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The *Canada Communicable Disease Report* (CCDR) is a bilingual, peer-reviewed, open-access, online scientific journal published by the Public Health Agency of Canada (PHAC). It provides timely, authoritative and practical information on infectious diseases to clinicians, public health professionals, and policy-makers to inform policy, program development and practice.

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The picture on the cover of this issue shows an HIV virus in the blood stream attacking the immune system. Illustration by Shutterstock (https://www.shutterstock.com/image-illustration/3d-rendered-hiv-virus-blood-stream-766978168).

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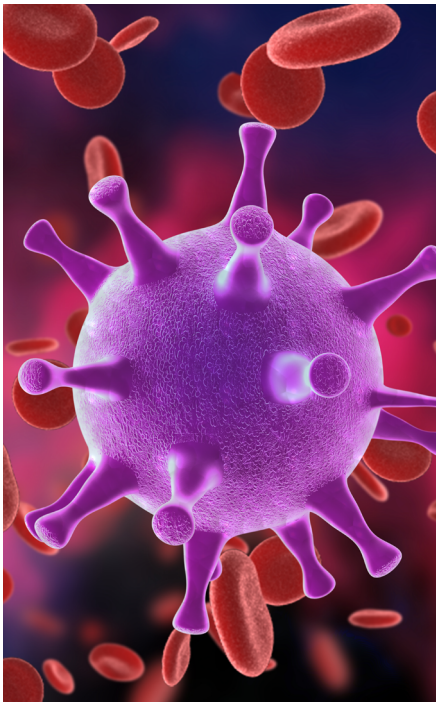
HIV



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HIV in Canada—Surveillance Report, 2018

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Abstract

Background: Human immunodeficiency virus (HIV) is a global public health issue, with an estimated 36.9 million people living with HIV in 2017. HIV has been reportable in Canada since 1985 and the Public Health Agency of Canada (PHAC) continues to monitor trends in new HIV diagnoses.

Objective: The objective of this surveillance report is to provide an overview of the epidemiology of all reported diagnoses of HIV in Canada since 1985 with a focus on 2018 overall, and by geographic location, age group, sex, and exposure category.

Methods: PHAC monitors HIV through the national HIV/AIDS Surveillance System, a passive, case-based system that collates nonnominal data that is voluntarily submitted by all Canadian provinces and territories. Descriptive epidemiological analyses were conducted on national data and those relating to specific populations provided by Immigration, Refugees and Citizenship Canada and the Canadian Perinatal HIV Surveillance Program.

Results: In 2018, a total of 2,561 HIV diagnoses were reported in Canada, an increase of 8.2% compared with 2017. The national diagnosis rate increased to 6.9 per 100,000 population in 2018 from 6.5 per 100,000 population in 2017. Saskatchewan reported the highest provincial diagnosis rate at 14.9 per 100,000 population. The 30–39 year age group continued to have the highest HIV diagnosis rate at 15.4 per 100,000 population. Overall, the diagnosis rate for males continued to be higher than that of females (9.8 versus 4.0 per 100,000 population, respectively); however, females experienced a larger increase in reported cases and diagnosis rate. The gay, bisexual and other men who have sex with men (gbMSM) exposure category continued to represent the highest proportion of all reported adult cases (41.4%), though the proportion has decreased over time. Five perinatal HIV transmissions were documented, three where related to the mother not receiving perinatal antiretroviral therapy prophylaxis.

Conclusion: The number and rate of reported HIV cases in Canada increased in 2018, gbMSM continued to account for the largest exposure category and the number and rate of reported HIV cases among women increased. PHAC will continue to work with its national partners to refine the collection, analysis and publication of national data to better understand the burden of HIV in Canada.

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Keywords: HIV, surveillance, gay, bisexual and other men who have sex with men, people who inject drugs, perinatal HIV, heterosexual contact, Canada

Introduction

Human immunodeficiency virus (HIV) remains a global public health issue. In 2017, the estimated number of people living with HIV had grown to 36.9 million (1). HIV has been reportable in Canada since 1985 and the Public Health Agency of Canada (PHAC) continues to monitor trends in new HIV diagnoses. In Canada in 2017, there were 2,402 newly reported HIV diagnoses with a diagnosis rate of 6.5 per 100,000 population (2), which is an increase from 2014 when the rate of new HIV diagnoses was 5.8 per 100,000 population (2). Moreover, an estimated $686.8 million was spent on HIV prevention and treatment in Canada in 2015, demonstrating a significant economic burden of disease (3).

Recently, PHAC released a Pan-Canadian framework for action and an associated five-year action plan on sexually transmitted and bloodborne infections, which detail the importance of a

common approach to addressing key populations disproportionately affected by these infections (4,5). Early HIV diagnosis and reporting is crucial for monitoring trends in newly diagnosed infections to inform and evaluate prevention and care programs (6–9).

The objective of this surveillance report is to provide an overview of the epidemiology of all reported diagnoses of HIV in Canada from 1985 to end of 2018, overall, as well as by geographic location, age group, sex and exposure category. As in previous reports, updated information on immigration medical screening results for HIV and on the number of infants perinatally exposed to HIV and perinatally infected with HIV are presented. This report will also discuss recent work completed by PHAC aimed at quantifying and explaining the effect of previously diagnosed cases of HIV on the trend of new HIV diagnoses in Canada (10). In addition, although PHAC has historically published surveillance reports pertaining to newly diagnosed cases of AIDS, PHAC is reporting 2018 AIDS cases through the Canadian Notifiable Disease Surveillance System (11) and, as such, AIDS cases will not be presented here.

It is important to keep in mind that surveillance data describe only the diagnosed portion of the HIV epidemic. National HIV estimates of prevalence and incidence that describe the overall HIV epidemic in Canada, including people with both diagnosed and undiagnosed HIV infection, are produced using statistical modelling and additional sources of information; these are published separately (12).

Methods

Data sources

The data presented in this HIV surveillance report come from three different sources: the national HIV/AIDS Surveillance System (HASS) maintained by PHAC; immigration medical screening for HIV by Immigration, Refugees and Citizenship Canada (IRCC); and the Canadian Perinatal HIV Surveillance Program (CPHSP).

HIV/AIDS Surveillance System

The HASS is a passive, case-based surveillance system that collates nonnominal data on persons diagnosed with HIV infection who meet the national case definition (13). Data, including but not limited to age, sex, race/ethnicity and risks associated with the transmission of HIV (exposure categories), are voluntarily submitted to PHAC from provincial and territorial public health authorities. For the purposes of this report, an "adult" is anyone aged 15 years or older.

It is important to note that Quebec does not submit exposure category or race/ethnicity information for HIV cases to PHAC, British Columbia does not submit race/ethnicity information for HIV cases to PHAC and Ontario has no race/ethnicity data available for reported HIV cases prior to 2009. In addition, for 2018, Saskatchewan attributed cases to being Indigenous or non-Indigenous only with respect to race/ethnicity without further breakdown.

Provinces and territories provide data through the National Case Report Form (14) or through a secure electronic dataset transmission. All raw data (paper forms and electronic datasets) are retained in compliance with the Directive for the Collection, Use and Dissemination of Information relating to Public Health (*PHAC, 2013, unpublished document*). Data quality assessment, such as the detection of duplicate entries, is handled by the provinces and territories prior to submission to PHAC. The data presented in this surveillance report represent newly reported HIV cases diagnosed on or before December 31, 2018, that were submitted by provincial and territorial surveillance programs to PHAC up to July 12, 2019. Additional details on the HASS's methods can be found elsewhere (2,14).

Immigration medical screening for HIV

All foreign nationals 15 years of age and older applying for permanent residence and some applying for temporary residence in Canada must undergo an Immigration Medical Exam (IME) administered by IRCC, either in Canada or overseas. IRCC provides PHAC with nonnominal data collected during the IME on migrants who tested positive for HIV, either in Canada or overseas. The term "migrant" is used broadly and includes the following: immigrants (permanent residents of Canada); refugees; refugee claimants or convention refugees; and temporary residents (visitors, students or foreign workers). The IME data presented here were obtained from IRCC's Global Case Management System, updated to March 2019, which contains the IME information for all applicants screened in Canada or overseas who tested positive for HIV. Aggregate data were provided to PHAC in July 2019. The data presented in this report focus on those tested in Canada.

IRCC shares nominal data from overseas IME test results with provinces and territories for all clients who have been diagnosed as having HIV and have a valid Canadian residential address on file that indicates their current province/territory of residence. These data may subsequently be incorporated, to varying degrees, into the provincial/territorial routine HIV case-based surveillance systems, with some jurisdictions reporting these HIV-positive migrant cases as a new diagnosis and others excluding them from provincial/territorial reporting to PHAC.

Canadian Perinatal HIV Surveillance Program

National data on the HIV status of infants exposed perinatally to HIV infection are collected through the CPHSP, an initiative of the Canadian Paediatric AIDS Research Group. The CPHSP is a sentinel-based active surveillance system that collects data on two groups of children: infants born to HIV-positive women and HIV-infected children receiving care at any participating site (whether born in Canada or abroad). Additional information on CPHSP methodology has been described previously (2).

Surveillance data for 2018, including data updates for previous years, were submitted to PHAC in March 2019.

Analysis

Descriptive trends overall and by geography, age group, sex, exposure category and key population are presented. Microsoft Excel 2010 (Redmond, Washington, United States [US]) and SAS Enterprise Guide v7.1 (Cary, North Carolina, US) software were used for data cleaning and analysis. Standardized data recoding procedures were applied to all submitted provincial and territorial datasets to create a national dataset for analysis. The surveillance data presented in this report were validated by all provinces and territories to ensure accuracy. No statistical procedures were used for comparative analysis, nor were any statistical techniques applied to account for missing data since analyses were limited to cross-tabulations due to the descriptive nature of the analysis. The proportions presented in the text exclude records with missing values unless otherwise noted.

The population data source used to calculate rates was the Annual Demographic Statistics, issued by Statistics Canada in July 2018 (15).

Supplementary tables are listed in the **Appendix** and are available upon request.

Results

Overall trends

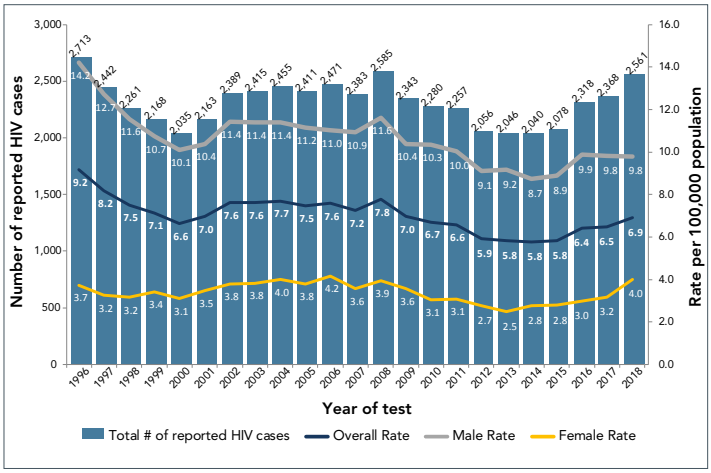
A cumulative total of 88,881 HIV diagnoses have been reported to PHAC since HIV reporting began in Canada in 1985. In 2018, a total of 2,561 HIV diagnoses were reported, an increase of 8.2% compared with 2017. The national diagnosis rate has fluctuated over the years with a downward trend between 2008 and 2015, followed by slight increases to 6.9 per 100,000 population in 2018 (**Figure 1**).

Since 2009, the diagnosis rates for males and females have fluctuated. For males, there has been a slight decrease since 2009 (10.4 per 100,000 population in 2009 to 9.8 per 100,000 population in 2018). For females, the rate of HIV diagnoses has fluctuated between 2.5 and 4.2 per 100,000 population since 1996. In the last five years, the rate increased: 2.5 in 2013, 3.2 in 2017 and 4.0 in 2018, always per 100,000 population.

Geographic distribution

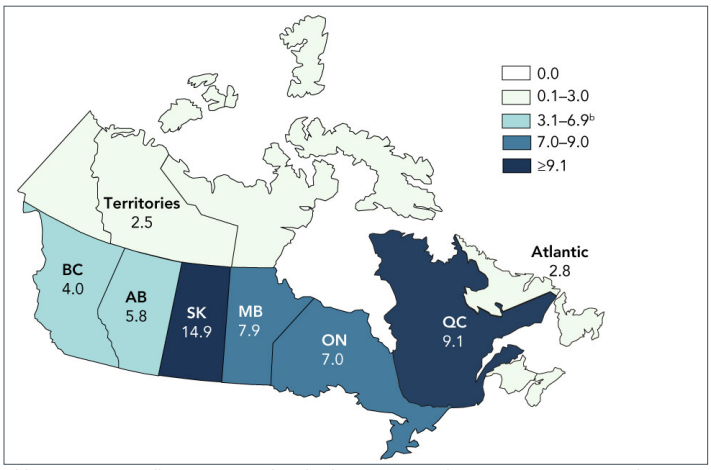
In 2018, Ontario accounted for the highest number and proportion of reported HIV cases in Canada (n=1,003, 39.2%), followed by Quebec (n=766, 29.9%), Alberta (n=249, 9.7%) and British Columbia (n=199, 7.8%). As in 2017, the provincial and territorial rates of reported HIV diagnoses varied across Canada. Saskatchewan continued to have the highest diagnosis rate at 14.9 per 100,000 population, although the province accounted for only 6.8% of the total number of reported HIV cases. Quebec had the second highest diagnosis rate at 9.1 per 100,000 population followed by Manitoba (7.9 per 100,000 population), and Ontario (7.0 per 100,000 population) (**Figure 2**). Increases in the rate of HIV diagnoses were observed in Quebec, Manitoba and Ontario (from 8.1, 6.7 and 6.5 per 100,000 population in 2017, respectively), while Saskatchewan and Alberta experienced decreases (from 15.6 and 6.8 per 100,000 population in 2017, respectively). An increase was observed in the diagnosis rates for females in British Columbia, Saskatchewan, Manitoba, Ontario and Quebec from 2017 to 2018.

Figure 1: Number of reported cases of HIV and diagnosis rates overall, by sex and year, Canada, 1996–2018[a]



[a] Overall rate includes cases where sex is transgender, transsexual, not reported or unknown

Figure 2: HIV diagnosis rate, (per 100,000 population) by province and territory, Canada, 2018[a]



Abbreviations: AB, Alberta; BC, British Columbia; MB, Manitoba; ON, Ontario; QC, Quebec; SK, Saskatchewan; ≥, greater than or equal to

[a] Rates for the territories (Yukon, Nunavut, and Northwest Territories) and Atlantic region (Prince Edward Island, New Brunswick, Nova Scotia and Newfoundland and Labrador) are presented as averages

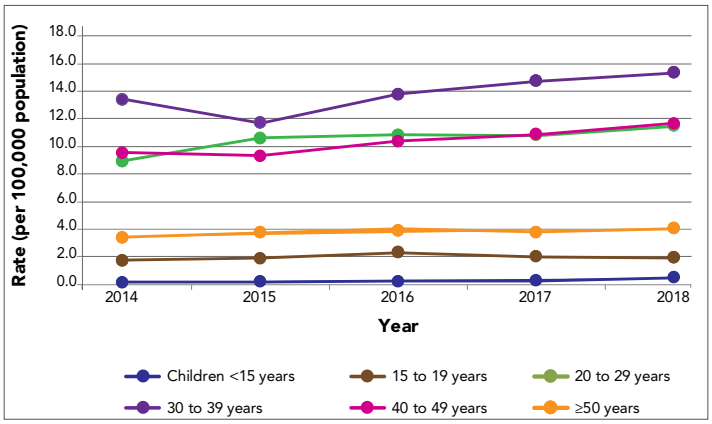
[b] National rate of 6.9 cases per 100,000 population

Age group and sex distribution

In 2018, data on age groups were available for nearly 100% (n=2,558) of all reported HIV cases. The 30–39 year age group continued to have the highest number and proportion of reported HIV cases (n=778, 30.4%), which is similar to 2017. The ≥50 and 20–29 year age group presented the second highest proportion of reported HIV cases at 22.5% for each age group (n=576 and n=575, respectively). This was followed by the 40–49 year age group (n=559, 21.9%). The 15–19 age group and children (less than 15 years of age) represented 1.6% and 1.1% of new HIV diagnoses, respectively.

Accordingly, the 30–39 year age group had the highest rate of reported HIV cases at 15.4 per 100,000 population (**Figure 3**). The 40–49 year age group had the second highest rate at 11.7 per 100,000 population, followed by the 20–29 year age group at 11.5 per 100,000 population. The 20–29 year and 40–49 year age groups have had similar rates since 2016. Overall, the diagnosis rates for children (less than 15 years of age), the 15–19 year age group, and those who are 50 years of age or older remained relatively stable over the last five years.

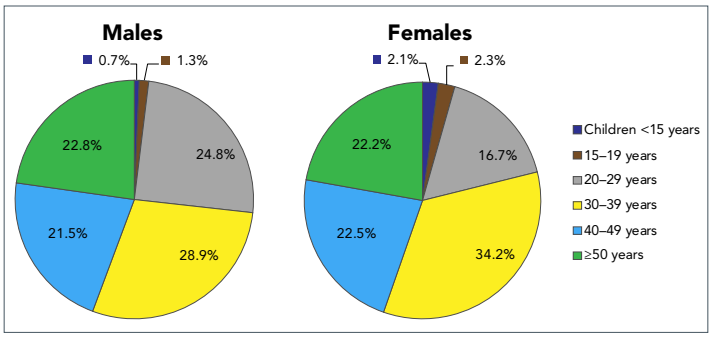
Figure 3: HIV diagnosis rate, by age group and year, Canada, 2014–2018[a]



Abbreviations: <, younger than, ≥ older than or equal
[a] Excludes cases where age is not reported or unknown
Population data source: Annual Demographic Statistics, Statistics Canada (15)

In 2018, data on sex were available for nearly 100% (n=2,552) of all reported HIV cases. Males accounted for 70.7% of them, while females accounted for 29.3%. This is a slight change in the proportion between sexes when compared with 2017, where males accounted for 75.3% of reported HIV cases and females accounted for 24.7%, where sex was known. The 30–39 year age group had the highest proportion of HIV cases in both males (n=521, 28.9%) and females (n=256, 34.2%) (**Figure 4**). The proportions of HIV cases in the 40–49 year and ≥50 year age groups were similar for both males and females. However, the proportion of HIV cases was lower in females for the 20–29 year age group and higher in both the 15–19 year and <15 year age groups.

Figure 4: Proportion of new HIV cases, by age group and sex, Canada, 2018[a,b]



Abbreviations: <, younger than; ≥, older than or equal
[a] Excludes cases where sex is transsexual, transgender, not reported or unknown
[b] Excludes cases where age is not reported or unknown

Similar to the overall trend, when stratifying by sex the highest diagnosis rates were observed in the 30–39 year age group at 20.5 per 100,000 population for males and 10.1 per 100,000 population for females. When observing the rates in other age groups, the 20–29 and the 40–49 year age groups had the second and third highest diagnosis rates in males at 17.2 and 16.4 per 100,000 population, respectively. The opposite trend was observed in the female population where the 40–49 year age group had the second highest diagnosis rate at 7.0 per 100,000 population, followed by the 20–29 year age group with a rate of 5.2 per 100,000 population.

Overall, since 2014, males aged 20–29 years old experienced the highest increase in HIV diagnosis rates; whereas in females, those aged 30–39 years had the highest increase in HIV diagnosis rates, followed by the 40–49 year age group.

Exposure category distribution

Trends in exposure category have shifted since HIV reporting began in 1985. Over the years, although the gay, bisexual and other men who have sex with men (gbMSM) exposure category has continued to account for the highest proportion of cases, the proportion has decreased over time. In 2018, among all cases where exposure category was known (n=1,462, 57.1%), 41.4% of all reported cases in adults (n=600 of 1,450) were attributed to the gbMSM exposure category (**Table 1**). This was a decrease from 46.6% in 2017. The second most reported exposure category among adults continued to be heterosexual contact at 32.3% of adult cases with known exposure, and a shift was observed in the distribution of the proportions for each heterosexual contact subgroup in the past five years. The proportion of the three heterosexual subgroups was almost equal in 2014, with an average of 9.6%, whereas in 2018, this distribution varied with 15.4% attributed to heterosexual contact among people born in a country where HIV is endemic (Het-Endemic), 6.2% among heterosexual contact with a person at risk (Het-Risk) and 10.7% among heterosexual contact with no identified risk (Het-NIR). People who inject drugs (PWID) accounted for the third most frequently reported exposure category among adults in 2018 at 18.3% (Table 1).

Table 1: Number and proportion of HIV cases (≥15 years of age) by sex and exposure category, Canada (excluding Quebec), 2017–2018[a–e]

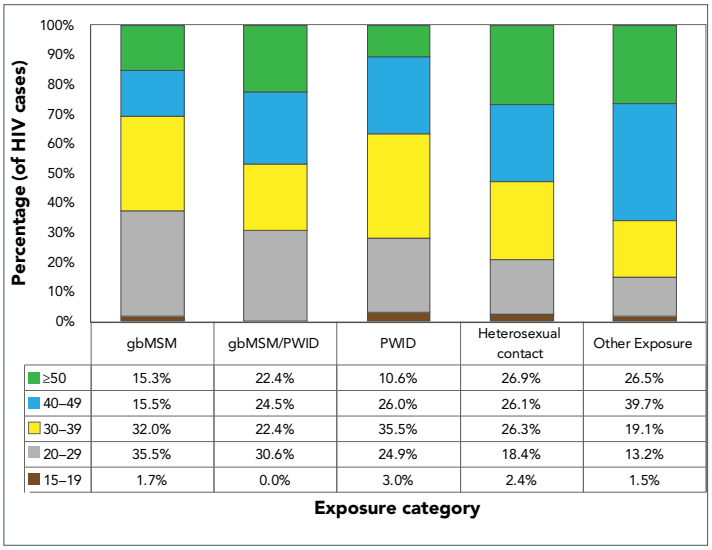
Exposure category	2017						2018					
	Male		Female		Total[a]		Male		Female		Total[a]	
	n	%	n	%	n	%	n	%	n	%	n	%
gbMSM	667	61.0	n/a	n/a	667	46.6	600	58.1	n/a	n/a	600	41.4
gbMSM/PWID	39	3.6	n/a	n/a	39	2.7	49	4.7	n/a	n/a	49	3.4
PWID	138	12.6	93	27.6	232	16.2	146	14.1	118	28.4	265	18.3
Heterosexual contact	204	18.6	207	61.4	412	28.8	200	19.4	266	64.1	468	32.3
a) origin from an HIV endemic country	62	5.7	105	31.2	167	11.7	82	7.9	140	33.7	223	15.4
b) sexual contact with a person at risk	51	4.7	46	13.6	98	6.8	37	3.6	52	12.5	90	6.2
c) no identified risk	91	8.3	56	16.6	147	10.3	81	7.8	74	17.8	155	10.7
Other[b]	46	4.2	37	11.0	83	5.8	37	3.6	31	7.5	68	4.7
Subtotal[c]	1,094	100.0	337	100.0	1,433	100.0	1,032	100.0	415	100.0	1,450	100.0
No identified risk[d]	60	3.4	8	1.4	69	2.9	54	3.0	22	3.0	77	3.0
Exposure category unknown or not reported ("missing")[e]	613	34.7	230	40.0	846	36.0	703	39.3	295	40.3	1,002	39.6
Total	1,767	n/a	575	n/a	2,348	n/a	1,789	n/a	732	n/a	2,529	n/a

Abbreviations: gbMSM, gay, bisexual and other men who have sex with men; n/a, not applicable; PWID, people who inject drugs
[a] Total column includes transsexual, transgender and cases where sex was not reported, whereas "male" and "female" columns exclude these cases
[b] Other`` includes cases from Alberta identified through Immigration Refugees and Citizenship Canada, blood/clotting, and other exposure categories
[c] Proportions are based on the subtotal count for known exposure category
[d] No identified risk: Used when the history of exposure to HIV through any of the other modes listed is unknown, or there is no reported exposure history (e.g. because of death, or loss to follow-up) (14)
[e] Includes all cases where exposure category was unknown or not reported. As exposure category information was not submitted by Quebec, new HIV diagnoses reported by Quebec are included here

Analysis of the exposure category variable was done separately for males and females since the gbMSM exposure category only applies to males. Among adult males in 2018, the gbMSM exposure category accounted for the highest proportion (58.1%) of reported cases, and in adult females, exposure through heterosexual contact accounted for the highest proportion at 64.1% (33.7% Het-Endemic, 12.5% Het-Risk and 17.8% Het-NIR). In addition, PWID accounted for a little over a quarter of adult female HIV cases (28.4%) compared to 14.1% among adult males (Table 1).

In 2018, more than one third of reported gbMSM HIV cases were between 20–29 years of age (35.5%) and around one third were aged 30–39 years (32%) (**Figure 5**). Similarly, 30.6% of gbMSM/PWID cases were 20–29 years of age, and a similar distribution was observed for cases aged 30–39 years, 40–49 years and those ≥50 years (22.4%, 24.5% and 22.4%, respectively). Among the PWID risk group, cases were reported among a slightly older age group compared to gbMSM and gbMSM/PWID with 35.5% of cases aged 30–39 years. Cases reported within the heterosexual contact exposure category were evenly distributed among the 30–39, 40–49 and ≥50 year age groups (26.3%, 26.1% and 26.9%, respectively).

Figure 5: Proportion of reported HIV cases (≥15 years of age) by exposure category and age group, Canada, 2018[a,b]



Abbreviations: gbMSM, gay, bisexual and other men who have sex with men; PWID, people who inject drugs; ≥, older than or equal
[a] Excludes cases where exposure category was "not reported"
[b] "Other exposure" category includes cases from Alberta identified through Immigration Refugees and Citizenship Canada, blood/clotting, and other exposure categories

Race/ethnicity information

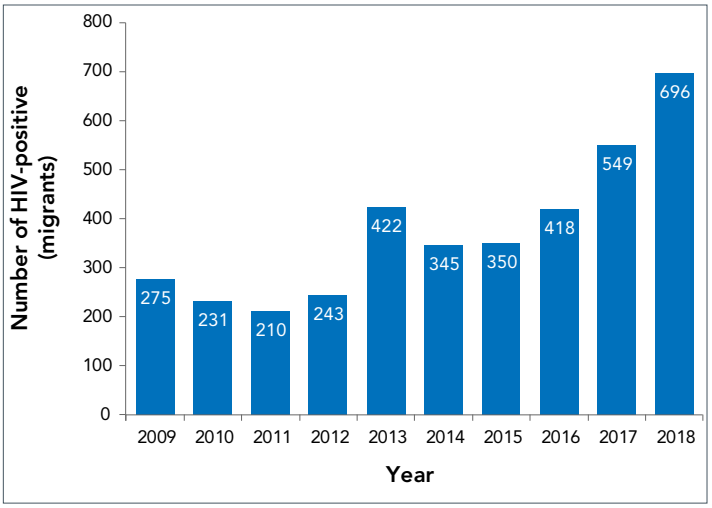
Over the years, the extent of completion of national data for race/ethnicity has varied. Race/ethnicity is not presented in this report, as it has been in previous reports, for two main reasons. First, race/ethnicity information was available for less than half of reported HIV cases in 2018 (n=1,196, 46.7%, excluding Quebec and British Columbia). In addition, in 2018 for the first time, Saskatchewan attributed cases to two categories only: Indigenous and non-Indigenous, with no further breakdown. Secondly, due to Canada's population diversity and recent changes to Statistics Canada's methodology for categorizing ethnic origin (16), the current categories for race/ethnicity may need to be reassessed.

Of the cases with known race/ethnicity information, 19.3% were reported as Indigenous and 80.7% were reported as other races/ethnicities. These results are similar to those seen in 2017, when 20.1% were reported as Indigenous and 79.9% as other races/ethnicities.

Immigration medical screening for HIV

In 2018, a total of 1,026 migrants tested positive for HIV through the IME. Of these, 696 were tested in Canada (**Figure 6**) and 330 were tested overseas. This is an increase from 2017, when a total of 835 migrants tested positive on an IME, with 549 tested in Canada. Migrants who tested positive on the IME in Canada are highlighted in this report because these individuals are tested within the provincial/territorial public health systems and are therefore captured in the HASS.

Figure 6: Number of migrants who tested positive for HIV during an Immigration Medical Exam conducted in Canada, 2009–2018



Of applicants tested in Canada from 2009 to 2018, a total of 3,739 migrants were diagnosed with HIV with an average of 374 per year (range 210–696). Slightly more than half of the HIV-positive migrants tested in Canada in 2018 were male (57.0%) and the majority of all applicants tested in Canada were 30–39 years old (39.8%), followed by 40–49 years old (26.4%). Individuals aged 20–29 years old, or ≥50 years accounted for 16% each of the total. The majority of HIV positive applicants resided in Ontario (52.7%) and Quebec (29.3%).

Canadian Perinatal HIV Surveillance System

There were 259 infants perinatally exposed to HIV in Canada in 2018. Of these, five infants were confirmed to be infected with HIV. Among these five infants, three were born to mothers who did not receive perinatal antiretroviral therapy (ART) prophylaxis and two were born to mothers who received perinatal ART prophylaxis. The number of infants perinatally exposed and confirmed to be infected with HIV has fluctuated slightly since 2011, but remained within the range of two to nine confirmed infected infants per year. The percentage of HIV-positive mothers receiving ART remained relatively stable in the last two years at 95.9% in 2017 and 96.5% in 2018.

In 2018 the most frequently reported exposure for mothers continued to be heterosexual contact at 75.0%, followed by PWID at 20.1%. With respect to the racial/ethnic origin of the mothers, 54.4% of perinatally exposed infants were born to mothers identified as Black in 2018. This was followed by 22.8% and 16.2% of HIV-exposed infants born to Indigenous and Caucasian mothers, respectively. The maternal region of birth for the majority of infants perinatally exposed to HIV in 2018 was Africa (45.2%) followed by North America (39.8%).

Discussion

In Canada, 2,561 HIV diagnoses were reported in 2018. This is an increase of 8.2% compared with 2017, and an overall increase of 9.3% in the last decade. The national diagnosis rate in 2018 was 6.9 per 100,000 population, a slight increase from 6.5 per 100,000 in 2017. It is difficult to situate Canada's 2018 HIV diagnosis rate among other high income countries as most of them have not yet released their 2018 HIV surveillance data. With respect to 2017 data, rates of new HIV diagnoses varied between countries; for instance, the US, Australia and the United Kingdom reported national rates of 11.8, 4.0 and 6.7 per 100,000 population, respectively (17–19), compared with 6.5 per 100,000 population in Canada in 2017.

As previously discussed (2), the increase in the number of new HIV diagnoses observed since 2014 in Canada may be due to several factors: an increase in HIV transmission (i.e. HIV incidence); an increase in HIV testing; changes in reporting practices; and/or an increase in the number of HIV-positive people migrating to Canada who are either testing positive for HIV for the first time in Canada or are re-testing in Canada (Figure 6). Data from IRCC indicate that while the proportion of migrants with positive HIV test results on their IME has remained relatively stable in recent years, the overall number of people migrating to Canada has increased. Of the 696 migrants who tested positive for HIV during in-Canada IMEs in 2018, it is not known how many were infected with HIV overseas versus in Canada, since the time between arrival in Canada and undergoing an IME varies. This distinction between HIV being acquired overseas versus in Canada is important because the focus of national surveillance is examining the epidemiology of domestic HIV transmission. Although a migrant who was infected overseas may be testing positive for the first time in Canada (and this information is important for measures of HIV prevalence and health services planning), counting the case as a "new" diagnosis complicates the interpretation and use of the national diagnosis rate as an indicator of domestic transmission. Other organizations such as the European Centre for Disease Prevention and Control are developing methods to distinguish between these two groups, and PHAC hopes to continue working with IRCC to follow suit.

A first step in identifying (and separating out from national HIV surveillance counts) migrants who were infected with HIV outside of Canada is identifying individuals who report a previous diagnosis of HIV in another country. PHAC recently analyzed national data between 2007 and 2017 to identify cases using a common definition of "previous HIV-positive test result" to quantify the effect of all previously diagnosed cases, whether in another country or another province, on the national trend. The percent increase in HIV diagnoses over this time period

decreased from 16% (reported in the previous annual surveillance report) (2) to 9% when previously diagnosed cases were removed (10). Moving forward, future national surveillance reports will present trends of new HIV diagnoses (not known to be previously diagnosed) separately from all HIV diagnoses. Continuation of this work will refine the number and rate of new diagnoses, leading to more precise information about transmission of HIV within Canada.

As reported historically, the gbMSM exposure category remains the largest proportion of new HIV diagnoses and accounted for over half of adult male cases (58.1%) in 2018. However, the proportion of gbMSM cases has declined over time. Moreover, since 1996, the rate of HIV diagnoses in females has fluctuated between 2.5 to 4.2 per 100,000 population. In the last five years, the rate has increased from 2.5 to 4.0 per 100,000 population in 2018. The provinces of British Columbia, Saskatchewan, Manitoba, Ontario and Quebec observed increased rates in the female population in 2018 when compared with 2017. Increased rates in females have not been observed in other high income countries: diagnosis rates among females in Australia have been stable with the highest rates among women aged 30–39 years old (19), and the US and the United Kingdom both reported a decrease in the diagnosis rates for women (17,18). This increase among females in Canada is observed across all exposure categories and future data will help determine its significance.

Strengths and limitations

The main strength of this report is that it is the only source of national epidemiological data on all reported HIV diagnoses in Canada.

Limitations of HASS have been described previously (2,14). One limitation to note is the variation in reporting of previously diagnosed cases among the provinces and territories; the inclusion of some of these cases has likely led to an over counting of new HIV diagnoses in Canada (10). Future surveillance information will include methods to mitigate this limitation. Additionally, conclusions on race/ethnicity of newly reported HIV diagnoses in 2018 could not be made due to missing data from provincial/territorial submissions. Moving forward, PHAC will work with its surveillance partners to improve race/ethnicity information to understand these trends among those newly diagnosed with HIV.

Data in this report are considered provisional and may be subject to change in future HIV surveillance reports. If there are discrepancies between the data summarized in this report and provincial and territorial reports, the most recent provincial and territorial report should be used because updated national data may still be pending.

Conclusion

The number and rate of reported HIV cases in Canada increased in 2018 and this may be due in part to cases who were diagnosed for the first time within a province and territory but had been previously diagnosed either in other provinces or from outside the country. The gbMSM exposure category continued to account for the highest exposure category proportion of HIV in Canada, although this proportion has decreased. The number and rate of new diagnoses increased among women in all exposure categories. PHAC will continue to work with provinces and territories to more accurately describe the trends in HIV transmission occurring in Canada, including the identification of previously diagnosed cases.

Authors' statement

NH — Conceptualization, research, writing, original draft, final draft, review, editing, data validation, visualization, supervision
AR — Data management, data validation, research
AW — Data validation, editing, research
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Appendix: List of supplementary tables

These tables are available upon request at: phac.hass.aspc@canada.ca.

Table S1: HIV diagnosis rate (per 100,000 population) by province/territory and year of diagnosis (all ages)

Table S2: Number of HIV cases (all ages) by province/territory, sex and year of diagnosis—Canada, 1985–2018

Table S3: Number of HIV cases by age group and province/territory—Canada, 2017–2018

Table S4: Cumulative number of HIV cases among adults (≥15 years old) and children (<15 years old) by sex—Canada, between November 1, 1985 and December 31, 2018

Table S5: Number of HIV cases among adults (≥15 years old) by year of diagnosis and sex—Canada, 1985–2018

Table S6: Number of HIV cases by age group, sex and year of diagnosis—Canada, 1985–2018

Table S7: Number and percentage distribution of HIV cases among adults (≥15 years old) by exposure category and year of diagnosis—Canada, 1985–2018

Table S8: Number and percentage distribution of HIV cases among adult males (≥15 years old) by exposure category and year of diagnosis—Canada, 1985–2018

Table S9: Number and percentage distribution of HIV cases among adult females (≥15 years old) by exposure category and year of diagnosis—Canada, 1985–2018

Table S10: Number and percentage distribution of HIV cases among adults (≥15 years old) by exposure category and age group—Canada, 2016–2018

Table S11: Number of HIV cases by exposure category and province/territory—Canada, 2016–2018

Table S12: Number and percentage distribution of immigration applicants to Canada diagnosed with HIV as a result of an Immigration Medical Exam by year—2002–2018

Table S13: Number and percentage distribution of immigration applicants to Canada diagnosed with HIV as a result of an Immigration Medical Exam by sex, age group and province—2002–2018

Table S14: Number of perinatally HIV-exposed infants by year of birth, current status and use of antiretroviral therapy for prophylaxis—Canada, 1984–2018

Table S15: Number of perinatally HIV-exposed infants by maternal exposure category and year of infant birth—Canada, 1984–2018

Table S16: Number of perinatally HIV-exposed infants by ethnic status and infection status—Canada, 1984–2018

Table S17: Number of perinatally HIV-exposed infants by maternal country of birth and infection status—Canada, 1984–2018

Table S18: Number of perinatally HIV-exposed infants by geographic region and status at last report—Canada, 1984–2018

Table S19: International statistics on reported HIV cases—Canada, 2017

Table S20: Rates of HIV cases by age group, sex and year of diagnosis—Canada, 2014–2018

Improving national surveillance of new HIV diagnoses

N Popovic[1]*, Q Yang[1], N Haddad[1], A Weeks[1], C Archibald[1]

Abstract

The purpose of national HIV surveillance is to track and summarize trends in newly diagnosed cases as an indicator of HIV transmission within Canada, and supports the development and evaluation of programs and policies for prevention, testing and delivery of care. Accurately capturing and interpreting trends in HIV diagnoses within national surveillance becomes complicated when there is movement of people within a country or when individuals are diagnosed with HIV prior to migrating to a new country. This has been identified as an issue in other countries, including Australia, New Zealand and Switzerland. The Public Health Agency of Canada (PHAC) recently assessed this in Canada after noting a rise in new HIV cases in Canada between 2014 to 2017. An environmental scan was conducted to better understand how new and previously diagnosed cases of HIV were recorded by and reported to PHAC from provincial and territorial (PT) public health authorities. It was discovered there was variation with respect to the reporting of cases who had received a new diagnosis of HIV within the province or territory, but who had previously received an HIV diagnosis from another PT or another country. Five PTs included cases previously diagnosed in another Canadian PT within the HIV surveillance data reported to PHAC and nine PTs included people who were diagnosed with HIV outside of Canada. The provincial and territorial public health authorities then reviewed HIV surveillance data from 2007 to 2017 to identify cases using a common definition of "previous HIV-positive test result". This included any case who gave a history, or had laboratory evidence, of an HIV-positive result from another PT or another country before presenting for care in the province or territory where they now resided. When these cases were subtracted from the total, a revised number of new HIV diagnoses was calculated for Canada. Re-analysis of surveillance data using this common definition for 2007 to 2017 explained more than half of the increase in HIV cases that had been documented in Canada over the last four years. In the future, national surveillance data will be calculated adopting this new common definition of a previous positive test result, in order to more accurately describe the trends in HIV transmission occurring in Canada.

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Keywords: HIV, AIDS, epidemiology, surveillance

Introduction

In Canada, national HIV surveillance is conducted by the Public Health Agency of Canada (PHAC) through the annual voluntary submission of data on new HIV diagnoses by all Canadian provinces and territories (PTs) (1). The purpose of national HIV surveillance is to track and summarize trends in newly diagnosed cases as an indicator of HIV transmission within Canada, which supports the development and evaluation of programs and policies for prevention, testing, and delivery of care. Within national HIV surveillance, a new HIV diagnosis is defined as a person's first HIV positive test result in Canada. However, variations existed regarding how people previously diagnosed with HIV in other PTs or other countries were reported by PTs, especially when there was no laboratory report available. Depending on whether these cases are included or not can affect the trends in new HIV diagnoses.

The challenge in counting people who have received a diagnosis of HIV and then move to a new place and received care in that area, has been dealt with in different ways internationally. For example, both Australia and New Zealand collect information on where a person was first diagnosed with HIV (i.e. in the country versus overseas), but report this information in different ways in their respective surveillance reports (2,3). New Zealand includes previous positive overseas diagnoses in their annual HIV case counts, whereas Australia excludes them and presents them separately, to provide a more accurate representation of the

transmission occurring within the country. In contrast, Switzerland reports on the HIV status of foreign nationals now living in the country, but does not provide any distinction as to whether or not the person was diagnosed prior to arrival in the country (4). The European Centre for Disease Prevention and Control includes a separate section within its surveillance report on the probable region of infection; however, these cases are included in overall surveillance counts (5).

In Canada, the number of reported HIV cases increased by 16% from 2014 to 2017 (1). There are a number of possible explanations for this increase, including increased testing, increased HIV transmission (1), and possible variations in reporting practices such as the inclusion of HIV cases moving into a new province or territory and the number of HIV-positive people migrating to Canada. For example, a person who has his/her first HIV diagnosis in province A is reported to PHAC as a new HIV diagnosis. If this person then moves to province B and is retested for HIV when they enter care, this test result may again be reported to PHAC as a new diagnosis by province B, if province B is not aware or does not report to PHAC that this person was previously diagnosed elsewhere. The PTs do not report personal identifiers, so PHAC is unable to delete duplicate case reports at the national level. In addition, PTs may have information on people migrating to Canada who have been previously diagnosed with HIV in another country, either through the person reporting his/her previous diagnosis to their health care provider or through HIV testing as part of the Immigration Medical Exam conducted by Immigration, Refugees and Citizenship Canada. Persons who have been previously diagnosed with HIV in another country could be reported to PHAC's national surveillance as a new HIV diagnosis if the health care provider is not aware that the person was previously diagnosed with HIV or if the health care provider does not report this information to public health.

This article describes an initial analysis completed by PHAC in collaboration with all the PTs, to evaluate the impact on the national trend of new HIV diagnoses in Canada when a common definition and methodology is used for previously diagnosed cases of HIV.

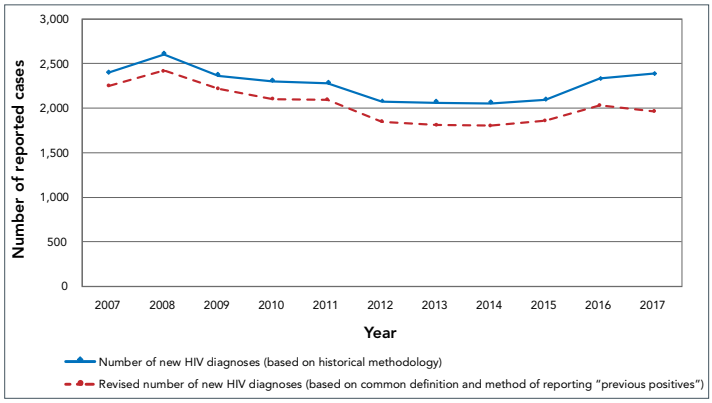
Analysis

Between December 2018 and April 2019, an environmental scan was conducted with all technical laboratory and epidemiological partners from Canadian PT public health authorities to better understand how previously diagnosed cases of HIV have been recorded in each PT and reported to PHAC. Results from this environmental scan showed that five PTs included cases previously diagnosed in another Canadian PT within the HIV surveillance data that they reported to PHAC and nine PTs included people who were diagnosed with HIV outside of Canada. The PT public health authorities were then asked to review the annual surveillance counts that they provided to PHAC between 2007 and 2017, and to identify the number of cases with a known previous HIV-positive test result (either through laboratory evidence or self-reported) from another PT or from another country ("previous positives"). The methods used for reviewing historical surveillance data varied by PT, depending on their respective surveillance systems, and included a review of a specific field or code within an electronic case management system or a review of paper-based forms.

As a result of this review, revised counts of new HIV diagnoses for the years 2007 to 2017 were calculated, with individuals with a previous HIV-positive test result from another Canadian PT removed to reduce double-counting at the national level. In addition, individuals with a known HIV-positive test result from outside of Canada were removed to better assess trends in HIV transmission within Canada.

Trends in the national number of new HIV diagnoses for 2007 to 2017 are shown in **Figure 1**. The solid line displays the trend in the reported number of HIV diagnoses as presented in PHAC's annual surveillance reports, based on historical PT reporting practices (1). The dotted line shows the revised trend in HIV diagnoses following the removal of known previous positives. For most years, the revised trend follows the same pattern as the currently reported trend, with an average of 200 fewer HIV diagnoses each year. This pattern is continued until 2017 when the revised number of HIV diagnoses does not continue to increase like the original surveillance number. When previous positives were identified and removed, the percent change from 2014 to 2017 went from a 16% increase down to a 9% increase.

Figure 1: Number of new HIV diagnoses in Canada 2007–2017 based on historical methodology compared to the new common definition of "previous positives"



Discussion

In an effort to reduce double-counting and to more accurately represent trends in HIV transmission occurring within Canada, PHAC worked with the PTs to identify reported cases of HIV that had evidence of a previous positive HIV diagnosis from outside the PT or country. A reanalysis of HIV data between 2014–2017 using a common definition and method showed that instead of a 16% increase in newly reported cases of HIV there was a 9%

increase. This indicates that previously diagnosed cases of HIV accounts for a little more than half of the increase in HIV cases in Canada reported to PHAC by the PTs over the past four years. Additionally, in 2017 when the historical methodology was used, there was a slight increase in new diagnoses compared with 2016. However, when the common definition and method was used, it resulted in a slight decrease in 2017 compared with 2016. This suggests that in 2017 the reported increase in new diagnoses was a result of an increase in previously diagnosed HIV cases, rather than an increase in HIV transmission in Canada or other factors.

Ontario has undertaken similar work at the provincial level and has also found that the increase in the number of new HIV diagnoses in recent years was largely due to "out-of-province" previous diagnoses (6,7). In addition, several provinces already separate previously diagnosed cases of HIV from their annual number of new HIV diagnoses within provincial surveillance reports (8–10). Globally, the various approaches used to account for known previous positives in national HIV surveillance systems demonstrate the complexity of this issue and highlight the differences in the definitions of previous positive and in reporting practices (2–5).

Several limitations to this analysis should be considered when interpreting these results. First, the number of previous positives could be an underestimate, since it often relies on self-disclosure of a previous HIV diagnosis. In addition, persons who were first tested anonymously and later diagnosed nominally may produce duplicate positives that cannot be identified and removed. Lastly, PHAC's ability to detect previously diagnosed cases is limited as there are not enough identifiers to detect duplicates.

Next steps

Tracking and reporting on HIV cases is a complex and decentralized process. Going forward, PHAC will monitor both:

- The total number of reported HIV diagnoses in Canada (consistent with previous surveillance reports) to assess the burden of HIV in the country
- The number of new HIV diagnoses (not known to be previously diagnosed) to inform trends in HIV transmission occurring within Canada

Migrants who have been diagnosed with HIV outside of Canada will continue to be included in PHAC's national estimates of HIV prevalence to provide an accurate national picture of the number of people living with HIV who require care. PHAC will also work with PTs to collect additional demographic information on previously diagnosed cases of HIV from outside of Canada to help inform public health prevention and control efforts for this group.

Conclusion

PHAC will continue to work with PT public health authorities to standardize reporting of previously diagnosed individuals who have recently moved. The use of a common approach for reporting previous HIV diagnoses explains more than half of the increase in HIV cases over the last four years. Future national surveillance reports will include data based on this revised definition/methodology to more accurately describe the trends in HIV transmission occurring within Canada.

Authors' statement

This work was completed by employees of the Public Health Agency of Canada. Authors' contributions are outlined below:
NP — Conceptualization, data curation, interpretation of data, writing original draft, review, editing, validation, writing final draft, visualization
QY — Interpretation of data, contributed to first draft
NH — Contributed to first draft
AW — Contributed to first draft
CA — Conceptualization, review/revision of the paper, final approval

Conflict of interest

None.

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Preventing transmission of bloodborne viruses from infected healthcare workers to patients: Summary of a new Canadian Guideline

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Abstract

Background: Although it is well documented that bloodborne viruses (BBVs), including human immunodeficiency virus (HIV), hepatitis C virus (HCV) and hepatitis B virus (HBV) have been transmitted from patients to healthcare workers (HCWs), there has also been reported transmission from HCWs to patients during the provision of health care. With remarkable progress in infection prevention, diagnosis tools, treatment regimens and major improvements in guideline development methodology, there was a need to develop an evidence-based guideline to replace the 1998 Canadian consensus document for managing HCWs infected with BBVs.

Purpose: This article summarizes the Canadian *Guideline on the Prevention of Transmission of Bloodborne Viruses from Infected Healthcare Workers in Healthcare Settings.*

Methods: A Guideline Development Task Group was established and key questions developed to inform the guideline content. Systematic reviews were conducted to evaluate the risk of HCW-to-patient transmission of HIV, HCV and HBV. Environmental scans were used to provide information on Expert Review Panels, disclosure of a HCW's serologic status and lookback investigations. Federal, provincial and territorial partners and key stakeholder organizations were consulted on the Guideline.

Results: The risk of HCW-to-patient BBV transmission was found to be negligible, except during exposure-prone procedures, where there is a risk that injury to the HCW may result in exposure of a patient's open tissues to the HCW's blood. Risk of ensuing transmission and the rate of transmission varied by BBV, and were lowest with HIV and highest with HBV. The Guideline provides key content, including recommendations regarding criteria to determine if a procedure is an exposure-prone procedure, management of HCWs infected with a BBV, including considerations for the HCW's fitness for practice, Expert Review Panels, HCW disclosure obligations and right to privacy and lookback investigations.

Conclusion: This new Guideline provides a pan-Canadian approach for managing HCWs infected with a BBV, with recommendations related to preventing HCW-to-patient transmission of BBVs during the provision of care.

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Keywords: bloodborne viruses, HIV, hepatitis C, hepatitis B, transmission, bloodborne pathogens, healthcare workers, exposure-prone procedure, guideline, recommendations, Canada

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Introduction

The purpose of the new *Guideline on the Prevention of Transmission of Bloodborne Viruses from Infected Healthcare Workers in Healthcare Settings* (hereafter called Guideline) (1) is to provide a national framework for developing policies and procedures to prevent the transmission of bloodborne viruses (BBVs), specifically human immunodeficiency virus (HIV), hepatitis C virus (HCV) and hepatitis B virus (HBV), from infected healthcare workers (HCWs) to patients in the Canadian healthcare setting. The Guideline was developed by the Public Health Agency of Canada (PHAC) with technical expertise provided by a Guideline Development Task Group (Task Group) of the National Advisory Committee on Infection Prevention and Control (NAC-IPC) (2). This Guideline replaces Health Canada's 1998 *Proceedings of the Consensus Conference on Infected Health Care Workers: Risk for Transmission of Bloodborne Pathogens* (3). This article summarizes the development, key content and recommendations of the Guideline.

The Guideline assumes that HCWs will adhere to Routine Practices when providing care to all patients at all times and in all settings (4). Failure to adhere to infection prevention and control principles identified as Routine Practices could result in transmission of BBVs. For HCWs who perform exposure-prone procedures, there is a risk of percutaneous injury and therefore a subsequent risk of patient exposure to the HCW's blood. Our review of the worldwide literature identified several reports of HCW-to-patient transmission of BBVs in healthcare settings (5–7). Transmission incidents from the 1980s and 1990s highlighted the need for policies and guidelines internationally with a goal to minimize the risk of transmission. In defining the risk of transmission of a BBV from an infected HCW to a patient, both the actual risk determined from available evidence, and the risk perceived by the public inform what is considered to be acceptable risk. While zero risk of transmission is unattainable, the availability of a vaccine that prevents HBV infection, effective treatment for HCV resulting in a sustained virologic response and suppression of HIV with strict adherence to antiviral therapy could render transmission risks from these BBVs negligible.

The Guideline provides a comprehensive summary of relevant background information, current evidence and recommendations to inform the prevention of transmission of BBVs from HCWs to patients while providing care.

Methods

Stakeholder consultation and scope

A preliminary consultation with key partner and stakeholder organizations was conducted prior to the development of the Guideline. This involved collating feedback via a needs assessment to inform the Guideline scope and key issues.

A project protocol was developed to outline the steps and methods for conducting systematic reviews and environmental scans necessary to address issues within the scope of the guideline and inform the recommendations provided. Key questions were developed to address issues identified. These questions were informed by conducting six systematic reviews, one narrative review, and three environmental scans.

Consultation with relevant organizations was ongoing as needed during the development of the Guideline, and a final broad consultation with all pertinent partners, key stakeholder organizations and subject matter experts was conducted upon completion of a full draft of the Guideline.

Review of epidemiologic investigations

Worldwide reports of potential BBV exposure via an infected HCW (with or without transmission to patients) were reviewed to help identify factors that influence the risk of percutaneous injury to HCWs and the risk of BBV transmission to patients, given HCW injury.

The approach to determining risk associated with procedures reported in the epidemiologic investigations and the categorization of exposure-prone procedures in key international guidelines were reviewed to inform the definition for exposure-prone procedures in the Guideline.

Systematic reviews

Six systematic reviews (encompassing literature from 1995 to 2016) were conducted for key questions to specifically evaluate factors affecting the risk of transmission of HIV, HCV and HBV from infected HCWs to patients and examine infectivity of each virus related to the source serum viral load at time of exposure. Four databases were reviewed: Ovid MEDLINE; EMBASE; Global Health; and Scopus. Pre-identified screening criteria helped determine studies (published in English and French) that were eligible to inform relevant sections in the Guideline. Critical appraisal of eligible studies and grading of evidence was conducted using PHAC's Critical Appraisal Tool Kit (8). The evidence from eligible studies was reviewed and summarized. Complete details of the key questions, study eligibility criteria and findings from the systematic reviews for each BBV will be published in separate articles.

A narrative review of relevant published studies, including a systematic review of randomized controlled trials (9), was conducted to inform a key question regarding the clinical effectiveness of double gloving.

Environmental scans

Environmental scans were conducted to address key questions where the topic dealt with organizational, regulatory, and/or ethical issues not solely or directly informed by scientific research. These provided background information and helped identify the general consensus of opinion internationally regarding Expert Review Panels, disclosure of a HCW's

serologic status, and conducting lookback investigations. The environmental scans involved identifying and reviewing relevant documents obtained from a search of grey literature or articles outside of the indexed medical literature, including regulatory authorities' and professional associations' policy documents, other international and provincial guidelines and reports from government institutions.

Technical expertise for evidence reviews and developing recommendations

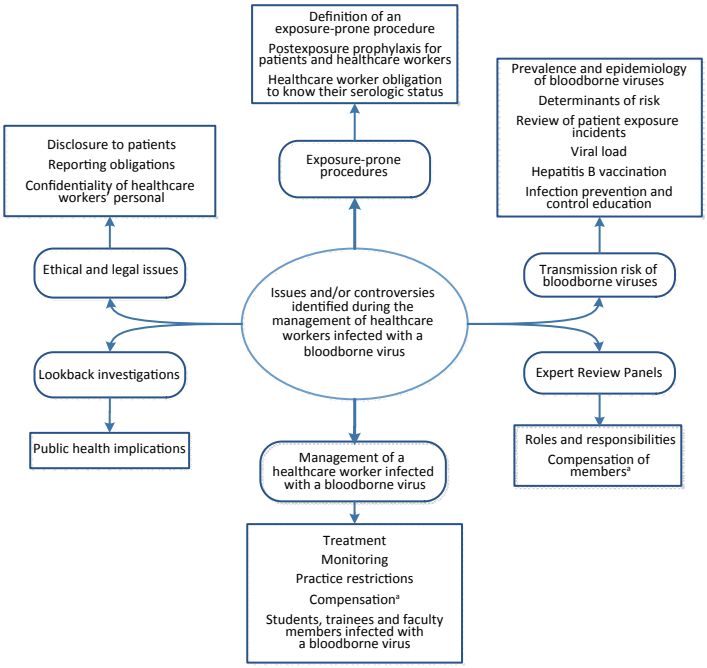
Technical expertise for review of the evidence around risk factors for transmission, including definition of an exposure-prone procedure and development of recommendations, were provided by the Task Group. The group was composed of members with expertise in infectious diseases, medical microbiology and virology, infection prevention and control, public health, occupational health, hepatology, dentistry, medical ethics and obstetrics and gynecology (refer to the Guideline for list of names and affiliations of group members) (1). The Task Group reported to the NAC-IPC.

Findings

Stakeholder consultation and scope

Feedback from the preliminary stakeholder consultation (needs assessment) identified the key issues for inclusion in a national guideline on this topic (**Figure 1**).

Figure 1: Key issues and/or controversies regarding the management of a healthcare worker infected with a bloodborne virus



[a] The issue of compensation of healthcare workers and Expert Review Panel members is beyond the scope of the Guideline

All feedback received from the final broad consultation was reviewed and addressed as appropriate by the Task Group, prior to finalizing the Guideline. The list of all partners, organizations and subject matter experts who were invited to provide feedback is provided in the Guideline (1).

Review of epidemiologic investigations

Factors affecting the risk of percutaneous injury to HCWs included the type and duration of procedure performed, surgical techniques and expertise and compliance with infection prevention and control practices. Factors affecting risk of transmission included the nature of the injury and exposure, frequency of injury, size of inoculum or volume of blood present in an exposure incident, viral load and clinical status of the source and susceptibility of the exposed individual.

Other factors affecting transmissibility include communicability of the BBV and immunologic status of the HCW. Identified investigations reporting on potential patient exposure to HCWs infected with HIV, HCV or HBV are summarized in **Table 1**. The number of exposure incidents involving transmission was lowest for HIV and highest for HBV.

Table 1: Epidemiologic investigations involving potential patient exposure to a bloodborne virus during procedures performed by infected healthcare workers

Virus (publication year)	Number of investigations with no transmission	Number of investigations with transmission	Number of patients infected	Total number of investigations
HIV (1985–2017)	45	4	9	49
HCV (1996–2013)	7[a]	24	68[a]	31
HBV (1986–2013)	3	29	237	32
Total	55	57	314	112

Abbreviations: HBV, hepatitis B virus; HCV, hepatitis C virus; HIV, human immunodeficiency virus
[a] Excludes investigations that reported illicit drug use by a healthcare worker infected with hepatitis C virus

Exposure-prone procedures

Exposure-prone procedures are defined as invasive procedures where there is a risk that injury to the HCW may result in the exposure of the patient's open tissues to the blood of the HCW. Exposure-prone procedures vary from specialty to specialty. For transmission of a BBV from an infected HCW to patient to occur during an exposure-prone procedure, three conditions are necessary:

- The HCW must sustain an injury or have a condition that allows for exposure
- The HCW's blood must come in contact with a patient's wound, traumatized tissue, mucous membranes or similar portal of entry
- The HCW must be sufficiently viremic

Systematic reviews

Eligible studies mainly comprised of reported exposure incidents with or without ensuing transmission. These helped identify risk factors for BBV transmission and thus best practice to prevent transmission. Findings from the systematic reviews were analyzed by the Task Group. This analysis as well as expert opinion where gaps existed, informed the development of recommendations. Publication of the full systematic reviews is pending and not included in this summary.

Guideline recommendations: HIV, HCV and HBV

The following recommendations are common to HCWs infected with any of the three BBVs (refer to the Guideline for full context and footnotes on these):

- All HCWs who perform exposure-prone procedures have ethical and professional obligations to know their HIV/HCV/HBV status
  - If their status is negative, the HCWs should be tested at appropriate intervals: as determined by their level of risk and whenever an exposure has occurred
- HCWs infected with HIV/HCV/HBV who do not perform exposure-prone procedures do not need any restrictions on practice based on their BBV status alone
- If a HCW-to-patient transmission of HIV/HCV/HBV occurs, the HCW should cease clinical practice immediately until determination for fitness to return to practice is made

Recommendations specific to HCWs infected with HIV, HCV or HBV are summarized in **Tables 2, 3** and **4** respectively.

Table 2: Recommendations for management of healthcare workers infected with HIV

Recommendations
HCWs infected with HIV should seek medical care from a physician with expertise in HIV management for optimal health maintenance and should be managed according to current recommendations with regular monitoring of HIV RNA levels.
HCWs infected with HIV should be restricted from performing exposure-prone procedures until: • the HCW is under the care of a physician with expertise in HIV management; and • the HCW is either on effective combination antiretroviral therapy or has been identified as an elite controller; and • the HCW's viral load is undetectable[a].
HCWs infected with HIV who are on effective combination antiretroviral therapy (or are elite controllers), and have an undetectable viral load should have no restrictions on practice based on HIV status alone.

Abbreviations: HCW, healthcare worker; HIV, human immunodeficiency virus; RNA, ribonucleic acid
[a] There are variations in minimum detectable viral load thresholds for different assays. In addition, there may be situations where very low viral loads and/or transient blips (up to 400 copies/mL) may occur. These blips may not be clinically relevant and thus do not indicate treatment failure and will not necessarily trigger practice restrictions or lookback investigations. However, some jurisdictions may manage transient blips by maintaining stricter or more conservative thresholds

Table 3: Recommendations for management of healthcare workers infected with hepatitis C virus

Recommendations
Confirmation of active HCV infection should be done using HCV RNA testing. HCWs infected with HCV should seek medical care from a physician with expertise in HCV management for optimal health maintenance and should be managed according to current recommendations.
HCWs testing positive for HCV RNA should be restricted from performing exposure-prone procedures until: • the HCW is under the care of a physician with expertise in HCV management; and • the HCW has completed effective therapy[a,b]; and • the HCW has tested negative for HCV RNA at least 12 weeks post-treatment[b]. Note: Expert Review Panels may individualize practice restrictions to allow a HCW to perform exposure-prone procedures while on effective therapy provided the virus is undetectable. The HCW's practice should then be restricted post treatment until a sustained virologic response is confirmed.
HCWs testing negative for HCV RNA 12 weeks post-treatment can be considered to have a sustained virologic response and should have no restrictions on practice based on HCV status alone.

Abbreviations: HCV, hepatitis C virus; HCW, healthcare worker; RNA, ribonucleic acid
[a] Due to the availability of effective therapy for HCV with sustained virologic response, this guideline does not recommend a serum HCV RNA cut off level for practice restrictions as recommended in other guidelines
[b] The overarching principle for management of HCWs infected with HCV who perform exposure-prone procedures is to restrict practice while the virus is detectable

Table 4: Recommendations for management of healthcare workers infected with hepatitis B virus

Recommendations
HCWs who remain susceptible to HBV (anti-HBs negative and anti-HBc negative) should be tested at appropriate intervals as determined by their level of risk and whenever an exposure has occurred.
HCWs born or previously residing in high HBV endemic countries should be tested for both anti-HBc and HBsAg to fully define HBV status[a,b].
HCWs infected with HBV should seek medical care from a physician with expertise in HBV management for optimal health maintenance and should be managed according to current recommendations with regular monitoring of HBV DNA level[c].
HCWs infected with HBV should be restricted from performing exposure-prone procedures until: • the HCW is under the care of a physician with expertise in HBV management; and • the HCW's HBV DNA level is below 10^3 IU/mL (5 x 10^3 GE/mL)[d] or equivalent and monitored regularly (every 3 to 6 months)[e].
HCWs infected with HBV who have HBV DNA levels less than or equal to 10^3 IU/mL (5 x 10^3 GE/mL)[d] or equivalent should have no restrictions on practice based on HBV status alone.

Abbreviations: anti-HBc, antibody to hepatitis B core antigen; anti-HBs, antibody to hepatitis B surface antigen; DNA, deoxyribonucleic acid; HBcAg, hepatitis B core antigen; HBsAg, hepatitis B surface antigen; HBV, hepatitis B virus; HCW, healthcare worker
[a] Countries or areas with moderate to high risk of HBV are identified by the World Health Organization
[b] Refer to the Canadian Immunization Guide for Immunization of Persons New to Canada
[c] HBV antiviral therapy may be required to allow HCWs infected with HBV to perform exposure-prone procedures
d One IU/mL is considered equivalent to five copies/mL (i.e. one copy/mL is equivalent to 0.2 IU/mL)
[e] Because the focus is on patient safety, HCWs who perform exposure-prone procedures should be treated at this serum level regardless of recommendations in current treatment guidelines. With adherence to treatment as part of the threshold for infected HCWs to perform exposure-prone procedures, HBV DNA levels are reduced to almost undetectable in most people. As a result, several known inconsistencies (e.g. differences in recommended HBV DNA threshold in various international guidelines, in vivo fluctuations in a person's HBV DNA levels without treatment, variation in HBV DNA test results based on different assays used, or variations in results from repeated test of the same blood sample using the same assay) will likely have minimal impact on decisions regarding practice restrictions

Co-infection with bloodborne viruses

If a HCW who performs exposure-prone procedures is co-infected with any combination of HIV, HCV and/or HBV, the HCW should meet the defined criteria recommended for safe practice by HCWs infected with each virus.

Double gloving

Overall, there was insufficient evidence to recommend for or against double gloving to prevent HCW-to-patient transmission of a BBV.

Environmental scans and technical expertise

Findings from the environmental scans and expert opinion informed the Guideline content on Expert Review Panels (ERPs), disclosure of HCWs' serologic status, and lookback investigations, with recommendations developed to fit the Canadian context. Readers interested in the full discussion on the environmental scans should refer to the Guideline (1).

Expert Review Panel

At the time of developing this guideline, not all HCWs infected with a BBV in Canada had access to an ERP. Recommendations provided for establishing ERPs address the following areas:

- Accountability, governance and membership of the ERP
- Roles and responsibilities of an ERP
- HCW referral to an ERP
- Implementation, monitoring and compliance with ERP recommendations
- Model ERP process for regulated HCWs infected with a BBV

Disclosure of serologic status of healthcare workers

Many of the current guidelines and policies that address HCWs and BBV infections do not contain explicit recommendations regarding disclosure obligations of HCWs to patients. **Table 5** shows recommendations provided on this topic in the Guideline.

Table 5: Recommendations for healthcare worker disclosure obligations and right to privacy

Recommendations
A HCW infected with a BBV who performs exposure-prone procedures does not have an obligation to routinely disclose his or her serologic status to patients to obtain their informed consent provided that the HCW's health status and practice have been assessed by an Expert Review Panel and all the panel's recommendations are followed.
All HCWs, including those infected with a BBV, have a right to privacy and confidentiality of personal health information.
Regulatory authorities should have policies on the management of HCWs infected with a BBV that are transparent about and detail how the right to privacy of HCWs will be upheld.
When a patient has been exposed to the blood of a HCW, the HCW must seek follow-up through their organizational process and the patient must be promptly informed of the nature of the exposure and the appropriate postexposure protocol. However, the identity and confidentiality of the HCW should be protected to the greatest extent possible.

Abbreviations: BBV, bloodborne virus; HCW, healthcare worker

Lookback investigations

Lookback investigations have been found to require significant financial and human resources to identify, notify, counsel and test all the potentially exposed patients. The Guideline provides a checklist and algorithm to help determine the requirement for a lookback investigation and considerations for conducting one (1). These investigations may be undertaken for the following reasons:

- To notify patients of their potential exposure
- To identify infected patients and provide appropriate advice and treatment recommendations
- To prevent secondary transmission
- To reassure the public
- To maintain the public's trust and confidence in the healthcare system
- To contribute to the evidence base on risk of transmission

Discussion

This evidence-based Guideline presents a comprehensive review of relevant literature and provides national leadership on organizational policy to facilitate a consistent pan-Canadian approach to the management of HCWs infected with a BBV. It outlines steps to be taken to further reduce the minimal risk of HCW-to-patient transmission of BBVs, striking a balance between the reasonable expectations of the public (protection from harm) and the reasonable expectations of individual HCW's (right to privacy).

All HCWs should adhere to Routine Practices, including performing hand hygiene as required and using personal protective equipment as appropriate (4). Adequate training and education on the prevention and management of occupational injuries and potential exposures are fundamental for all HCWs as part of an occupational health program. In addition, ongoing awareness of their own serologic status is essential both for optimal health maintenance for HCWs and patient safety during exposure-prone procedures.

Reports show that the average risk of transmission following exposure is highest for HBV and lowest for HIV (10). Although a HCW with high levels of circulating BBV may pose some risk if their blood comes in contact with a patient's open tissue, the risk approaches zero if that HCW is treated and eradicates (HCV) or decreases circulating virus in their blood (HIV and HBV). In addition, with the introduction of routine hepatitis B vaccination, most HCWs are protected from infection with this BBV, thus further diminishing this risk.

The Guideline applies to all HCWs, with specific recommendations for HCWs infected with a BBV. The recommendations are intended to assist those involved with the assessment and management of HCWs, either individually (e.g. treating physician, members of Expert Review Panels) or generally (e.g. regulatory authorities).

Conclusion

This Guideline was developed with a rigorous methodology involving robust systematic reviews, a narrative review, environmental scans, summaries of published epidemiologic investigations, and grading of available evidence with consideration of collective expert opinion in the development of recommendations. Adhering to recommendations provided in this Guideline will result in safer practice for healthcare workers infected with a bloodborne virus. Although the Guideline reflects the latest scientific data, as new evidence is published, it may be necessary to update the applicable recommendation(s).

Authors' statement

TO — Conceptualization, project administration, methodology, research, data abstracting, writing (original draft), writing (review and editing)
KD — Conceptualization, project administration, research, data abstracting, writing (review and editing)
BLJ, MV, BH — Conceptualization, clinical expertise, data interpretation, intellectual content, writing (review and editing)
AMJ, BC, MC, DKW, TM, JW, IB — Clinical expertise, data interpretation, intellectual content, writing (review and editing)
MAI — Bioethics expertise, writing (review and editing)
YR — Intellectual content, review
K Dunn — Supervision, review

Conflict of interest

None.

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Accelerating our response: Government of Canada five-year action plan on sexually transmitted and blood-borne infections

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Abstract

Sexually transmitted and blood-borne infections (STBBI)—which include HIV, hepatitis B and C, chlamydia, gonorrhea, syphilis and human papillomavirus—remain significant public health issues both nationally and globally. In 2018, a *Pan-Canadian STBBI Framework for Action* (the Framework) was released by federal, provincial and territorial governments to provide an overarching and comprehensive approach to addressing STBBI for all those involved. This includes all levels of government, First Nations, Inuit and Métis communities and leadership, frontline service providers, clinicians, public health practitioners, non-governmental organizations and researchers. The Framework includes strategic goals, guiding principles and pillars for action to address STBBI in Canada. In response, the Government of Canada released its own action plan in July 2019: *Accelerating Our Response – Government of Canada Five-Year Action Plan on Sexually Transmitted and Blood-Borne Infections* (the Action Plan). This document identifies seven priority areas for federal action on STBBI over the next five years: 1) moving toward truth and reconciliation with First Nations, Inuit and Métis Peoples; 2) stigma and discrimination; 3) community innovation—putting a priority on prevention; 4) reaching the undiagnosed—increasing access to STBBI testing; 5) providing prevention, treatment and care to populations that receive health services or coverage of health care benefits from the federal government; 6) leveraging existing knowledge and targeting future research; and 7) measuring impact—monitoring and reporting on trends and results. The Government of Canada is currently working with provincial and territorial governments, First Nations, Inuit and Métis partners, and other stakeholders to develop STBBI indicators and targets for the Canadian context that are appropriate, feasible and measurable against the shared strategic goals of the Framework and the Action Plan. In addition, the Government of Canada has also committed to reporting annually on its progress in implementing the priority areas laid out in the Action Plan.

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Introduction

Sexually transmitted and blood-borne infections (STBBI)—which include HIV, hepatitis B and C, chlamydia, gonorrhea, syphilis and human papillomavirus—remain significant public health concerns in Canada. Rates of sexually transmitted infections in Canada rose dramatically between 2008 and 2017: chlamydia rose by 39%, gonorrhea by 109% and syphilis by 167% (1). Over the past several years, a number of jurisdictions have declared syphilis outbreaks, and cases of congenital syphilis have also increased (2–4). Although HIV-related deaths and rates of reported hepatitis C cases have decreased substantially since the 1990s, new infections continue to occur (5,6). Globally, there is momentum to eliminate STBBI as a public health concern, and Canada has endorsed the World Health Organization's global targets for HIV, viral hepatitis and sexually transmitted infections. These infections share common transmission routes and risk factors, and the populations most affected or likely to be exposed often overlap.

Improving the prevention, testing, treatment and care of STBBI is complex and involves a number of actors, including all levels

of government, First Nations, Inuit and Métis communities and leadership (**Text box**), frontline service providers, clinicians, public health practitioners, non-governmental organizations and researchers. In 2018, the Public Health Agency of Canada released a *Pan-Canadian STBBI Framework for Action* (hereafter called the Framework) (7), which was endorsed by federal, provincial and territorial ministers of health. The Framework provides an overarching and comprehensive approach to addressing STBBI for all those involved. It identifies strategic goals, guiding principles and pillars for action spanning the STBBI continuum of care and highlights the role of enabling environments—social, cultural, physical, structural and legal conditions—that support the prevention of STBBI transmission and promote access to services. The Framework was summarized in a previous *Canada Communicable Disease Report* article (8).

Text box: Federal departments involved in the Government of Canada Five-Year Action Plan on Sexually Transmitted and Blood-Borne Infections:

- Public Health Agency of Canada
- Canadian Institutes of Health Research
- Correctional Service Canada
- Department of Justice
- Department of National Defence
- Department of Women and Gender Equality
- Health Canada
- Immigration, Refugees and Citizenship Canada
- Indigenous Services Canada
- LGBTQ2 Secretariat of the Privy Council Office

In July 2019, the Government of Canada (GoC) released its own plan outlining key federal priorities to reduce the public health impacts of STBBI in Canada and advance the work of the Framework from 2019 to 2024. This plan, entitled Accelerating Our Response: *Government of Canada Five-Year Action Plan on Sexually Transmitted and Blood-Borne Infections* (hereafter called the Action Plan) (9) takes a whole-of-government approach and involves ten federal departments whose mandates and activities address aspects of STBBI and/or who are responsible for providing prevention, treatment and care or coverage of health care benefits to specific populations.

This plan shares the strategic goals of the Framework. These goals are to 1) reduce the incidence of STBBI in Canada, 2) improve access to testing, treatment, care and support and 3) reduce the stigma and discrimination that create vulnerabilities to STBBI. The following article summarizes the Action Plan and briefly describes its seven priority areas.

Renewing the federal response to STBBI: Overview of the Action Plan

The Action Plan includes seven priority areas.

1. Moving toward truth and reconciliation with First Nations, Inuit and Métis Peoples

The Action Plan's commitment to moving toward truth and reconciliation with First Nations, Inuit and Métis Peoples reflects the broader GoC commitment to reconciliation. The GoC will take an approach to STBBI policy, programs and services that address the priorities identified by First Nations, Inuit and Métis communities. Under this priority area, the GoC will support First Nations, Inuit and Métis Peoples' priorities in relation to STBBI, improve availability and accessibility of community level data on STBBI outcomes, and invest in culturally safe and responsive initiatives for STBBI prevention, education, awareness, and ongoing care and support.

2. Stigma and discrimination

Stigma and discrimination remain key obstacles to effective STBBI prevention, care, treatment and support. Disproportionate rates of STBBI affect populations that face various types of stigma and discrimination, including sexism, racism and homophobia. Stigma and discrimination also impede access to appropriate prevention, care, treatment and support services for STBBI. The GoC will promote the important message of undetectable=untransmittable (U=U), which is based on the substantial body of scientific evidence indicating that, for people living with HIV who have achieved a sustained undetectable viral load, there is effectively no risk of sexual transmission. Under this priority area, the GoC will also work to:

- Address stigma and discrimination (including racism and sexism), gender-based violence, transphobia, biphobia and homophobia
- Equip professionals with skills to provide culturally safe and responsive services in safe environments
- Reduce the over-criminalization of HIV non-disclosure in Canada

3. Community innovation—putting a priority on prevention

The GoC will continue its long-standing support for community-based organizations that work to prevent STBBI with programs and interventions tailored to the particular contexts and priorities of specific communities. This includes federal grants and contributions programs including the *Harm Reduction Fund* (10) and the *HIV and Hepatitis C Community Action Fund* (11). Under this priority area, the GoC will support frontline, community-based projects to prevent new and recurring infections, reach the undiagnosed and link them to testing, treatment and care, and support efforts to bring high impact interventions, such as HIV preexposure prophylaxis, to scale so more people can benefit from them.

4. Reaching the undiagnosed—increasing access to STBBI testing

Testing for STBBI enables people to access care, treatment and support, and can ultimately reduce onward transmission of infections. However, current approaches to STBBI testing are not reaching everyone who could benefit. For this reason, under this priority area, the GoC will prioritize efforts to increase access to

culturally-safe and responsive testing models and expand the range of testing options available to people in Canada, including point-of-care testing, self-testing and the use of dried blood spot technology.

5. Prevention, treatment and care for populations that receive health services or coverage of health care benefits from the federal government

The GoC funds and provides health services or coverage of health care benefits for a number of specific populations, including members of the Canadian Armed Forces, certain immigrant populations, incarcerated individuals in federal correctional facilities and eligible First Nations and Inuit. Under this priority area, the GoC will ensure that eligible individuals receive effective and culturally safe and responsive prevention, including harm reduction, care and treatment services, and facilitate linkage to care for those transitioning from federal to provincial and territorial health systems.

6. Leveraging existing knowledge and targeting future research

Scientific research continues to advance and improve knowledge about STBBI, the conditions that promote vulnerability to infection, the development of new prevention and testing modalities and treatments and knowledge about the physical, mental and social impacts of living with chronic infection. Under this priority area, the GoC will invest in the following areas: research on basic, translational and clinical research; research supporting STBBI prevention, testing and diagnosis, treatment and care; and support for the development of First Nations, Inuit and Métis health research capacity.

7. Measuring impact—monitoring and reporting on trends and results

Global targets for HIV, hepatitis and sexually transmitted infections are part of the momentum driving Canada's efforts to reduce the health impacts of STBBI. However, global targets are not sufficient to unify efforts, drive change and measure Canada's progress. Under this priority area, the GoC will lead a process to develop indicators and targets for STBBI that are appropriate for the Canadian context. It will also prioritize efforts to strengthen Canada's STBBI surveillance system to ensure that the GoC has the data that is needed to focus efforts and monitor trends and changes over time. In addition, the GoC has committed to reporting on the results from this Action Plan on an annual basis.

Conclusion and next steps

The Action Plan outlines the seven priority areas for federal efforts to implement the Framework and support Canada's contribution to meeting the global targets for HIV, hepatitis and sexually transmitted infections by 2030 (**Table 1**). The GoC is currently working with provincial and territorial governments, First Nations, Inuit and Métis partners, and other stakeholders to develop STBBI indicators and targets within the Canadian context that are appropriate, feasible and measurable. This work will include a community consultation process over the coming months. The GoC has also committed to reporting annually on its progress in implementing the priority areas laid out in the Action Plan. Full implementation of the Framework, however, will require the ongoing and unified efforts of governments, stakeholders and affected communities to ensure that culturally-safe and responsive STBBI prevention, testing, care, treatment and support are available to those who need it.

Table 1: Global Targets for Sexually Transmitted and Blood-Borne Infections (STBBI)

STBBI	Target year	Global targets
HIV	2020	• 90% of people living with HIV know their status • 90% of people living with HIV who know their status are receiving treatment • 90% of people on treatment have suppressed viral loads • Fewer than 500,000 new HIV infections • Elimination of HIV-related discrimination
	2030	• Zero new HIV infections • Zero AIDS-related deaths • Zero discrimination
Hepatitis	2020	• 30% reduction in new cases of chronic viral hepatitis B and C infections • 10% reduction in hepatitis B and C deaths • 30% of viral hepatitis B and C infections are diagnosed • Five million people receiving hepatitis B treatment, and three million people receiving hepatitis C treatment • Achieve and maintain up-to-date 90% coverage for vaccination of hepatitis B vaccine (three doses)
	2030	• 90% reduction in new cases of chronic viral hepatitis B and C infections • 65% reduction in hepatitis B and C deaths • 90% of viral hepatitis B and C infections are diagnosed • 80% of eligible people receiving hepatitis B and C treatment
Sexually transmitted infections	2030	• 90% reduction of syphilis incidence globally • 90% reduction in gonorrhea incidence globally • 50 or fewer cases of congenital syphilis per 100,000 live births in 80% of countries • Sustain 90% national coverage and at least 80% in every district (or equivalent administrative unit) in countries with the human papillomavirus vaccine in their national immunization programme

The success of these efforts lies in partnerships. The GoC is committed to implementing the *Truth and Reconciliation Commission's Calls to Action* (12) and will continue to engage closely with First Nations, Inuit and Métis communities and leadership. The GoC is also committed to continuing to work with people with lived experience as programs and policies are developed. In addition, the GoC's collaborative work with provinces, territories and community-based organizations

remains critical to achieving the shared strategic goals for STBBI. With the Action Plan, the federal government will continue to drive progress on HIV, viral hepatitis and sexually transmitted infections within the context of the Framework.

Authors' statement

CJ — Writing and editing
GT — Writing and editing

Conflict of interest

None.

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2020 GLOBAL TARGETS for Sexually Transmitted and Blood-Borne Infections 2030

HIV

90%

- 90% people with HIV know their status
- 90% people with HIV who know their status are receiving treatment
- 90% people on treatment have suppressed viral loads

ZERO

- 0 New HIV infections
- 0 AIDS-related deaths
- 0 Discrimination

HEPATITIS

90% 90% vaccination coverage for hepatitis B vaccine (3 doses) x3

30%

- 30% reduction in new cases of chronic viral hepatitis B and C infections
- 30% of viral hepatitis B and C infections are diagnosed

10% 10% reduction in hepatitis B and C deaths

90%

- 90% reduction in new cases of chronic viral hepatitis B and C infections
- 90% of viral hepatitis B and C infections are diagnosed

80% 80% of of eligible people receiving hepatitis B and C treatment

65% 65% reduction in hepatitis B and C deaths

SEXUALLY TRANSMITTED INFECTIONS

STIs

90%

- 90% reduction of syphilis incidence globally
- 90% reduction in gonorrhea incidence globally

90% 90% **human papillomavirus** immunization rate in countries with HPV vaccine

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APPRECIATION

Thank you to the CCDR peer reviewers of 2019

Many thanks to the following people for the time and expertise they have given to the *Canada Communicable Disease Report* (CCDR) as peer reviewers in 2019. These individuals have worked anonymously, in their spare time, with no remuneration. Their comments and insights have been vital to enhancing the quality of articles published in CCDR. CCDR aims to provide practical and authoritative information for clinicians and public health professionals in Canada and internationally.

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PNAS Plus: *Borrelia burgdorferi* peptidoglycan is a persistent antigen in patients with Lyme arthritis

Source: Jutras BL, Lochhead RB, Kloos ZA, Biboy J, Strle K, Booth CJ, Govers SK, Gray J, Schumann P, Vollmer W, Bockensted LK, Steere AC, Jacobs-Wagner C. *Borrelia burgdorferi* peptidoglycan is a persistent antigen in patients with Lyme arthritis. PNAS 2019;116(27):13498-13507. https://doi.org/10.1073/pnas.1904170116

Lyme disease is a multisystem disorder caused by the spirochete *Borrelia burgdorferi*. A common late-stage complication of this disease is oligoarticular arthritis, often involving the knee. In ~10% of cases, arthritis persists after appropriate antibiotic treatment, leading to a proliferative synovitis typical of chronic inflammatory arthritides. Here, we provide evidence that peptidoglycan (PG), a major component of the *B. burgdorferi* cell envelope, may contribute to the development and persistence of Lyme arthritis (LA). We show that *B. burgdorferi* has a chemically atypical PG (PG^{Bb}) that is not recycled during cell-wall turnover. Instead, this pathogen sheds PG^{Bb} fragments into its environment during growth. Patients with LA mount a specific immunoglobulin G response against PG^{Bb}, which is significantly higher in the synovial fluid than in the serum of the same patient. We also detect PG^{Bb} in 94% of synovial fluid samples (32 of 34) from patients with LA, many of whom had undergone oral and intravenous antibiotic treatment. These same synovial fluid samples contain proinflammatory cytokines, similar to those produced by human peripheral blood mononuclear cells stimulated with PG^{Bb}. In addition, systemic administration of PG^{Bb} in BALB/c mice elicits acute arthritis. Altogether, our study identifies PG^{Bb} as a likely contributor to inflammatory responses in LA. Persistence of this antigen in the joint may contribute to synovitis after antibiotics eradicate the pathogen. Furthermore, our finding that *B. burgdorferi* sheds immunogenic PG^{Bb} fragments during growth suggests a potential role for PG^{Bb} in the immunopathogenesis of other Lyme disease manifestations.

Work on a rapid point-of-care diagnostic test for Lyme disease

Source: U.S. Department of Health and Human Services. National Institutes of Health NIH. News National Institute of Allergy and Infectious Diseases (NIAID). Scientists Work Toward a Rapid Point-of-Care Diagnostic Test for Lyme Disease. October 16, 2019. https://www.niaid.nih.gov/news-events/scientists-work-toward-rapid-point-care-diagnostic-test-lyme-disease

A study published in the *Journal of Clinical Microbiology* describes a new rapid assay for Lyme disease that could lead to a practical test for use by healthcare providers. The researchers found the assay, which uses several biomarkers to detect Lyme disease infection, was more sensitive than current laboratory-based tests when diagnosing Lyme disease early after suspected infection. The research was supported by the National Institute of Allergy and Infectious Diseases (NIAID), part of the National Institutes of Health.

Lyme disease is caused by *Borrelia burgdorferi*, a spiral-shaped bacterium transmitted by deer ticks. Most cases of Lyme disease can be treated effectively with a short course of antibiotics. However, Lyme disease can be difficult to diagnose because it causes a wide range of symptoms, from fever and rash to neurologic and cardiac symptoms and joint pain. Current Lyme disease tests also can miss an infection if performed too early. The Centers for Disease Control and Prevention recommends a two-step blood test for diagnosing Lyme disease that looks for antibodies against Lyme disease. These tests require specialized laboratory equipment and can require days or weeks to return results. The authors of the paper plan to develop a simpler, faster, more sensitive test that could be used at the point of care during a single visit to a healthcare provider.

The researchers first screened a set of known Lyme disease biomarkers for their ability to indicate infection. They then tested for the top three biomarkers on samples from people with early Lyme disease, from healthy individuals from areas where Lyme disease is endemic, and from people with Lyme arthritis. This was compared to results obtained using the standard two-step testing procedure.

Overall, the new set of biomarkers was more sensitive than standard Lyme disease tests. These biomarkers were better at picking up signs of Lyme disease infection in early stage samples-possibly because they were able to detect antibodies that peak in the first two to six weeks after a person is infected with Lyme disease. These results open the possibility of developing a point-of-care test for Lyme disease. While the assay will require more refinement and testing before it can be approved by the Food and Drug Administration for widespread use as a simple diagnostic test for Lyme disease, the researchers say that these results show great potential.

Reference: Arumugam S, Samiksha N, Williams T, di Santa Maria FS, Guedes MS, Chaves RC, Linder V, Marques AR, Horn EJ, Wong SJ, Sia SK, Gomes-Solecki M. A multiplexed serologic test for diagnosis of Lyme disease for point-of-care use. *Journal of Clinical Microbiology*. https://jcm.asm.org/content/early/2019/10/03/JCM.01142-19 (2019)

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