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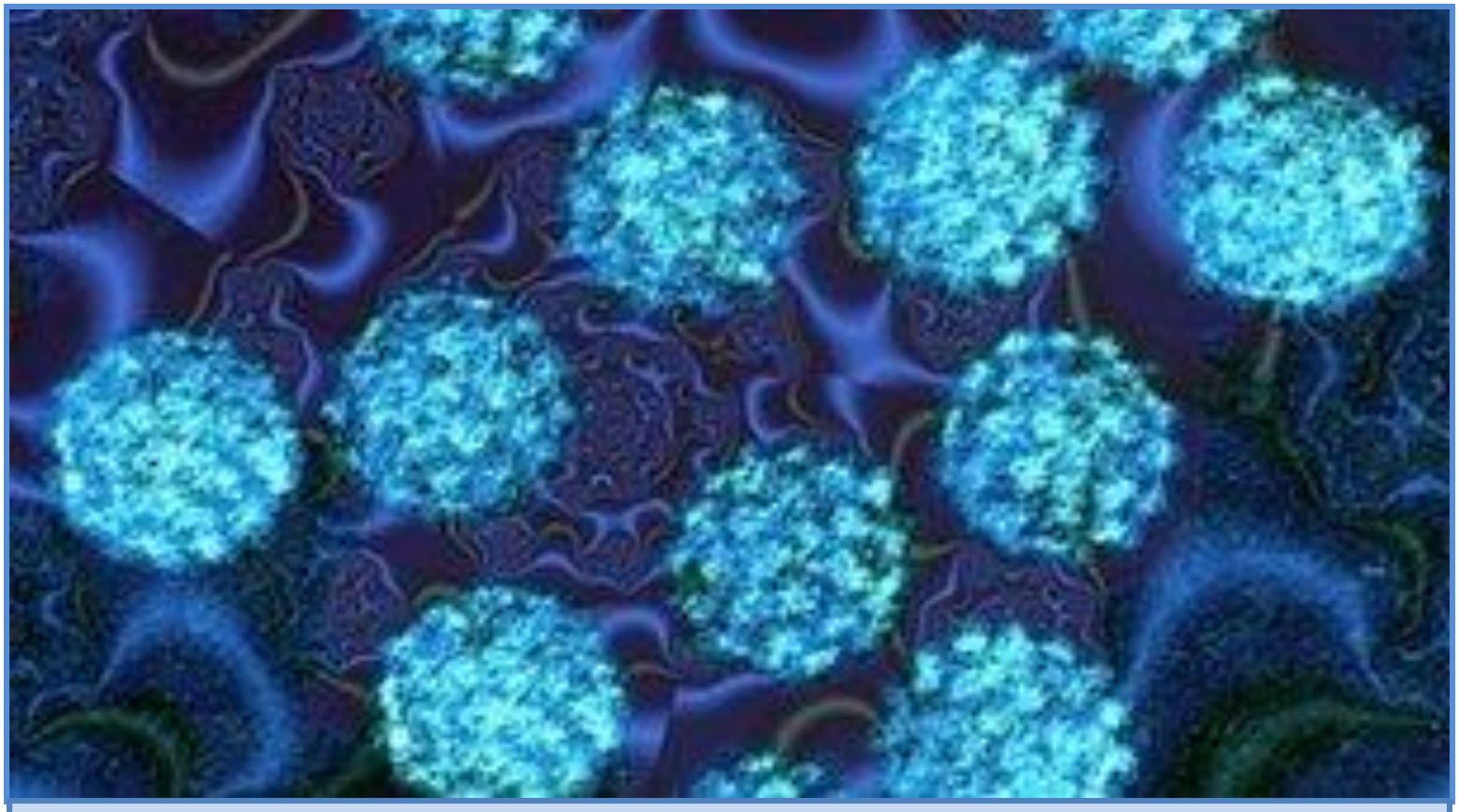

BC Cancer Registry
2014 Annual Report

Special Focus
HPV-Associated Cancers in British Columbia

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About the BC Cancer Agency:

The BC Cancer Agency, an agency of the Provincial Health Services Authority, provides a comprehensive cancer control program for the people of BC in partnership with regional health authorities. This includes prevention, screening and early detection programs, research and education, and care and treatment.

The Mission of the BC Cancer Agency is:

- *To reduce the incidence of cancer*
- *To reduce the mortality rate of people with cancer*
- *To improve the quality of life of people living with cancer*

This Report:

This report has been prepared by members of the BC Cancer Agency's Cancer Control Research and Cancer Surveillance & Outcomes, Population Oncology

This publication is available from the BC Cancer Agency website at: http://www.bccancer.bc.ca/health-professionals/professional-resources/bc-cancer-registry

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[June 2015]

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Message

Message from the Scientific Director

I am very excited to present to you the BC Cancer Registry 2014 Annual Report. This marks our second year since we have returned to an annual report in this format and I hope you will enjoy the content. This year we have prepared a special feature on Human Papillomavirus (HPV) and cancer in British Columbia. We have also tried to provide highlights of some of the work that was undertaken or completed this past year using data from the BC Cancer Registry.

I would very much like to thank the members of the HPV Focus Report's Content Advisory Group who contributed ideas, feedback and expertise to this section of the report. Many thanks go out to:

Dr. Ajit Auluck
Dr. Gina Ogilvie
Dr. Erich Kliewer
Dr. John Hay
Dr. Dianne Miller
Colleen Mcgahan

Dr. Ogilvie recently was awarded a Canada Research Chair in Global Control of HPV-Related Disease and Cancer. Congratulations to Dr. Ogilvie!

I hope you enjoy this year's report and we look forward to our continuing work in 2015.

Ryan Woods
Scientific Director, BC Cancer Registry

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Special Focus: HPV-Associated Cancers in British Columbia

Report Summary

- HPV is the most common sexually transmitted infection in British Columbia (BC) and North America; HPV causes several types of cancer as well as genital warts.
- In 2012, close to 600 British Columbians were diagnosed with an HPV-associated cancer.
- Rates of some HPV-associated cancers such as oral and anal cancers are rising in BC; these rate increases have been observed in both males (oral) and females (oral, anal).
- HPV infection (and thus HPV-associated cancer) is preventable. Increasing vaccine coverage across the province is important to reduce the future burden of HPV-associated cancers. Further, regular screening for cervical cancer with the Pap test is critical to enable BC's continued success against cervical cancer incidence and mortality in BC.

1

What is HPV?

HPV is short for human papillomavirus which is not one, but a group of more than 150 related viruses. The term 'papilloma' refers to the warts that develop after infection with many types of HPV. Some types of HPV can also cause cancers and this is the issue that will be explored further within this report.

HPV is generally transmitted through sexual contact and is the most common sexually transmitted infection. Vaginal, anal or oral sex with an infected individual can all result in transmission of the virus. Most sexually active individuals will be infected at some point in their life with HPV and most will never know that they have been infected as they will experience no symptoms from the infection.

Describing the exact prevalence of HPV in the population is complex due to the number of different HPV types as well as a strong relationship between prevalence and age. In British Columbia (BC), studies have estimated the overall prevalence of HPV infection in women to be about 17%. The prevalence has generally been found to be highest in women of younger age (< 25 years) with prevalence tending to decline with increasing age.

2

HPV and Cancer

Although most people who are infected with HPV will not develop symptoms from their infections, some who are infected with certain types of HPV, will go on to develop cancer. The process from infection with a cancer-causing type of HPV to the development of cancer may take several years to complete. Although we probably don't yet know all of the cancers caused by HPV, we do know that HPV causes cancers of the cervix, vagina, vulva, anus, penis, oral tissues such as the tonsils and base of the tongue (which we term cancers of the "oropharynx"), and some other types. For the purpose of this report, we will refer to these cancers as "HPV-associated" even though HPV causes some, but not all, of the cancers diagnosed annually in each of these tissues.

The percentage of these various cancers caused by some type of HPV is not precisely known, but estimates are available from several North American studies. Table 1 provides ranges of estimates of the percentages of different cancer cases we currently feel are attributable to infection with HPV. From these percentages it is evident why these are referred to as "HPV-associated" as HPV has been shown to cause a high fraction of cases for each of these types of cancer. As a comparator, lung cancer is termed "smoking-related" and the fraction of lung cancer cases we estimate that are caused by smoking is about 80%. (Note: definitions for the cancers used in this report are found in the appendix).

As noted above, not all types of HPV are thought to be associated with cancer; some cause non-malignant conditions such as genital and other warts. Types of HPV known to cause cancer are often referred to as "high-risk" types. HPV types 16 and 18 are the most commonly occurring high-risk types of HPV and thus public health efforts to specifically prevent infection with these types of HPV exist in many jurisdictions (see Prevention section).

Who gets HPV-associated cancers?

Table 2 below shows a breakdown of the annual number of HPV-associated cancers diagnosed in BC for the period 2008-12. An average of almost 600 British Columbians were diagnosed with an HPV-associated cancer each year, of which about 30% were cervical cancers. In recent years, close to 100 cases of anal cancer were diagnosed annually, about 2/3 of which were diagnosed in women. Cancers of the penis and vagina were uncommon with about 20 cases each.

Table 1: Estimated Percentage of Selected Cancers Associated with HPV Infection

Cancer	Estimated % of New Cancers Attributable to HPV Infections
Cervix	96-100%
Vagina and Vulva	40-64%
Anus	90-93%
Oropharynx	35-63%
Penis	36-50%

Because of the earlier establishment of the relationship between cervical cancer and HPV infection, a misconception exists that HPV-associated cancers arise only in females. As noted above, cancers of the penis are often associated with HPV infection and presently in BC, more male cases of oropharyngeal cancers (OPCs) are diagnosed annually than female cases. Over the period from 2008-2012, an average of 154 cases of HPV-associated oral cancers were diagnosed annually in BC males compared to an average of 35 cases per year in females. To help put the 154 cases in perspective, we can compare this to the 109 cases per year of male smoking-related oral cancers (see definition in appendix Table A1) over this same period. Thus HPV-associated oral cancers in males outnumber oral cancers believed to be caused by smoking in BC with the number of diagnoses for HPV-associated oral cancers being about 50% greater than smoking-related ones.

In examining the data presented in Table 2, it is also apparent that some HPV-associated cancers are diagnosed at younger ages than are typical for other common cancers.

Table 2: Average Annual Cases of HPV-Associated Cancer and Age at Diagnosis, 2008-2012, British Columbia

Cancer	Average Annual Number of Cases		Average Age at Diagnosis	
	Males	Females	Males	Females
Cervix		178		50.2
Vulva		77		68.2
Vagina		20		71.0
Penis	21		70.4	
Anus	34	60	63.5	63.5
Oropharynx	154	35	60.1	64.0
All HPV-associated Cancers	209	370	62.2	60.2
All Cancers	12168	11028	67.6	65.5

Data Source: BC Cancer Registry

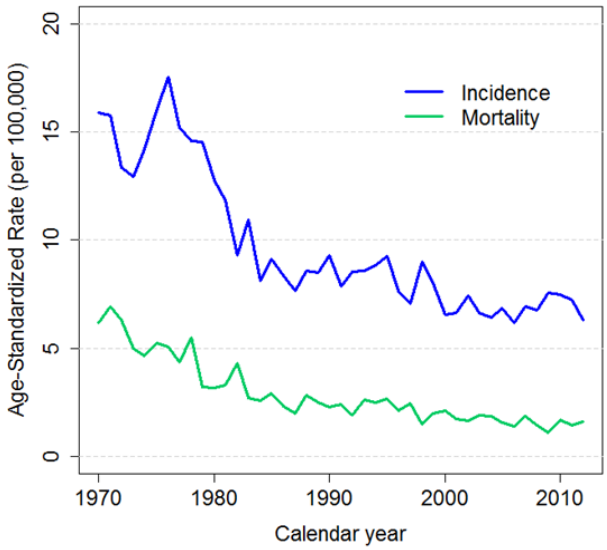
For example, the average age of women diagnosed with cervical cancer was just 50.2 years; this contrasts with the average age at diagnosis of 65.5 for all female cancers over this period. Another example is male OPCs where the average age of diagnosis was about 60.1 years; this is about 7.5 years younger than the average age of all male cancers diagnosed over this same period. Anal cancers were diagnosed at an average age of 63.5 for both males and females which is about 6.5 years younger than the average age at diagnosis for colorectal cancer over this same period.

Rates of HPV-associated cancers

Although Table 2 above presents the average number of annual cases of HPV-associated cancers in BC, to understand better if these cancers are becoming more or less common over time, we need to examine the cancer rates. Additionally, examining cancer rates allows us to see if some age groups are at higher risk of developing these cancers than others as the calculation of rates controls for the population size of different age groups.

Perhaps the most impressive time trends we have seen in HPV-associated cancers are the declining rates of cervical cancer incidence and mortality over the past several decades (Figure 1). Rates of new cases and deaths due to cervical cancer have been declining from the 1970's, largely attributable to the success of BC's Cervical Cancer Screening Program. Pap tests have the ability to detect pre-cancerous changes in cells of the cervix and can thus identify women who require treatment before they develop cancer; this has led to a reduction in the actual numbers of cancers diagnosed in BC women.

Figure 1: Age-standardized cervical cancer incidence and mortality rates for British Columbia women, 1970-2012



Data Source: BC Cancer Registry

Additionally, due to these early detections and reduction in the incidence of disease, fewer women have died of cervical cancer in the province and thus the mortality rate has seen a corresponding reduction. These time trends demonstrate the significant impact that early detection and prevention have had on this specific cancer.

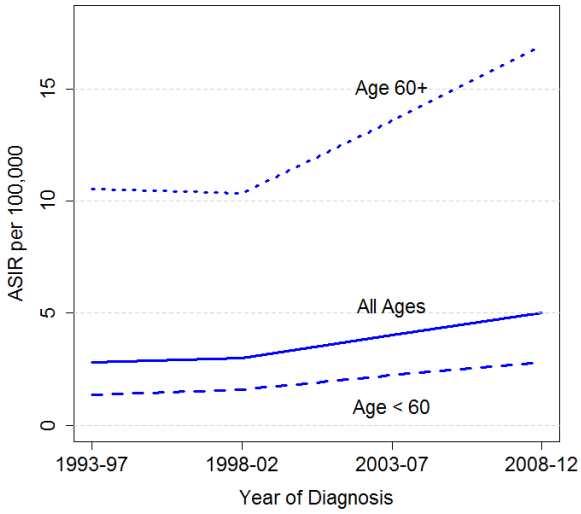
Further discussion of the prevention of cervical cancer is found in the later sections of this report.

Unfortunately, the observed trend pattern for cervical cancer is not representative of the time trends for other HPV-associated cancers in BC. In recent years, an increase has been observed for several other HPV-associated cancers in our province most notably cancers of the anus and oropharynx. Figure 2 (below) provides plots of the trends in age-standardized incidence rates over the past 20 years. For BC males, rates of OPCs have been increasing steadily, for both younger and older men.

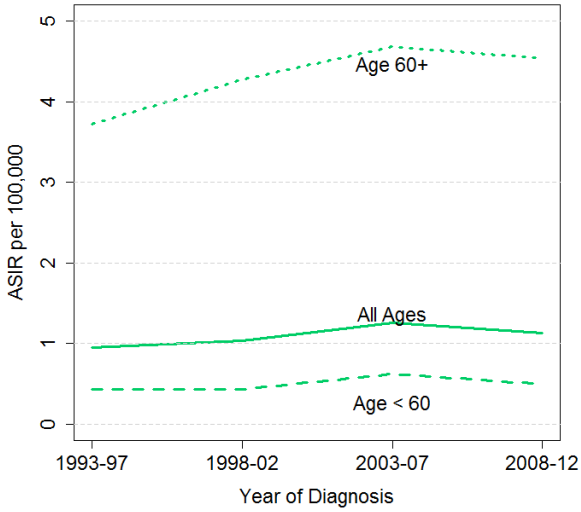
Figure 2: Age-standardized Cancer Incidence Rates for British Columbia 1993-1997 through 2008-2012 for Oropharyngeal and Anal Cancers by Sex.

Data Source: BC Cancer Registry

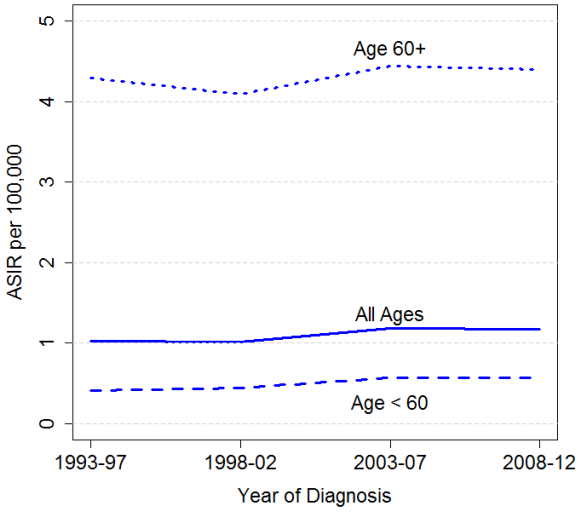
a) Oropharynx, males



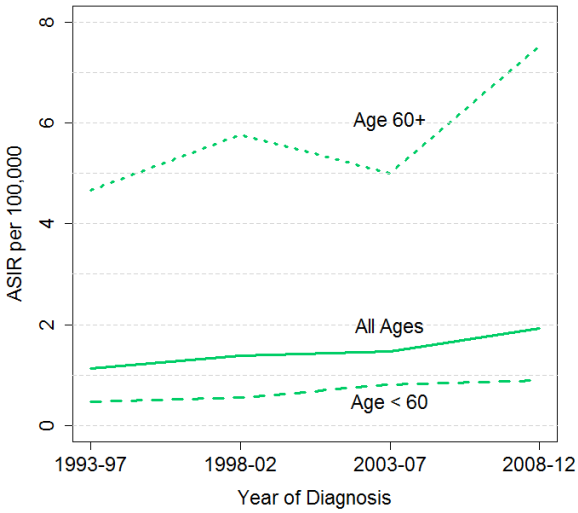
b) Oropharynx, females



c) Anus, males



d) Anus, females



The increase was less pronounced for females; however an increasing trend is visible in women aged 60 or older. Rates of anal cancer however have increased steadily in both younger and older women in BC over the past 20 years. Rates for anal cancer in men (Figure 2c) as well as cancers of the penis, vagina and vulva (data not presented) have been all been relatively stable over this same period.

Tables 3a and 3b present recent rates of HPV-associated cancers for BC females and males by age group. A few patterns are visible within these tables:

- Cervical cancer risk is more evenly distributed across the age groups than the other HPV-associated cancers. Women of age <45 years show a higher risk of this cancer compared to other HPV-associated cancers.
- Rates of anal cancer are higher in females than males in almost all age groups. The risk in females aged 55-74 is more than double the risk of males in these age groups. In men, the risk in the oldest age group (age ≥75) is similar to the risk in females of the same age, but is approximately twice as high as the male risk in the age groups 55-64 and 65-74.
- The risk of cancers of the oropharynx are substantially higher in men than in women. Men between 55 and 64 years of age are at highest risk of being diagnosed with this cancer; the risk in this age group is more than 6 times the risk of women of similar age. Men age 45-54 show an oropharyngeal cancer risk comparable to the risk of cervical cancer in women in this age group.
- Cancers of the penis, vagina and vulva show a fairly consistent pattern of increasing risk with age.

Finally, as noted above, cervical cancer rates in BChave dropped substantially from the rates observed in the 1970's due in large part to provincial successes with cervical cancer screening.

Table 3a: Age-specific rates for female HPV-associated cancers for BC, 2008-2012

Cancer	Age Group				
	< 45	45-54	55-64	65-74	≥75
Cervix	6.3	10.2	9.8	10.3	9.2
Anus	0.3	3.0	6.6	8.7	6.2
Vulva	0.4	3.1	5.3	7.2	18.5
Vagina	0.1	0.3	1.1	2.6	5.1
Oropharynx	0.1	1.9	3.5	5.5	4.0

Table 3b: Age-specific rates for male HPV-associated cancers for BC, 2008-2012

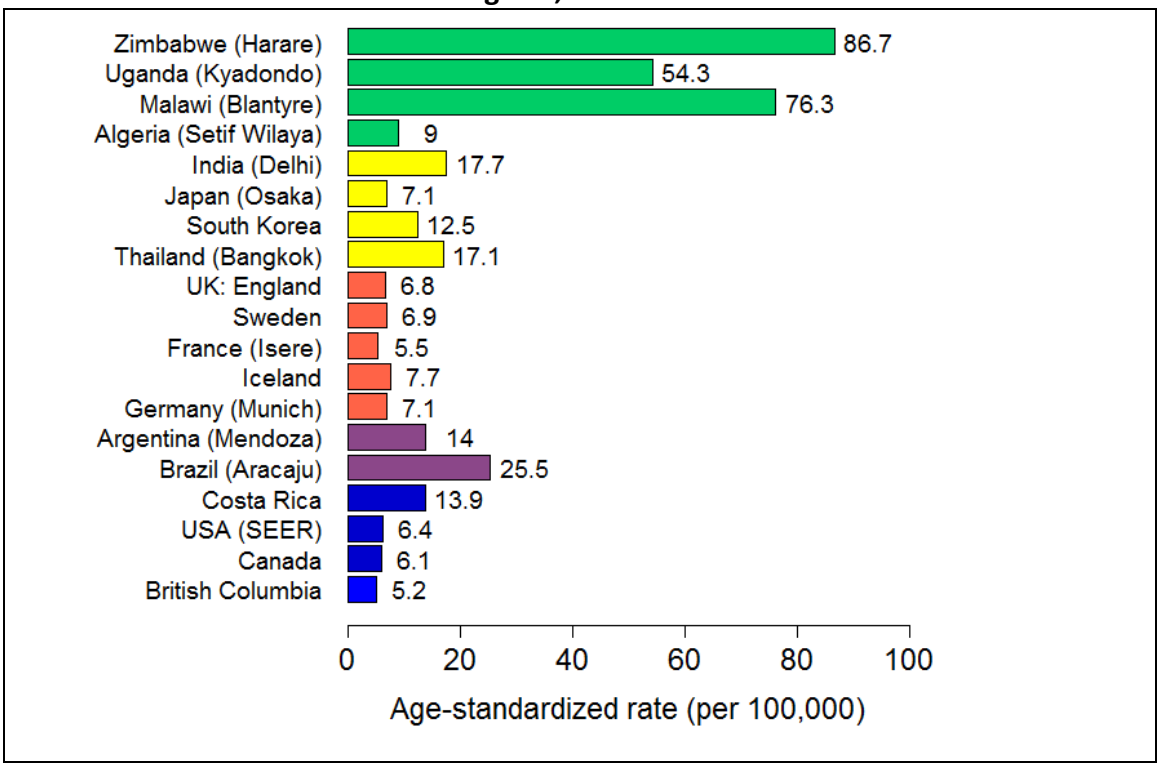
Cancer	Age Group				
	< 45	45-54	55-64	65-74	≥75
Anus	0.2	2.1	3.2	3.3	6.5
Penis	0.1	0.6	1.1	2.9	7.0
Oropharynx	0.3	11.1	22.9	18.8	8.0

Data Source: BC Cancer Registry
Note: Rates are per 100,000 population

It is interesting to contrast cervical cancer rates from BC with those observed in other regions of the world as there is considerable variation in rates reflecting differences in screening and prevention efforts.

Figure 3 below presents data on cervical cancer incidence collected within the International Agency for Research on Cancer's *Cancer Incidence in Five Continents* (Volume X) monograph. The BC Cancer Registry contributes data to this publication every five years for the purpose of creating a resource from which standardized, global cancer statistics can be generated. The rate of cervical cancer in BC over this period is very low relative to the other jurisdictions; it is also lower than the rates observed over this period for Canada as a whole and the United States. Brazil and Argentina have generally shown to have rates of cervical cancer much higher than here in BC and other parts of Canada and the United States.

Figure 3: Age-standardized Cervical Cancer Incidence Rates for Select World Regions, 2003-2007



Data Source: Cancer Incidence in Five Continents (Volume X)
Notes: Rates are standardized to the 1960 world population; data for Zimbabwe, Brazil: 2003-2006.

European registries generally report similar incidence rates to those from Canada and the US. Rates reported from Asian registries are quite variable with some jurisdictions reporting similar rates to Canada and others with rates 2-3 times those reported here. The highest rates of cervical cancer incidence reported in the monograph were generally from Sub-Saharan Africa where in contrast to Canada, cervical cancer is one of the most common cancers in women and a significant source of cancer mortality.

3

HPV Prevention and Cancer Screening

As infection with HPV can lead to serious health consequences, it is important that prevention measures be undertaken to reduce infection with HPV. As with all sexually transmitted infections, the use of condoms during sex can help reduce transmission of the virus, however condoms do not fully guarantee complete protection against HPV.

Vaccination for HPV

Vaccines have been developed for HPV and are a very effective way of reducing infections. There are different vaccines available and approved for use in different jurisdictions which may vary in the types of HPV that the vaccines provide protection against. The two vaccines approved for use in Canada are Cervarix and Gardasil vaccines. The Cervarix vaccine is called 'bivalent' as it protects against two high-risk types of HPV (types 16 and 18) which cause cervical cancer. Gardasil is referred to as 'quadrivalent' as it protects against four kinds of HPV, including those noted above that cause cervical cancer, as well as types 6 and 11 that cause genital warts.

During the 2008-09 school year, the BC government implemented a program that offered funded vaccinations for girls in grade 6 and 9. Although the long-term plan for the program was to target girls entering grade 6, a 3-year "catch-up" program was initiated to target girls entering grade 9. Presently, the program offers two doses of Gardasil, administered six months apart, to grade 6 girls through the routine school vaccination program. The vaccine is also provided free of charge on request to any girls born in 1994 or later and can be obtained from their health unit or care-provider. A limited time program also exists in BC that is offering the Cervarix vaccine to women aged 26 or younger and born before 1994. For more information on these vaccine programs, see the "Further Reading" section of this report for links to relevant web pages.

Vaccination coverage (meaning the percentage of eligible people that have received the vaccine) statistics now exist for BC's HPV vaccination program and are available from the BC Centre for Disease Control's website. For grade 6 girls, the coverage has been increasing since the program was initiated (2009: 61.8%) to the most current period for which statistics are available (2013: 69.1%). There is however a fair amount of regional variation in the 2013 coverage rates ranging from 53.5% (for the Kootenay Boundary Health Service Delivery Area) to 74.3% (in the Thompson Cariboo). It is interesting to note that within each of the five regional health authorities there is some variation in coverage rates by sub-region. For the grade 9 catch-up program that existed for three years in BC, the coverage was 61.7% when the three-year program ended in 2011.

Although not funded in BC, the Gardasil vaccine is also recommended for adult women up to 45 years of age, boys and men aged 9 to 26, and men older than 26 who have sex with men.

Cancer screening for HPV-associated cancers

As noted previously in this report, cervical cancer screening in British Columbia has been extremely successful at reducing both cervical cancer incidence and mortality rates. In BC, screening for cervical cancer is currently done with a Pap test. Women in BC are recommended to receive a Pap test starting at age 21 or 3 years following first sexual contact. Women are screened annually for the first three years, followed by biennial screening thereafter. In BC, Pap tests are generally taken by primary care providers however the samples are examined and interpreted by a centralized provincial screening program at the BC Cancer Agency. Table 4 below shows some program statistics from the BC Cancer Agency's Cervical Cancer Screening Program, 2013 Annual Report. In 2012, more than 500,000 women received Pap tests in BC. Despite this high number of participants, recent reports have suggested that participation in cervical cancer screening in BC is declining. This decline has also been observed specifically in women who previously participated in the program.

Table 4: Select program statistics from the BC Cervical Cancer Screening Program, 2012

Number of participants (BC)	527,189
Participation rate (BC)*	69.9%
Number of women with abnormal test result (ASCUS/LSIL)	15,175
Pre-cancer detection rate (per 1,000 tests done)	6.9%
% of cervical cancers that were in women who have not been screened or >5 years overdue	42%

Source: Cervical Cancer Screening Program 2013 Annual Report
Notes: *Hysterectomy adjusted rate

At present there are no approved tests for HPV in the mouth or throat to determine if people might be at increased risk of future oral cancers. There are also no funded oral cancer screening programs operating at a population-level in BC.

As such, it is important that vaccination and other preventative measures be considered to reduce risk of these cancers in the population. The BC Oral Cancer Prevention Program has produced guidelines for early detection of oral cancers to provide guidance to dentists on the use of oral cancer screening techniques. These are available from the BC Cancer Agency website.

4

Research on HPV and Cancer in BC

HPV Focal Trial

HPV FOCAL is a Canadian Institutes for Health Research (CIHR) funded trial being conducted through the BC Cancer Agency (Provincial Health Services Authority), in collaboration with hundreds of health care providers in BC. HPV FOCAL is the first North American randomized controlled trial evaluating high-risk HPV DNA testing (with an extra test called liquid-based cytology -- or LBC – for women who test positive for HPV), compared to LBC testing alone (with HPV testing of women with abnormal results). As noted previously in this report, it is well established that infection with high-risk types of HPV is the primary risk factor for the development of cervical cancer and its precursors. Testing for the presence of these high-risk HPV types could improve cervical cancer screening for all BC women. The findings from this landmark study are intended to provide a model for future screening not only within BC, but for other organized screening programs across Canada.

Over 25,000 BC women from Metro Vancouver and Greater Victoria were consented into the trial between January 2008 and May 2012. As of December 2014, 15,300 women have completed trial participation and just over 8,000 women remain in active follow-up. All participants are screened at the end of their determined follow-up period and it is expected the last of these "exit screens" will be complete by December 2016. There are multiple planned analyses for this study, some of which are already complete and others that will continue as the data on the participants continues to accrue.

The primary study outcome is the cumulative detection rate of severely abnormal or cancerous cells on the surface of the cervix at 4 years. Other trial objectives are to: establish the efficacy of HPV testing as a stand-alone screening test with cytology triage of HPV-positive women; establish the appropriate screening interval for HPV-negative women; establish the appropriate clinical follow-up for those who are HPV-positive; establish the cost-effectiveness of HPV testing for primary screening within the context of an organized Canadian cervical cancer screening program.

To learn more about the HPV FOCAL Study, please visit the BC Cancer Agency website at:

http://www.bccancer.bc.ca/health-professionals/clinical-trials/hpv-focal-study

QUEST HPV Trial

The QUEST HPV Study is enrolling more than 8,500 females in five Canadian provinces (including BC) in an effort to determine:

- the HPV vaccine's protection against future HPV infection;
- how long protection from the vaccine lasts and;
- if there are any differences between girls who received 2 or 3 doses of the vaccine.

The principal investigator for the BC region is Dr. Simon Hobson, a Clinical Associate Professor in the Department of Pediatrics at the University of British Columbia.

QUEST stands for **Qu**adrivalent HPV Vaccine **E**valuation **St**udy and thus is a study to evaluate quadrivalent HPV vaccines which protect against four kinds of HPV that cause cervical cancer and genital warts.

It is important to understand whether two doses of the vaccine might provide equivalent protection to three doses, as this could mean that girls are subjected to fewer shots, more women would be able to receive the vaccine and that middle and low-income countries might be more likely to provide the vaccine to girls.

Those interested in further information on the QUEST HPV Study can visit the study website at: http://questhpvstudy.ca/.

Epidemiology of Oropharyngeal Cancers in BC

In recent years several epidemiological studies related to trends in oropharyngeal cancer incidence and survival have been conducted by researchers at the BC Cancer Agency using data from the BC Cancer Registry. One of these studies (Auluck, 2010) first reported the recent increases in HPV-associated oral cancers in our province, which was shown previously in this report (Figure 2).

A second study examined the trends in the survival rates from both HPV- and smoking-related oral cancers in BC over the past several decades (Auluck, 2012). This study suggested that the survival rates from smoking-related cancers have not improved dramatically; however, survival for HPV-associated cancers in males have been improving. In fact, the survival rates for OPCs for males in this study eclipsed those of smoking-related oral cancers. Rates for females had not improved as dramatically, however survival rates for women had historically been higher than for men. In the most recent study period, the survival rates for HPV-associated oral cancers for females were shown to be comparable to those in men.

More recent work by some of these same researchers has been trying to better understand the relationship between socioeconomic status and the development of oral cancers. The team is using geographical information systems (GIS) tools to map out areas of higher oral cancer incidence and the corresponding neighborhood socioeconomic status. For more information about these projects, please see the short video published by the Canadian Dental Association at: http://www.oasisdiscussions.ca/2015/01/23/ajits

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Further Reading about HPV

The following are web-based resources that provide further information and materials related to HPV as well as further information on the vaccination program within BC.

For general information on HPV, including fact sheets in several languages, and links to further information about HPV vaccination in BC, please visit:
http://www.healthlinkbc.ca/healthfiles/hfile101a.stm

For further information on vaccination against HPV in British Columbia, please visit the BC Centre for Disease Control's (BCCDC) website at:
http://www.bccdc.ca/imm-vac/VaccinesBC/HPV/default.htm

The United States Centre for Disease Control also has online information about HPV, prevention, and vaccines on their website at:
http://www.cdc.gov/hpv

Information on British Columbia's Cervical Cancer Screening Program can be found online at:
http://www.screeningbc.ca/Cervix/default.htm

6

References

1. Moore RA, Ogilvie G, Fornika D, et al. **Prevalence and type distribution of human papillomavirus in 5,000 British Columbia women—implications for vaccination** *Cancer Causes Control*. 2009; 20:1387–1396.

2. Krueger H, Stuart G, Gallagher R, Williams D. **HPV and Other Infectious Agents in Cancer – Opportunities for Prevention and Public Health**. New York, NY: Oxford University Press, 2010.

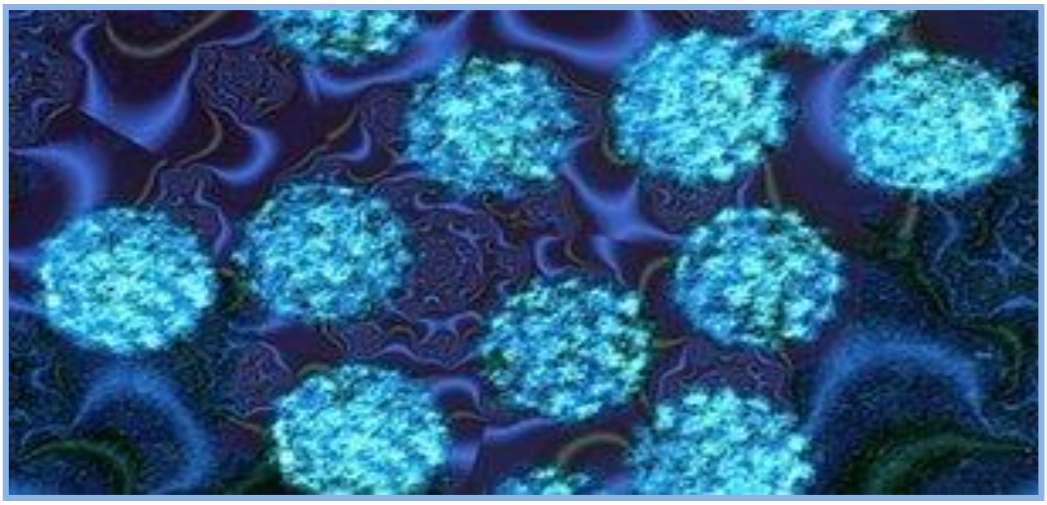
3. Government of Canada, Public Health Agency of Canada. **Update on human papillomavirus (HPV) vaccines** *Canada Communicable Disease Report*, vol. 38 (2012) (ACS-1) [Available from http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/12vol38/acs-dcc-1/index-eng.php]

4. Auluck A, Hislop G, Bajdik C, et al **Trends in oropharyngeal and oral cavity cancer incidence of human papillomavirus (HPV)-related and HPV-unrelated sites in a multicultural population: the British Columbia experience**. *Cancer*. 2010; 116:2635–2644

5. Auluck A, Hislop G, Bajdik C, et al. **Gender- and ethnicity-specific survival trends of oral cavity and oropharyngeal cancers in British Columbia**. *Cancer Causes Control.* 2012; 23:1899–1909

6. **Immunization Uptake in Grade 6 Students, 2002-2013**. Vancouver, BC: BC Centre for Disease Control; 2013 [Available from http://www.bccdc.ca/imm-vac/BCImmunizationCov/schoolagecoverage/default.htm]

7. **Immunization Uptake in Grade 9 Students, 2002-2013**. Vancouver, BC: BC Centre for Disease Control; 2013 [Available from http://www.bccdc.ca/imm-vac/BCImmunizationCov/schoolagecoverage/default.htm]



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Recent Research Work Undertaken with the BC Cancer Registry

In the Spotlight

For this year's *Spotlight* research report we highlight some of the unique work being led by Dr. Rob Olson, a BC Cancer Agency radiation oncologist and researcher, from the BCCA Centre for the North in Prince George. Two recently initiated studies that use the BC Cancer Registry data to better understand barriers and bottlenecks to care in Northern BC are described here.

Dr. Olson has undertaken a study that is looking at the time intervals between both symptoms to diagnosis, and diagnosis to treatment, for lung cancer patients diagnosed in northern BC. This study was motivated by reports based on BC Cancer Registry data that suggested lung cancer outcomes are significantly worse in northern BC. This study is unique, in that the former timeline (symptoms to diagnosis) is rarely reported in the literature. This is generally because of the difficulty in locating data on presenting symptoms and their dates. Obtaining this information for this study required a comprehensive review of each patient's chart. Initial results have demonstrated variation across regions of Northern Health, providing important data on where to focus interventions to improve delays in treatment.

A second study, also led by Dr. Olson, is focused on the remote island communities of Haida Gwaii (formerly the Queen Charlotte Islands).

Photo: Haida Gwaii Project Team Members (from left to right) Dr. Robert Olson, Caitlin Blewitt, Luke Hughson and Bill Clifford

This study is funded by the Canadian Breast Cancer Foundation and Vancouver Foundation. It will examine issues around bottlenecks and access to care using data from all residents of Haida Gwaii diagnosed with any cancer since 1969, including those not referred to the BCCA for care.

One of the unique aspects of this study is the linkage of data collected within Northern Health with the BC Cancer Registry data. Local clerical staff in Haida Gwaii were trained and joined the research team. They are entering data from Northern Health patient charts (the vast majority from deceased patients) into their electronic medical record (EMR). An upgrade was subsequently made to Northern Health's EMR allowing export of data into a useable format for research. Importantly, patients' status as First

Nations (the majority from the Haida First Nation) was confirmed and recorded, which will allow the comparison of the patient journey and outcomes between First Nations (FN) and non-FN populations. Haida Gwaii is a model community to explore difficulties faced by remote FN communities, for multiple reasons.

First, approximately half of the population is FN. Second, both FN and non-FN communities share similar difficulties of geographic isolation, allowing a comparison between FNs and non-FNs communities in Haida Gwaii. Therefore, this comparison will be able to better identify social and cultural factors specific to FN communities, rather than the influence of geographic isolation. Third, geographic remoteness and capture of the entire population's medical records allows for an ideal epidemiological model community where the entire population can be studied in finer detail than possible in large scale communities.

Early results from these novel studies are already being presented by the research teams with more final results expected to be published and presented over the coming few months.

CONCORD2 – Cancer Survival Study

This past year, data from the BC Cancer Registry were submitted to a global study of cancer survival called *CONCORD2*. The study was led by the *Cancer Survival Group*, a unit of *Cancer Research UK* that is located at the London School of Hygiene and Tropical Medicine in London, England. The purpose of the study was to estimate cancer survival rates for ten common adult cancers and childhood leukemia across more than 67 countries and more than 250 regions within these countries. In total the survival information from close to 26 million cancer cases was included in the study making this very likely the largest cancer survival study ever undertaken. Every Canadian province and territory took part in this study making Canada one of the only countries in the world that submitted data covering 100% of its territory.

Why do cancer registries participate in these projects?

Cancer survival is a key measure of the health of the cancer control system. In comparing our survival rates with other jurisdictions we are able to assess our health system performance and ensure the outcomes of people diagnosed with cancer in British Columbia remain high. By analyzing data from multiple regions within a single study, we have greater confidence that any observed differences in survival rates are reflective of the truth and not simply a result of how calculations and analyses may be done in different regions. Observed differences in cancer survival across regions might be a reflection of differences in the availability of treatments for cancer, the availability and success of cancer screening programs, or possibly the organization of health programs and services for those previously diagnosed with cancer.

In comparative studies of cancer survival, BC (and Canada as a whole) has generally demonstrated strong outcomes. This was also the case in the CONCORD2 study as data shown below in Table 5 and Figure 4 suggest. Table 5 below presents survival results for selected cancers and generally shows outcomes for BC are above the Canadian average. These results also compare well against other developed nations (Figure 4 for breast cancer; other data not shown).

Figure 4 below presents the survival estimates for breast cancer for G7 countries. The study suggested that breast cancer survival in Canada is comparable to most of the G7; Canada had the second highest survival for childhood leukemia among G7 nations (data not shown below).

For more information about the CONCORD2 study, see the Lancet publication online at: http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(14)62038-9/fulltext#sec1 or contact the BC Cancer Registry at registrydirector@bccrc.ca.

Figure 4: Five-year Net Survival Estimates for Breast Cancer for G7 Nations, 2005-2009

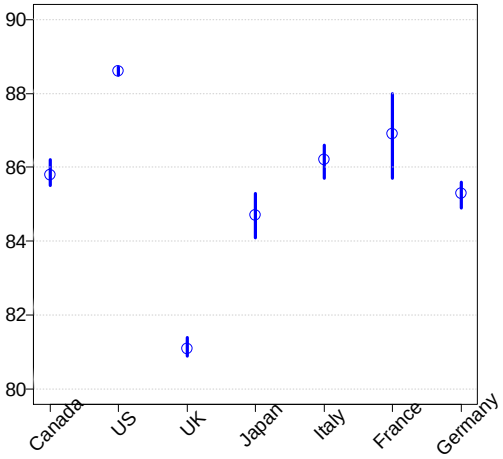

Table 5: Five-year Net Survival Estimates for Selected Cancers for British Columbia and Canada, 2005-2009

Cancer	British Columbia	Canada
Breast	88.1	85.8
Colon	64.0	62.8
Lung	17.2	17.3
Prostate	93.9	91.7
Childhood Leukemia	93.2	90.6

Data source: Allemani C, et al, Lancet, 2014

Dr. Andy Coldman Retires

This past year Dr. Andy Coldman, Vice President, Population Oncology at the BC Cancer Agency announced his retirement. Dr. Coldman first joined the BCCA in 1977 and soon after became internationally-known for his research work with Dr. James Goldie on mathematical models for chemotherapy resistance. Dr. Coldman was a skilled researcher who actively collaborated with clinical colleagues in conducting studies of patient outcomes and has an international reputation for his work in using data registries and models to evaluate population-based cancer screening programs. Dr. Coldman is the co-principal investigator for the HPV Focal Trial described earlier in this report. Dr. Coldman also played a significant leadership role at the BCCA, and among his responsibilities was the BCCA oversight of the BC Cancer Registry. The Registry is saddened to lose such an accomplished leader whose insights, ideas and experience in research and evaluation have been invaluable over the years. You will be missed Andy and we wish you the best!

Photo: Dr. Coldman (rear centre with tie) with colleagues in the early days of Cancer Control Research at the BC Cancer Agency in the 1980's

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Selected Recent Publications from Projects Undertaken with BC Cancer Registry Data

In August of this past year, the *Journal of the National Cancer Institute (JNCI)* released a monograph entitled:

"**Medical History, Lifestyle, Family History, and Occupational Risk Factors for Non-Hodgkin Lymphoma Subtypes: Pooled Analyses from the International Lymphoma Epidemiology Consortium.**"

Within this monograph were a number of studies co-authored by investigators at the BC Cancer Agency including several that used BC Cancer Registry data as part of the pooled analyses. Here are some examples of studies from this monograph that used the BC Cancer Registry data:

- Morton LM, Sampson JN, Cerhan JR et al. **Rationale and Design of the International Lymphoma Epidemiology Consortium (InterLymph) Non-Hodgkin Lymphoma Subtypes Project.** *J Natl Cancer Inst Monogr*. 2014 Aug; 2014(48):1-14.
- Bracci P, Moreno Y, Turner J, et al. **Medical History, Lifestyle, Family History, and Occupational Risk Factors for Marginal Zone Lymphoma: The Interlymph NHL Subtypes Project.** *J Natl Cancer Inst Monogr*. 2014 Aug; 2014(48):52-65.
- Aschebrook-Kilfoy B, Cocco P, et al. **Medical History, Lifestyle, Family History, and Occupational Risk Factors for Mycosis Fungoides and Sézary Syndrome: The InterLymph NHL Subtypes Project.** J Natl Cancer Inst Monogr. 2014 Aug; 2014(48):98-105.
- Morton LM, Slager SL, Cerhan JS et al. **Etiologic Heterogeneity Among NHL Subtypes: The InterLymph NHL Subtypes Project.** *J Natl Cancer Inst Monogr*. 2014 Aug; 2014(48):130-44.

The following are other examples of studies that were published in 2014 that used BC Cancer Registry data:

- Hamilton SN, Tyldesley S, Hamm J, et al. **Incidence of second malignancies in prostate cancer patients treated with low-dose-rate brachytherapy and radical prostatectomy.** *Int J Radiat Oncol Biol Phys*. 2014 Nov 15;90(4):934-41
- Vida S, Richardson L, Cardis E, et al. **Brain tumours and cigarette smoking: analysis of the INTERPHONE Canada case-control study.** *Environ Health*. 2014 Jun 27;13:55.
- Gaudet M, Hamm J, Aquino-Parsons C. **Incidence of ano-genital and head and neck malignancies in women with a previous diagnosis of cervical intraepithelial neoplasia.** *Gynecol Oncol*. 2014 Sep;134(3):523-6.
- Kobayashi LC, Janssen I, Richardson H, et al. **A case-control study of lifetime light intensity physical activity and breast cancer risk.** *Cancer Causes Control*. 2014 Jan;25(1):133-40.
- Berwick M, MacArthur J, Orlow I, et al. **MITF E318's effect on melanoma risk independent of but modified by other risk factors**. *Pigment Cell Melanoma Res*. 2014 [Epub ahead of print]

- Avina-Zubieta JA, Bhole VM, Amiri N, et al. **The Risk of Venous Thrombosis and Pulmonary Embolism in Giant Cell Arteritis: A General Population-Based Study**. *Ann Rheum Dis* Sept 29 2014; [Epub ahead of print]
- Chan E, Woods R, Virani S, et al. **Long term mortality from cardiac causes after adjuvant hypofractionated versus conventional whole breast radiotherapy for localized left-sided breast cancer**. *Radiotherapy and Oncology*, 2014 Sep 13 [Epub ahead of print]
- Auluck A, Walker BB, Hislop G, et al. **Population-based incidence trends of oropharyngeal and oral cavity cancers by sex among the poorest and underprivileged populations**. *BMC Cancer*. 2014 May 5;14:316.
- Huang J, Wai ES, Lau F, Blood PA. **Palliative radiotherapy utilization for cancer patients at end of life in British Columbia: retrospective cohort study**. *BMC Palliat Care*. 2014 Nov 18;13(1):49.
- Coldman A, Phillips N, Wilson C, et al. **Pan-Canadian study of mammography screening and mortality from breast cancer**. *J Natl Cancer Inst*. 2014 Oct 1;106.
- Tran H, Kwok J, Pickles T, et al. **Underutilization of local salvage therapy after radiation therapy for prostate cancer**. *Urol Oncol*. 2014 Jul;32(5):701-6.
- Cerhan JR, Berndt SI, Vijai J et al. **Genome-wide association study identifies multiple susceptibility loci for diffuse large B-cell lymphoma.** *Nat Genet*. 2014 Sep 28.[Epub ahead of print].
- Coldman AJ, Phillips N. **Breast cancer survival and prognosis by screening history.** *Br J Cancer*. 2014 Feb 4;110(3)556-9.
- Pataky R, Ismail Z, Coldman AJ, et al**. Cost-effectiveness of annual versus biennial screening mammography for women with high mammographic breast density**. J Med Screen. 2014 Dec;21(4):180-8.
- Skibola CF, Berndt SI, Vijai J et al. **Genome-wide association study identifies new follicular lymphoma susceptibility loci**. *Am J Hum Genet*. 2014 Oct 2;95(4):462-71.
- Taylor NJ, Reiner AS, Begg CB, et al. **Inherited variation at MC1R and ASIP and association with melanoma-specific survival**. *Int J Cancer* 2014 Nov 10; [Epub ahead of print]
- Berwick M, Reiner AS, Paine S, et al. **Sun exposure and melanoma survival: a GEM study**. *Cancer Epidemiol Biomarkers Prev* 2014 Jul 28; [Epub ahead of print]
- Le ND, Leung A, Brooks-Wilson A, Gallagher RP Swenerton KD, Demers PA, Cook LS. **Occupational exposure and ovarian cancer risk.** *Cancer Causes Control* 2014 Apr 12 [Epub ahead of print]
- Pataky R, Phillips N, Coldman AJ, Peacock S. **Cost-effectiveness of population-based mammography screening strategies by age range and frequency**. *J Cancer Policy*, 2014; 2(4):97-102
- Pataky R, Gulati R, Etzioni R, et al. **Is prostate cancer screening cost-effective? A microsimulation model of prostate-specific antigen-based screening for British Columbia, Canada**. *Int J Cancer*, 2014; 135(4):939-47.
- Sadetzki S, Langer CE, Bruchim R et al. **The MOBI-Kids Study Protocol: Challenges in Assessing Childhood and Adolescent Exposure to Electromagnetic Fields from Wireless Telecommunication Technologies and Possible Association with Brain Tumor Risk**. *Front Public Health*. 2014 Sep 23;2:124.

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Projects Underway in 2014 using BC Cancer Registry Data

BC Hepatitis Testers Cohort – A collaboration between PHSA agencies to inform hepatitis related cancer prevention

An exciting collaborative project (*The BC Hepatitis Testers Cohort*) including team members from two PHSA agencies got underway this past year to assess the burden of Hepatitis C (HCV) in the province of British Columbia (BC). The project, led by the BC Centre for Disease Control's Dr. Mel Krajden, aims to use de-identified linked laboratory and administrative health data to generate evidence to inform policy decisions and strategies for treatment and prevention of HCV in BC. Data from the BC Cancer Registry were provided to the linked-data resource and colleagues from the BC Cancer Agency will be collaborating on the project.

Why is it important to consider cancer when studying the burden of Hepatitis C in the province? It is well established that infection with HCV is a strong risk factor for some cancers such as liver cancer and lymphoma. Therefore, assessment for liver cancer is one of the important long term outcomes of HCV infection and successful treatment of HCV reduces the occurrence of this cancer. By using large, comprehensive, linked data sets we can study exactly how often individuals infected with HCV go on to develop different cancers and compare their incidence of disease with those not infected with HCV to better understand the "excess" of cancer associated with HCV infection. This can suggest how many cancers might be prevented by HCV treatments. This collaboration also provides an opportunity to gain a more detailed understanding of risk factors for specific cancers in this study population. Some opportunities exist to better our understanding of whether specific genotypes of HCV are more likely to result in cancer than others, and to see if certain virus genotypes favour specific cancers. This project will also be enable an examination of whether co-infection with other viral infections such as Hepatitis B and HIV modifies the risk of cancer in those infected with HCV. Some of these questions are difficult to explore in smaller study data sets and the large size of the linked data resource assembled for this project will enable the investigation of questions previously hampered by small study sample sizes.

For more information about this project please contact Dr. Naveed Janjua (naveed.janjua@bccdc.ca).

Population Data BC

The BC Cancer Registry continues to actively support Population Data BC, a multi-university resource that facilitates linkages of administrative health data for health research purposes. Researchers from across Canada apply to access de-identified data sets from the Cancer Registry and other health data sources for pre-specified research analyses. Successful applicants access the data via a remote log-in providing convenience to the researcher and strong privacy protection of the data being accessed.

In 2014, there were 22 studies active at Population Data BC that were using the BC Cancer Registry data with several others recently completed. Active studies from this past year have included investigations into cancer costing, cancer survivorship, cancer surgery wait-times, and cancer among individuals with other health conditions such as multiple sclerosis, rheumatoid arthritis and HIV.

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Examples of other projects that obtained approval to use BC Cancer Registry data in 2014

Researchers from a variety of health research disciplines apply to use data from the BC Cancer Registry and the projects listed below demonstrate the diversity of studies that make use of Cancer Registry data each year. The name of the principal investigator (PI) for the study is listed along with the study title.

- **Trends in systemic therapy use and cost in BC and Saskatchewan** (PI: Dr. S. Peacock)
- **An investigation into where prostate cancer patients obtain information and support** (PI: Dr. H. Carolan)
- **An investigation of pediatric melanoma in British Columbia** (PI: Dr. C. Verchere)
- **Personalized treatment of lymphoid cancer: British Columbia as model province** (PI: Dr. J. Connors)
- **Long-term health resource utilization and total economic burden following diagnosis of systemic autoimmune rheumatic diseases: a population-based study** (PI: Dr. A. Avina-Zubieta)
- **Exploring the impact of regionalization activities on patients undergoing high-risk, resource-intensive cancer surgery in Canada** (PI: Dr. C. Finley)
- **Risk factors for breast cancer subtypes** (PI: Dr. J. Spinelli)
- **A randomized controlled trial of an online support group for sexual distress due to gynecologic cancer** (PI: Dr. L. Brotto)
- **Applying biomarkers to long-term effects in child and adolescent cancer treatment (ABLE Team) thrombosis study** (PI: M. McBride)
- **A provincial database review of long term health outcomes of HIV uninfected children born to HIV infected mothers, and cellular aging and HIV comorbidities in women and children** (PI: Dr. P. Janssen)
- **An investigation of cervical cancer in women age 25 years or less in British Columbia** (PI: Dr. K. Ceballos)
- **Improving health system efficiency in tuberculosis prevention and control through targeted LTBI screening in the foreign-born** (PI: Dr. J. Johnston)
- **TNM staging and prognostic factors for neuroendocrine tumours of the small bowel, colon, appendix and rectum** (PI: Dr. H. Kennecke)

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A Snapshot of BC Cancer Statistics

Most Common Cancers, 2012 BC Males

Cancer	# New Cases
Prostate	3152
Lung	1501
Colorectal	1657
Bladder (includes in situ)	911
Non-Hodgkin Lymphoma	566
Melanoma (skin)	522
Kidney	401
Leukemia	377
Oral	345
Pancreas	299

- In 2012, there were 12,192 cancers diagnosed in BC males; 52% of these were cancers prostate, colon, rectum or lung
- In 2012, 4770 BC males died of cancer. Of these deaths, 1197 were due to lung cancer

Most Common Cancers, 2012 BC Females

Cancer	# New Cases
Breast	3198
Lung	1492
Colorectal	1364
Uterus	742
Melanoma (skin)	443
Non-Hodgkin Lymphoma	440
Ovary	316
Bladder (includes in situ)	293
Pancreas	281
Leukemia	247

- In 2012, there were 11,329 cancers diagnosed in BC females; 53% of these were cancers breast, colon, rectum or lung
- In 2012, 4337 BC females died of cancer of which 1059 died of lung cancer

For more BC Cancer Statistics please visit the BC Cancer Agency website at:
http://www.bccancer.bc.ca/health-info/disease-system-statistics/bc-cancer-statistics

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Appendix

Cancer Site Definitions

Table A1: Cancer grouping definitions for HPV special focus section

Cancer	ICDO-3 Site Codes
Anus	C21
Cervix	C53
Oral Cavity ("smoking-related oral cancer")	C020-C023,C028,C029,C030,C031,C039,C060-C062,C068,C069, C040,C041,C048,C049,C003-C005,C050-C052,C058,C059
Oropharynx ("HPV-associated oral cancer")	C090,C091,C098,C099,C019,C024,C102,C103,C108,C109
Penis	C60
Vagina	C52
Vulva	C51

Note: all invasive histology codes are included in these groups except: 95903-99923

Table A2: Cancer grouping definitions for other sections of this report

Cancer	ICDO-3 Site Codes
Prostate	C61
Lung	C34
Colorectal	C18, C19, C20, C26.0
Breast	C50
Bladder (includes in situ)	C67
Non-Hodgkin Lymphoma	Histology codes: Type 9590–9597, 9670–9719, 9724–9729, 9735, 9737, 9738; Type 9811-9818, 9823, 9827, 9837 all sites except C42.0, 42.1, 42.4
Melanoma (skin)	C44, histology 8720-8790
Kidney	C64-C65
Leukemia	Histology codes: Type 9733, 9742, 9800–9801, 9805-9809, 9820, 9826, 9831–9836, 9840, 9860–9861, 9863, 9865–9867, 9869–9876, 9891, 9895–9898, 9910, 9911, 9920, 9930–9931, 9940, 9945–9946, 9948, 9963–9964; Type 9811-9818, 9823, 9827, 9837 sites C42.0, 42.1, 42.4
Oral	C00-C14
Pancreas	C25
Uterus	C54
Ovary	C56
All Cancers	All invasive cancers to any site (C00-C80) and in situ bladder cases

Note: unless otherwise noted, all invasive histology codes are included in each grouping

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Analytic Methodology

Counts of new cancer cases are derived from the BC Cancer Registry. Population estimates used in the calculation of cancer rates were obtained from BC STATS and used PEOPLE Version 2013. Unless otherwise noted, all age-standardized rates are standardized to the 1991 Canadian population and are presented per 100,000 of population. The age-standardized cervical cancer rates from Figure 1 are however standardized to the 1960 World population for consistency with other global reports on cancer incidence.

Mortality rates and cancer deaths are derived from data provided by the BC Vital Statistics Agency.

Acknowledgements

The BC Cancer Registry would like to acknowledge the commitment of the many health care professionals who continue to provide active support to the Registry. We would also like to acknowledge the Vital Statistics Agency of British Columbia for their ongoing support in providing mortality information to the BC Cancer Registry which has enabled us to report on cancer mortality in our province and create mortality rate summaries such as those within this report.

We would again like to thank the members of the content advisory group who supported the special focus on HPV for their suggestions, feedback and content expertise contributed to this section.

Contact Information

If you would like more information about the BC Cancer Registry and any of our activities, please feel free to contact us. Additionally, if you have any questions or feedback on this report we would be happy to hear from you.

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