardized mortality rate
CI=Confidence interval
PHU=Public health unit
*Significantly different compared to the rate for Ontario
Note: Rates are per 100,000 and age-standardized to the 2011 Canadian population.
Analysis by: Surveillance, Analytics and Informatics, CCO
Data source: Ontario Cancer Registry (November 2016), CCO