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Using data linkage to report surgical treatment of breast cancer in Canada

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Release date: August 15, 2018



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Using data linkage to report surgical treatment of breast cancer in Canada

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Abstract

Background: National population information about the surgical treatment rate for primary cancers, including breast cancer, has remained a significant data gap in Canada. This gap has implications for cancer care planning and evaluating health system performance. New linkages between the Canadian Cancer Registry and hospital discharge records were conducted by Statistics Canada in 2016. Using already existing, routinely collected health administrative data, these linkages allow viable reporting of surgical cancer treatment for the first time for all provinces and territories (except Quebec).

Data and methods: Hospital record information about type and date of surgical treatment of tumours was provided by information from linked data. These linked data reported 50,740 incident primary malignant breast tumours diagnosed between January 1, 2010, and December 31, 2012, among females aged 19 years or older. The unadjusted treatment rate for primary surgical intervention within one year was calculated as the proportion of total tumours that were linkable to hospital records.

Results: For three combined years (2010, 2011 and 2012), 88.3% (N=44,780) of patients overall received at least one surgical treatment. Variations to the surgical rate occurred across jurisdictions, with the highest rate at 91-92% for Prince Edward Island, Newfoundland and Labrador, British Columbia and New Brunswick. Generally, there was an inverse gradient between surgical treatment rate and tumour stage.

Interpretation: The surgical treatment rate of new primary breast cancers varied across provinces and territories from 2010 to 2012. New linked data could be used to further identify geographic and demographic inequities in terms of receiving surgical cancer treatment and contribute to the evaluation of cancer system performance and outcomes.

Keywords: Breast cancer, surgical treatment, record linkage, administrative data, disease stage

Women in Canada are more likely to develop breast cancer than any other type of cancer.^{1,2} The lifetime probability of developing breast cancer (based on 2010 data) is 1 in 8 for women. An estimated 26,300 new cases of breast cancer and 5,000 deaths because of breast cancer were expected to have occurred in 2017. While the number of new breast cancer cases has been increasing, due largely to an aging population and population growth, the age-standardized incidence rate has remained stable. The age-standardized breast cancer mortality rate has been decreasing over time,^{2,3} falling 44% from 41.7 deaths per 100,000 population in 1988 to 23.2 deaths per 100,000 population in 2017.² This is likely partly the result of earlier diagnosis through screening and treatment advances.^{3,4}

Surgery, radiation therapy, or both are typically used to manage breast cancer locally. Cytotoxic chemotherapy, endocrine or biological therapy is used both as adjuvant therapy for patients with local disease, as well as treatment for patients with systemic disease. Combinations of these treatment approaches are used according to recommended national and international consensus guidelines,^{5,6} together with patient preferences. Population-level information regarding treatment rates for breast cancer in Canada is limited. Recently, a multi-province research initiative using administrative data aimed at understanding variation in treatment rates for breast cancer focused on chemotherapy treatment patterns; however, surgical treatment patterns were not considered.⁷ Previously, pan-Canadian patterns of breast cancer surgical care were reported based on diagnostic and surgical information from hospital data.^{8,9} However, those

data were not linked to cancer registry records that represent the gold standard for cancer diagnosis.

The objective of this study is to report the population rate of surgical treatment of incident primary female breast tumours diagnosed from 2010 to 2012 overall, and by disease stage in Canada (excluding Quebec). This study uses newly linked Canadian Cancer Registry and hospital discharge data, created in the Canadian Cancer Treatment Linkage Project (CCTLP) by Statistics Canada in 2016.¹⁰ The CCTLP received funding through the Coordinated Data Development Initiative (CCDI) of the Canadian Partnership Against Cancer (CPAC),¹¹ and was conducted in collaboration with the Canadian Council of Cancer Registries (CCCR). This project builds on a previous feasibility study estimating surgical treatment rates for selected cancers that were conducted in collaboration with the CCCR.¹²

Methods

Data sources

Canadian Cancer Treatment Linkage Project Analytical Dataset (CCTLPAD)

Linkages conducted for the CCTLP brought together information from Canadian Cancer Registry (CCR) records from 1992 to 2013,^{13,14} the Discharge Abstract Database (DAD), and the National Ambulatory Care Reporting System (NACRS) for all provinces and territories (except Quebec) from April 1, 1994, to March 31, 2015. The resulting CCR linkage keys used reported

What is already known on this subject?

- In the Canadian population, trends for age-standardized incidence rates of breast cancer have remained stable and mortality rates for breast cancer have declined.
- According to *Canadian Cancer Statistics 2017*, the lifetime probability of developing breast cancer (based on 2010 data) is 1 in 8 for women. An estimated 26,300 new cases of breast cancer were expected to have occurred in 2017.

What does this study add?

- This is the first study to report the rate of surgical interventions used to treat new primary female breast tumours for all of Canada (except Quebec) based upon hospital administrative data linked to the Canadian Cancer Registry, the gold standard for tumour diagnosis in Canada.
- Variation in the surgical treatment rate of new primary breast cancers was evidenced across provinces and territories.
- These results also provide new, information about the surgical treatment rate for breast tumours diagnosed at different stages of the disease.

tumour files registered from 2010 to 2012 to which International Agency for Research on Cancer (IARC) rules for multiple primary tumours were applied to construct the analytical dataset, CCTLPAD, used in this study. The DAD and NACRS are provided annually to Statistics Canada by the Canadian Institute for Health Information (CIHI); Quebec hospital data are not part of the DAD. The CCR is a population-based database created in partnership, whereby each provincial and territorial cancer registry supplies data on patients and

tumours to Statistics Canada. The DAD contains demographic, coded diagnostic and intervention data submitted by acute care hospital facilities and some psychiatric, chronic rehabilitation and selected day surgery hospital facilities.^{15,16} The NACRS contains data regarding visits to ambulatory health care facilities, including community-based services, day surgery procedures, emergency department visits, diagnostic imaging, and selected clinic visits (for example, oncology care).^{17,18}

The linkage was conducted at Statistics Canada using the Social Data Linkage Environment (SDLE), a highly secure linkage environment facilitating linked population data files for social analysis.¹⁹ Technical details regarding approaches to the CCTLP record linkage and linkage rate results for each of the respective source databases are reported elsewhere.¹⁰ Results of the CCTLP linkages were deemed unbiased and representative of the surgical treatment experience of patients for six types of cancers, including breast cancer.

The linkages were approved by Statistics Canada's Executive Management Board²⁰ as governed by the Directive on Microdata Linkage.²¹ Statistics Canada ensures respondent privacy during linkage and subsequent use of linked files.

Study cohort

This study used the CCTLPAD information for 50,740 incident primary single malignant female breast tumours diagnosed between January 1, 2010, and December 31, 2012, among people aged 19 years or older. International Classification of Diseases for Oncology, Third Edition (ICD-O-3) codes were used²² with Surveillance, Epidemiology, and End Results (SEER) Program grouping definitions.²³ The breast tumours defined used topography range C50.0-C50.9, with the following histological exclusions: mesothelioma (M-9050 to M-9055), Kaposi sarcoma (M-9140), and hematopoietic and lymphoid neoplasms (M-9590 to M-9992). To accurately attribute a surgical treatment to a specific tumour, it

was necessary to ensure only one tumour of a given topography was included for each cancer patient. To restrict the cohort to individuals with a single primary tumour, the IARC rules for multiple primary tumours²⁴ were applied to the CCR. Next, tumour records (individuals) were removed during further review of the 2015 IARC tabulation master file in the following cases: multiple tumours of the same type but different histology were identified for the same patient within one year before and/or after the date of diagnosis of the primary tumour in the reference period used for this study. The resulting breast tumours that could be linked to hospital records were largely representative (97.1%) of the entire universe of breast tumours registered in Canada from 2010 to 2012.¹⁰

Surgical interventions

The following surgical interventions were identified as primary treatments: partial or total excision of nipple or breast, with or without reconstruction; radical breast excision, with or without reconstruction (radical breast excision includes removal of axillary lymph nodes); excision partial, lymph node(s) axillary; excision total, lymph node(s) axillary. In the DAD/NACRS, an attribute code that accompanies recorded interventions can indicate sentinel lymph nodes (SNs); however, it was not mandatory to report in the vintage of data used.²⁵ SN biopsies were not considered as a lymph node treatment in this study.

The list of surgical treatments was developed based on a comprehensive review of published clinical guidelines. Conducted by a clinical classifications specialist, this review included the National Comprehensive Cancer Network Clinical Practice Guidelines in Oncology.²⁶ Following an initial review of intervention codes by classification experts from CIHI and clinical experts, a final set of surgical treatments was selected (Appendix A). The Canadian Classification of Health Interventions (CCI) versions 2009 and 2012 were used to define surgical interventions coded in the DAD and the NACRS.^{27,28} All available intervention fields in the DAD

(20 fields) and the NACRS (10 fields) were used to identify the occurrence of surgical treatments. This was done independently for each surgical treatment code because multiple treatments in a single hospital record are captured as separate intervention events.

Surgical treatment

The admission date recorded in the DAD and NACRS determined in-scope hospital records. Surgical treatments occurring within one year following or 31 days preceding the date of tumour diagnosis that was recorded on the CCR were in-scope for analysis.

Surgical rates represent the proportion of tumours treated at least once (using one or more of the selected breast surgeries) out of the total number of breast tumours among individuals whose records met the criteria for linkage to hospital records. Surgical rates are reported overall, as well as by province or territory and by tumour stage. Stage group was defined using the output from the Collaborative Stage Data Collection System, as specified by the American Joint Committee on Cancer (AJCC) 7th edition,²⁹ and was classified into five groupings (Appendix B). Cases with blank stage information were compiled with cases reported as “unknown,” or “not applicable.”

Treatment rates were not age-adjusted. Descriptive statistics regarding patient age and tumour characteristics by province and territory are presented in Table 1.

Results

Tumour stage and patient characteristics

Approximately three-quarters (76%) of breast tumours were diagnosed at earlier stages, with 41.9% of breast tumours diagnosed at stage I and 33.8% diagnosed at stage II (Table 1). Stage III tumours represented 12.9% of the total diagnosed breast tumours, while 4.9% were diagnosed at stage IV.

The median age of women having stage I, II or III tumours was age 62, 61 and 58 years, respectively. The median age for stage IV was 64 years. Median age by stage varied across provinces, notably for stage III, where median age ranged from 56 years in Prince Edward Island and Alberta to 63 years in New Brunswick (Table 1).

Surgical treatment rate

The majority of patients (88.3%) received at least one surgical treatment for their breast cancer during the follow-up period

(Table 2). Across the provinces, the surgical treatment rate ranged from highs of 92.4% in Prince Edward Island, 91.5% in Newfoundland and Labrador, 91.4% in British Columbia, and 90.7% in New Brunswick, to lows of about 85% to 86% in Manitoba and Ontario. Overall surgical rate for the territories was 88.5%.

Surgical treatment rate by tumour stage

Generally an inverse gradient between overall surgical treatment rate and tumour stage resulted (Table 2). Almost all (95.0%) stage I tumours received surgical treatment, at rates ranging from a high of 100% in Prince Edward Island, about 98% in British Columbia, to lows of 92.3% in Manitoba and about 94% in Ontario and Alberta. In the territories, 88.9% of stage I tumours received surgical treatment.

Surgical treatment rates were significantly lower for stage IV breast tumours, as expected. Overall, the surgical treatment rate of stage IV breast tumours was 29.1%. This rate varied significantly across the provinces, from a low of 24.0% in Ontario to a high of 44.4% in Newfoundland and Labrador.

Among tumours with missing/unknown/not applicable stage information, 60.5% (N=2,010) received one or

Table 1
Female breast linked tumour cohort: tumour and patient characteristics, by province and territory, Canada (except Quebec), 2010 to 2012 combined

Linked Tumour Cohort	American Joint Committee on Cancer stage at diagnosis												Stage missing/unknown/not applicable			
	I			II			III			IV			Count [†]	%	Median age	
	Count [†]	Count [†]	Median age	Count [†]	Count [†]	Median age	Count [†]	Count [†]	Median age	Count [†]	Count [†]	Median age				
Canada[‡]	50,740	21,245	41.9	62	17,150	33.8	61	6,530	12.9	58	2,490	4.9	64	3,325	6.6	65
Newfoundland and Labrador	1,055	455	43.1	61	340	32.2	61	155	14.7	58	90	8.5	68	20	1.9	87
Prince Edward Island	330	165	50.0	64	110	33.3	64	35	10.6	56	x	x	66	x	x	85
Nova Scotia	2,090	965	46.2	63	695	33.3	62	225	10.8	58	135	6.5	65	70	3.3	82
New Brunswick	1,555	695	44.7	63	540	34.7	62	195	12.5	63	100	6.4	66	20	1.3	87
Ontario	26,095	10,170	39.0	62	8,790	33.7	60	3,345	12.8	58	1,145	4.4	64	2,645	10.1	63
Manitoba	2,390	980	41.0	64	865	36.2	63	355	14.9	58	155	6.5	64	40	1.7	88
Saskatchewan	1,940	845	43.6	65	665	34.3	64	245	12.6	59	135	7.0	67	45	2.3	85
Alberta	6,185	2,930	47.4	61	2,070	33.5	58	785	12.7	56	295	4.8	63	105	1.7	80
British Columbia	8,970	3,995	44.5	63	3,035	33.8	61	1,170	13.0	58	415	4.6	63	355	4.0	78
Territories, Nunavut	130	45	34.6	55	40	30.8	59	20	15.4	54	x	x	62	x	x	59

x suppressed to meet the confidentiality requirements of the *Statistics Act*

[†] Counts have been rounded to the nearest 5.

[‡] Except Quebec.

Sources: February 2015 IARC tabulation master file; IARC-DAD-NACRS linked database, Statistics Canada.

Table 2

Count[†] and percentage of surgically treated female breast tumours, by American Joint Committee on Cancer stage at diagnosis, by province and territory, Canada (except Quebec), 2010 to 2012 combined

	At least one surgical intervention within 1 year		Stage I		Stage II		Stage III		Stage IV		Stage Missing/Unknown/NA	
	Count [†]	%	Count [†]	% of total stage I	Count [†]	% of total stage II	Count [†]	% of total stage III	Count [†]	% of total stage IV	Count [†]	% of total stage unresolved/NA
Canada[‡]	44,780	88.3	20,175	95.0	15,985	93.2	5,885	90.1	725	29.1	2,010	60.5
Newfoundland and Labrador	965	91.5	440	96.7	335	98.5	145	93.5	40	44.4	x	x
Prince Edward Island	305	92.4	165	100.0	100	90.9	30	85.7	x	x	x	x
Nova Scotia	1,875	89.7	940	97.4	665	95.7	210	93.3	45	33.3	15	21.4
New Brunswick	1,410	90.7	670	96.4	515	95.4	180	92.3	40	40.0	5	25.0
Ontario	22,565	86.5	9,545	93.9	8,045	91.5	2,975	88.9	275	24.0	1,725	65.2
Manitoba	2,040	85.4	905	92.3	780	90.2	310	87.3	40	25.8	5	12.5
Saskatchewan	1,740	89.7	820	97.0	645	97.0	225	91.8	40	29.6	10	22.2
Alberta	5,575	90.1	2,745	93.7	1,940	93.7	735	93.6	100	33.9	45	42.9
British Columbia	8,195	91.4	3,905	97.7	2,920	96.2	1,055	90.2	130	31.3	180	50.7
Territories, Nunavut	115	88.5	40	88.9	40	100.0	20	100.0	x	x	x	x

x suppressed to meet the confidentiality requirements of the *Statistics Act*

[†] Counts have been rounded to the nearest 5.

[‡] Except Quebec.

Sources: February 2015 IARC tabulation master file; IARC–DAD–NACRS linked database, Statistics Canada.

more surgical treatment(s). This was more prevalent for Ontario (65.2%), British Columbia (50.7%) and Alberta (42.9%).

Discussion

This study represents the first reporting of population breast cancer surgical treatment rate for all provinces and territories (except Quebec) using linked cancer registry and hospital data. Resulting treatment rates reasonably reflect expected surgical treatment rates and surgical patterns by stage. The distribution of available linked tumour stages aligns with the distribution of breast tumour stages previously published in 2010 for Canada.³⁰

Similar to these overall surgical rate results, others reported that 92% of women with invasive breast cancer underwent a definitive surgical procedure within one year, based on Ontario Cancer Registry linked data.³¹ Using ungrouped interventions (data not shown), CCTLPAD results revealed that 58% of these tumours were the target of at least one breast-conserving surgery (BCS), while Institute for Clinical Evaluative Sciences (ICES) researchers observed a rate of 61% of tumours were the target of at least one BCS. CPAC³² reported that 39.5% of women with breast cancer resections had

a mastectomy, while Porter et al.⁹ also reported that mastectomies comprised 39% of all breast cancer surgeries, using unlinked data. Consistently, 41% of breast tumours reported here underwent a mastectomy (data not shown).

Surgical indications depend on tumour and patient prognostic factors,³³ such as nodal status and number of lymph nodes involved.³⁴ Future research could investigate the relationship between tumour stage and outcomes using the CCTLPAD. However, compiling distinct surgical encounters for lymph nodes is not possible using these data because of the recognized limitations to CCI codes recorded before 2015.²⁵

Disease stage represents a key prognostic factor commonly used to assess the effect of screening programs on reducing the detection of cancers at late stages and assisting with planning. Therefore, different stages of disease progression have distinct implications for resource and service delivery.³⁵ For the breast tumours considered in this study, the distribution of tumour stage obtained using the CCTLPAD closely reflects the distribution reported from contents of unlinked provincial and territorial registry source data for 2010 and 2011.³⁵

While surgical treatment rates for stage IV tumours are much lower than rates found for earlier stage tumours,

less than one-third (29.1%) of stage IV tumours received surgical treatment nonetheless (Table 2). Improved survival outcomes for stage IV breast cancers that received surgical treatment was demonstrated through meta-analysis review.³⁶ However, those authors qualified that selection bias was likely a significant factor and that evidence from randomized controlled trials is still required. The results suggest that surgery may have been indicated for the tumours in this linked cohort despite the advanced disease stage, but further research on this topic is warranted. The higher median age reported for breast cancers diagnosed at stage IV (64 years) may partly account for the much lower surgical rates relative to rates at other stages.

Limitations

Validity of DAD surgical information was assumed. Breast cancer surgical treatments may have occurred outside of acute care³⁷ or in Quebec (i.e., not available). Therefore, surgical treatment events have likely been undercounted.

Conclusions

Variation in the surgical treatment rate of new primary breast cancers across provinces and territories in Canada was

evident from 2010 to 2012. The results of this study provide new information about surgical treatment rates for breast tumours according to disease stage.

While efforts to improve this sustainable linkage methodology could continue, these new linked data could be useful to identify geographic and demographic

inequities in terms of receiving surgical cancer treatment, and contribute to the evaluation of cancer system performance and outcomes. ■

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Appendix

Appendix A

Breast cancer surgical treatment, Canadian Classification of Intervention codes

Excision partial nipple 1.YK.87^^
 Excision total nipple 1.YK.89^^
 Excision partial breast 1.YM.87^^
 Excision partial breast WITH RECONSTRUCTION 1.YM.88^^
 Excision total breast 1.YM.89^^;
 Excision total breast 1.YM.90^^ WITH RECONSTRUCTION
 Excision radical breast 1.YM.91^^
 Excision radical, breast WITH RECONSTRUCTION 1.YM.92^^
 Excision partial, lymph node(s) axillary 1.MD.87^^
 Excision total, lymph node(s) axillary 1.MD.89^^

Sources: Canadian Institute for Health Information: Canadian Classification of Health Interventions (CCI), 2009; Canadian Institute for Health Information: Canadian Classification of Health Interventions (CCI), 2012.

Appendix B

Derived tumour stage grouping^{†‡}

Stage 1 (0, 0a, 0is, I, INOS, IA, IANOS, IA1, IA2, IB, IBNOS, IB1, IB2, IC, IS, IEA, IEB, IE, ISA, ISB - 000 to 240)
 Stage 2 (II, IINOS, IIA, IIANOS, IIA1, IIA2, IIB, IIC, IIEA, IIEB, IIE, IISA, IISB, IIS, IIESA, IIESB, IIES - 300 to 430)
 Stage 3 (III, IIINOS, IIIA, IIIB, IIIC, IIIC1, IIIC2, IIIEA, IIIEB, IIIE, IIISA, IIISB, IIIS, IIIESA, IIIESB, IIIES - 500 to 630)
 Stage 4 (IV, IVNOS, IVA, IVA1, IVA2, IVB, IVC - 700 to 740)
 Not applicable (888)
 OCCULT[§] / UNK (900, 999)

[†] Code ranges for each stage grouping follow from Edge S, Byrd DR, Compton CC, et al., eds. *AJCC Cancer Staging Manual*, 7th ed. New York: Springer, 2010.

[‡] Tumour records with blank information following derived tumour stage grouping were coded to "9" (missing from this analysis).

[§] For breast tumours, no occult stage group ('900) cases exist. Coded according to the AJCC 7th edition prognostic stage tables, this table presents the more generalized Derived Tumour Stage Grouping for all possible cancers.

UNK=Unknown