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CCDR

CANADA COMMUNICABLE DISEASE REPORT

ADULT IMMUNIZATION

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CANADA COMMUNICABLE DISEASE REPORT

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The cover photo shows one way mumps may have been spread among young adults in one of the largest outbreaks in 20 years in Toronto. Photo by Shutterstock (https://www.shutterstock.com/image-photo/couple-sharing-milkshake-coffee-shop-570811222?src=h8CRL8ZrH3KyciFztKZVfA-1-48).

Contact the Editorial Office

phac.ccdr-rmtc.aspc@canada.ca
613.301.9930

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ADULT IMMUNIZATION

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OUTBREAK REPORT

Investigation and management of a large community mumps outbreak among young adults in Toronto, Canada, January 2017–February 2018

V Dubey[1,2]*, O Ozaldin[1], L Shulman[1], R Stuart[1], J Maclachlan[1], L Bromley[1], A Summers[2]

Abstract

Background: In 2017, a mumps outbreak was identified in a cohort of 18–34 year olds in Toronto, Canada.

Objective: To describe a large community mumps outbreak in an urban centre from January 2017 to February 2018 among young adults.

Methods: A broad range of interventions were implemented in an attempt to reach the target audience; including case and contact management, vaccination clinics at schools and clinicians' offices, school exclusions, bar inspections, traditional communication strategies (including health care provider updates and posters) and newer communication strategies (including three sequential social media campaigns).

Results: A total of 143 cases of mumps were identified. Although cases' ages ranged from three to 72 years, most (76%) were 18–34 year olds, many of whom had frequented bars and local food establishments in downtown Toronto. Eighty-four percent (n=120) of the cases were community-acquired. Only 16% (n=23) of the cases reported exposures in schools and post-secondary school institutions. Of those, 39% (n=56) of cases had an unknown vaccination history; 34% (n=49) were either not vaccinated or partially vaccinated with one dose of measles-mumps-rubella vaccine; and 27% (n=38) had received the recommended two doses of mumps vaccine. Determining vaccination status was a challenge, in part due to the lack of a registry. Vaccination was recommended when subjects were known to have had fewer than two doses of vaccine or had an unknown vaccination status. A social media campaign, emphasizing the risk of social activities if not protected from the mumps, yielded over 500,000 impressions from Facebook and Twitter messages and ads and an impressive engagement rate of between 1% and 10%.

Conclusion: This was the largest mumps outbreak in Toronto in over 20 years. Among young adults, ongoing social media and traditional communication campaigns can contribute to the control of community mumps outbreaks. Encouraging vaccine uptake is desirable, but without a vaccine registry it is difficult to assess vaccination coverage among adults. Susceptible cohorts of young adults who were not adequately vaccinated pose a risk for future outbreaks. Given that almost 30% of the mumps cases were fully vaccinated with two doses of mumps-containing vaccine, even two doses may not provide complete protection.

Affiliations

[1] Toronto Public Health, Toronto, ON

[2] Dalla Lana School of Public Health, University of Toronto, Toronto, ON

***Correspondence:**
vinita.dubey@toronto.ca

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Keywords: mumps, outbreak, mumps vaccine, social media, vaccine coverage, vaccine registry, young adults, MMR, Toronto

Introduction

From January 2017 to February 2018, Toronto experienced the largest mumps outbreak in the city in over 20 years with 143 cases. Toronto is Canada's largest urban centre with a population of 2.7 million. Toronto has an average of five cases of mumps per year; largely travel-related. The last large outbreak in Toronto was in 2009, with 33 cases.

Mumps is a viral infection caused by a paramyxovirus, which can lead to symptoms of fever, malaise, headache, myalgia and parotitis. Orchitis is a common complication in postpubertal males. Although a third of cases have only mild symptoms, complications include meningitis, pancreatitis, myocarditis and deafness. Symptoms are often more severe in adults than children. The incubation period is 12–25 days, and communicability through droplet and direct contact with saliva or respiratory droplets occurs from seven days before to five days after onset of symptoms. Contagiousness is similar to that of influenza (1–3).

Adults born before 1970 are generally presumed to have acquired natural immunity to mumps. In Ontario, a single dose of measles-mumps-rubella (MMR) vaccine was provided from 1975 to 1996. In 1996, a second dose of MMR vaccine was added to the schedule and a single dose of monovalent measles vaccine was offered to all students 4–18 years of age (born in 1978 to 1992) (4,5). Coverage rates for two doses of mumps-containing vaccines among school-aged children has consistently been about 90% for the past ten years in Toronto schools (6,7).

This vaccination plan has left a cohort of individuals born after 1970 and before 1992 who received only one dose of mumps-containing vaccine. The National Advisory Committee of Immunization (NACI) has recommended that during a mumps outbreak, this age cohort receives a dose of mumps-containing vaccine; however, this cohort is notoriously difficult to reach (8).

Vaccine registries are important tools to document and improve coverage. When vaccine preventable disease outbreaks occur, a registry can confirm previous vaccinations and readily assess susceptible individuals in the defined population who require vaccination.

The objective of this article is to describe this recent large community mumps outbreak in Toronto and novel approaches for communication and outbreak control using social media and posters.

Outbreak detection

The outbreak began in January 2017 when two unvaccinated siblings (18 and 20 years of age) were reported to Toronto Public Health with laboratory-confirmed mumps infections. Both had symptoms of fever, fatigue and parotitis. It was determined that the infection was likely acquired during a house party in Guelph, Ontario (small city approximately 100 kilometres south west of Toronto) in mid-January. Cases were also detected across Ontario related to this house party exposure. Additional cases of mumps were then detected in young adults with links to downtown Toronto bars and food establishments that had no identified connections to the Guelph house party, travel or other cases. An outbreak of mumps for the City of Toronto was declared on January 30, 2017.

Outbreak response

Case definitions and investigations

The outbreak case definitions are summarized in **Appendix 1**. In Ontario all laboratory specimens for mumps were reported directly to the local public health unit for follow up as per the Ontario Public Health Standards Infectious Diseases Protocol (9). Public health staff then interviewed all cases, utilizing an Integrated Public Health Information System (iPHIS) case investigation tool that was customized for this specific outbreak. Clients were asked to provide information on their vaccination history, symptoms, occupation, attendance at medical and school settings, medical and social risk factors and potential acquisition and transmission exposure sites. Early in the outbreak, it became clear that clients were not forthcoming with their answers to all of the questions, especially those questions relating to details of contacts and possible exposure sites.

The Public Health Ontario Laboratory forwarded specimens to the National Microbiology Laboratory (NML) for genotyping. Due to delays in receiving results, genotyping was not included in the case definitions.

Descriptive analyses to assess the demographics, geography, vaccination status, genotype and symptoms associated with cases were performed. Social networking analysis was contemplated early in the outbreak, however since cases were not forthcoming with all of their exposures and social networks, there was not enough information to pursue this analysis.

Case and contact management

Conventional case management of mumps was undertaken (3,9). Cases were asked to self-isolate and were excluded from work, school, social gatherings and health care facilities during the period of communicability (five days after onset of symptoms). Interviews were completed with cases in order to identify potential sites of acquisition and transmission during the incubation period and period of communicability. Contact management, as used in the outbreak, is summarized in **Appendix 2**.

Health care provider updates

The majority of vaccinations in Ontario are provided by primary care clinicians. Numerous messages were sent to vaccine providers to update them on the status of the outbreak, to provide instructions on how to diagnose and test for mumps infection and

to encourage them to vaccinate their 18 to 35 year old patients. Because mumps-containing vaccines in Toronto are ordered by providers and shipped from the Ontario Government Pharmacy and Medical Supply Service, the Panorama vaccine inventory database was used to determine mumps-containing vaccines that were ordered and shipped from March to August in 2017 compared with the same time period in 2018 (post-outbreak).

Mandated exclusion of susceptible student contacts from school

Ontario's Immunization of School Pupils Act requires that all students are either vaccinated against certain diseases or have submitted a medical or philosophical/religious exemption (10). In the context of an outbreak, public health officials may exclude students who are not up-to-date with their vaccinations or do not have evidence of immunity. In schools where a case was reported, attention was given to update vaccine records and to vaccinate those who were not up-to-date with two doses of mumps-containing vaccines. In one high school where there were two cases with possible transmission in the school setting, students who were not up-to-date with their vaccinations or who were non-immune to mumps were excluded from school until they could provide proof of vaccination. Vaccine clinics were held at schools to update vaccination records and to quickly vaccinate staff and students. Further transmission in elementary and high schools did not occur.

Bar inspections

In the initial phase of the outbreak, bars that had been visited by confirmed cases during their period of communicability were inspected. The inspections focused on potential infection prevention and control lapses that might have explained the transmission, such as inadequate dish and glass cleaning and disinfection. A letter and fact sheet on mumps were developed and given to bar owners.

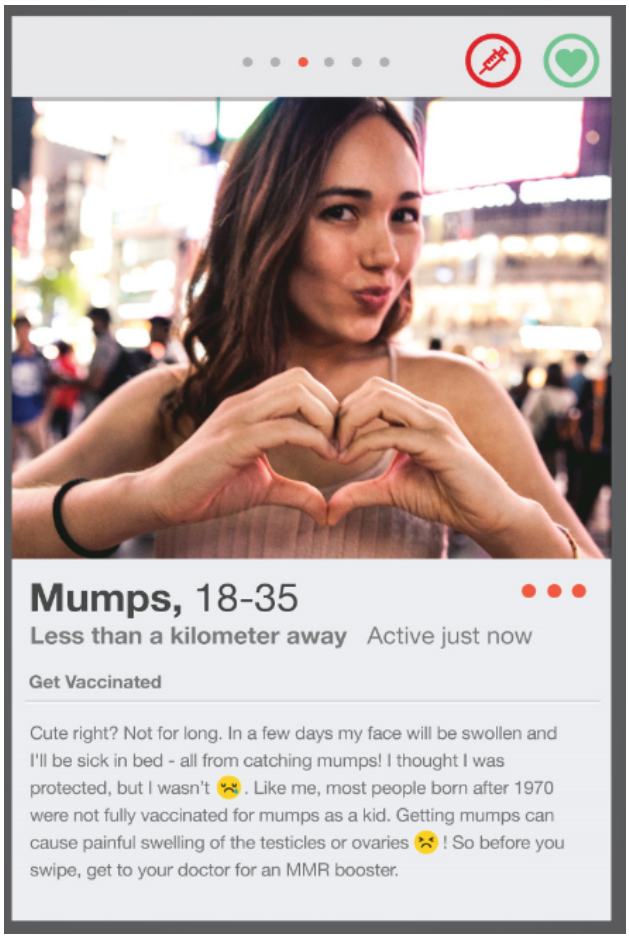
Communication strategy

A communication strategy was developed to target young adults who commonly attended bars in the west downtown core of Toronto. The key messages focused on educating the target audience about mumps infection and transmission, and promoting vaccination. Over 70 media interviews were conducted via multiple media and news outlets. Letters and posters were created and distributed to various audiences in an attempt to reach the target young adults (**Figure 1**). Community centres were accessed through internal city listings and gyms were identified through listings available online. All post-secondary institutions in Toronto were identified and sent materials in August 2017 in advance of "frosh week" and the start of classes.

Since many cases had listed downtown bars and restaurants as possible exposure settings early in the outbreak, over 4,000 letters were mailed to downtown bars and restaurants. Many staff members in these bars were identified as cases, so posters aimed at these staff were also created and disseminated in the middle of the outbreak.

Figure 1: Sample poster and social media image used for Toronto mumps outbreak, 2017–2018

Sample poster



Sample social media image

An outbreak webpage was created and updated regularly with new case counts and prevention messages.

Social media strategy

Three social media campaigns were launched throughout the outbreak on Facebook and Twitter. In the first wave of the

outbreak, a social media campaign ran from February to April 2017, targeting socially-active young people in Toronto's downtown west end. The goal was to raise awareness that mumps was circulating in Toronto and to encourage the target audience to check vaccination records or speak with their doctor to make sure that vaccinations were up to date. Creative images were designed to reflect the style, attitudes and online behaviours of the target audience (Figure 1). Sample social media messages used during the Toronto mumps outbreak included the following:

- Spread love, not mumps. Don't share drinks, utensils, food or water bottles
- Your style is up to date, but are your vaccines? Make sure you are protected from mumps
- Mumps is more than a funny word—it's on the rise in Toronto
- Catch feelings this summer, not mumps.Talk to your doctor about the MMR

The second social media campaign ran from July to September 2017, with an updated creative design and a stronger call to action. As it became clear that the outbreak was not ending and increasing herd immunity was essential, "learn more" messages were repositioned to "get vaccinated". The images and messages were reworked to relate to the summer events that might lead to possible increased transmission.

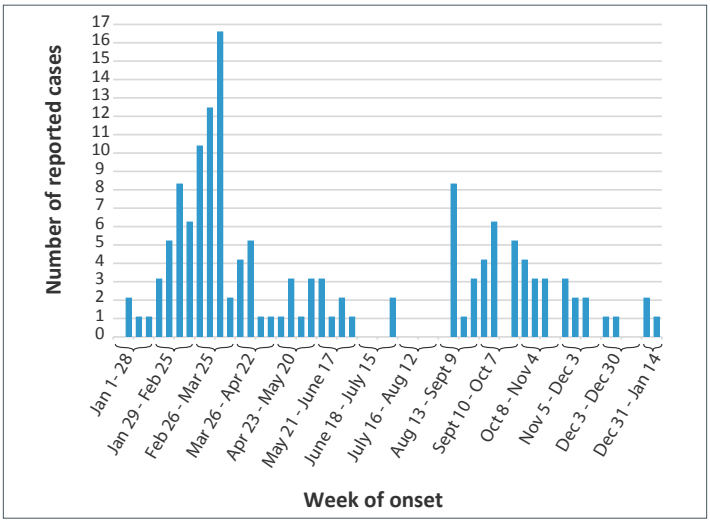
Following another wave of cases in the fall, a campaign in December focused on images and messages updated with winter and holiday images. The main message was to get vaccinated.

Results

Description of the outbreak

A total of 143 cases of mumps were identified from January 1, 2017 to February 26, 2018. The outbreak had an initial peak in early March 2017, and by June 2017 the cases has declined substantially (**Figure 2**). A second peak began in late August and lasted into the fall, and then declined throughout the rest of 2017. The mumps outbreak was declared over on February 26, 2018; 50 days (two incubation periods) after the onset in the last case.

Figure 2: Epidemic curve of confirmed mumps cases in Toronto by week, January 1, 2017 to February 26, 2018



Seventy-six percent of cases were between the ages of 18 to 34 years. The mean age of cases in the outbreak was 28 years old (range of 3–72 years old). The cases were fairly evenly distributed between genders (55% male). Most (84%) of the cases were community-acquired and only 16% of the cases were either a staff or a student at an elementary, high school or post-secondary institution; sustained transmission in these settings did not occur (**Table 1**).

Table 1: Descriptive summary of Toronto mumps cases, January 1, 2017 to February 26, 2018

Reported cases		
Descriptive characteristics	**n**	**%**
Total number of cases	143	100
Age[a] (years)		
0–5	1	1
6–11	0	0
12–17	9	6
18–25	44	31
26–34	65	45
35–49	21	15
50–64	2	1
65+	1	1
Gender		
Male	79	55
Female	64	45
School exposures[b]		
Yes	11	8
No	132	92
Bar exposures[b]		
Yes	70	49
No	73	51
Post-secondary school exposures[b]		
Yes	11	8
No	132	92
Vaccination status		
Vaccinated	38	27
Not vaccinated	16	11
Partially vaccinated	33	23
Unknown	56	39

Abbreviation: n, number
[a] In this outbreak, the mean age was 28. Age ranged between 3 and 72 years old
[b] Cases may have reported more than one site of exposure. Coverage rates for two doses of mumps-containing vaccines among school-aged children has consistently been about 90% for the past ten years in Toronto schools (6,7)

Parotitis was the most common symptom, reported by 97% (n=139) of cases. Serious complications were rare among cases: only two of the 143 cases visited the emergency room for their symptoms, and only one of those cases was admitted. Orchitis was reported by 23% (n=18) of male cases.

Most cases (73%) were either not vaccinated (11%), partially vaccinated with one dose of MMR vaccine (23%) or had an unknown vaccination history (39%). Only 27% had known vaccination with two doses of MMR vaccine. Five cases (3%) born before 1970, who were presumed to be immune by age, also developed the mumps.

Most of the cases in the outbreak were locally-acquired (93%). Of the 139 cases that were tested for genotype, the majority (n=115) were genotype G. Other genotypes identified included one genotype C and one genotype K, both travel-related. The travel-related cases were included in this outbreak because they were in Toronto for at least part of their acquisition period and the genotyping information was not included in the case definitions. The remainder (n=22) were indeterminate.

Initially, most new cases were not clearly linked to each other or to common institutions; however, on epidemiologic assessment, cases were found to be geographically located in west downtown Toronto and common exposures at dozens of west downtown Toronto bars and restaurants were noted, either from a patron or a staff member at these establishments. As the outbreak progressed, the majority of cases were no longer reporting only bar exposures or west downtown Toronto exposures, and wide spread community transmission across the city was evident.

Mumps-containing vaccine orders by primary care providers

During the period from March to August 2017, a total of 78,680 doses of mumps-containing vaccine (MMR) were shipped by the Ontario Government Pharmacy and Medical Supply Service in orders from Toronto health care providers, which was an average of 13,113 doses per month. In the same period in 2018 (March to August), only 66,509 mumps-containing vaccines were shipped, with an average of 11,085 doses per month. This represents an increase of 12,000 doses shipped during the peak outbreak period in 2017, compared with a similar period the following year.

Performance of social media campaigns

The outcome of the social media messages exceeded expectations. For the first campaign from February to April, 2017 during the peak of the first wave of the outbreak, there were over 360,000 impressions and over 14,000 engagements from the Facebook and Twitter messages and ads. The engagement rate on Twitter reached 10%, compared with the Toronto Public Health corporate account, which nearly averaged 1%. For the 2017 summer campaign, the engagement rate on Facebook and Twitter was still high, at 1%, and the accounts achieved an additional 50,000 impressions. The third campaign in December again maintained a high engagement rate, at 2%, with almost 120,000 impressions.

The reception to the campaign was evaluated by monitoring the comments and reactions to the campaign messages. Overall positive responses (likes, loves and laughs) far outnumbered the negative. People liked the humorous approach and noted the importance of vaccination. As expected, anti-vaccination comments were also present.

The mumps outbreak investigation webpage had a substantial increase in web traffic, from 161 visits in January 2017 to 13,698 visits from February to April 2017 at the height of the outbreak. Web hits increased when there was high media coverage, retweets by influential people and Facebook ads.

Discussion

This community-based outbreak predominately made up of young adults aged 18–34 years began in a distinct geographic area in west downtown Toronto bars and restaurants, and spread throughout the city.

Although some of the young adults were part of the cohort born after 1970 and before 1992 that had only one mumps-containing vaccine as a child, 50% of cases had an unknown vaccination status or were not vaccinated. Five people (3%) born before 1970, who were presumed to be immune by age, also developed the mumps. Without a vaccine registry, it is difficult to determine how many of those who had unknown vaccination status were actually vaccinated. A registry would also enable calculations of time since last vaccination which may be an important indicator of mumps vaccine-derived immunity in an outbreak setting (11).

This outbreak presented unique challenges in contact tracing and public health messaging, especially since the outbreak did not begin in an institution or well-defined group of individuals. There were difficulties reaching the clients through traditional phone calls and letters. Many were reluctant to provide contact information for their symptomatic close contacts (friends, coworkers or casual sexual partners) so it was left to the cases to notify their contacts. Some cases worked at a food establishment and were reluctant to provide their work information because they were concerned about negative publicity for the food establishment and the risk of termination.

Most young adults prefer to communicate and receive information through texting and social media rather than through more conventional methods such as newspapers and letters. Platforms such as Twitter and Facebook were identified as the ideal channels to quickly and efficiently engage the target audience. The challenge was to make the public health message relevant, engaging and urgent to a younger demographic. In this outbreak, we found that many young adults assumed they were fully vaccinated so the vaccination message did not seem relevant to

them. They did not feel vulnerable to illness nor did they perceive an urgency for vaccination. To address this, a social media strategy focused on the 'hipster' target audience, highlighting the social consequences of falling ill, such as missing social events and feeling left out. The response was generally positive, similar to that reported in other outbreaks (12).

Many cases and contacts had a difficult time finding their vaccination records (39% of cases). Encouraging vaccination rather than serologic testing of immunity in someone with unknown records became an important message to health care providers. Without a registry, it was difficult to say how many people were vaccinated in response to the outbreak; however, a proxy measure, vaccines distributed to providers, showed an increase in orders for mumps-containing vaccines during the height of the outbreak.

Other large mumps outbreaks have been reported in North America in recent years and the majority of these outbreaks have occurred in schools, colleges or sports teams, and many have been reported in populations assumed to be fully-vaccinated (13,14). Recently, the Advisory Committee on Immunization Practices in the United States has recommended a third dose of mumps-containing vaccine in an outbreak setting where there is already high two-dose coverage among cases (11). In the Toronto outbreak, almost a third of cases (27%) occurred in fully-vaccinated adults.

It is often difficult to determine why an outbreak ends. This was a thirteen-month community outbreak in a large urban centre. Sustained transmission in the schools did not occur. Public health messaging to modify social behaviours, such as sharing utensils while in a bar and restaurant setting, may also have been important. Increased vaccination likely played a role in ending this outbreak. Although an excess of 12,000 doses of vaccine were given in a six-month period during the height of the outbreak compared with the subsequent year, it is difficult to determine how large the susceptible cohort of young adults remains in Toronto without a registry.

Limitations

Underreporting of cases is likely for a number of reasons: improper, incomplete or no testing from clinicians; mild or asymptomatic cases who were less likely to seek medical attention; and some cases who were reluctant to report symptomatic contacts. Immunization status was difficult to verify as cases and contacts often did not have records available.

Conclusion

Among susceptible cohorts of young adults, ongoing social media and traditional communication campaigns can contribute to the control of community mumps outbreaks. Encouraging vaccine uptake is desirable, but without a vaccine registry it is difficult to assess vaccination coverage among adults. Susceptible cohorts of young adults who were not adequately vaccinated because of historic vaccination policies pose a risk for future outbreaks. Additionally, given that almost 30% of the mumps cases were fully vaccinated with two doses of mumps-containing vaccine, even two doses may not provide complete protection.

Authors' statement

All of the authors had access to the data, contributed to the preparation and revision of the manuscript and approved the final version.

Conflict of interest

None.

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Appendix 1

Case definitions use in Toronto mumps outbreak, January 1, 2017 to February 16, 2018

Confirmed

A resident of or visitor to Toronto with the following:

1. Laboratory confirmation of infection with a specimen collection date on or after January 1, 2017 with clinical signs and symptoms compatible with mumps infection with symptom onset on or after January 1, 2017

OR

2. Clinically compatible signs and symptoms with mumps infection with onset on or after January 1, 2017 in a person with an epidemiologic link to a laboratory-confirmed outbreak case

AND

3. Not linked to a travel-related exposure

Probable

A resident or visitor to Toronto with the following:

1. Clinical sign and symptoms compatible with mumps infection with symptom onset on or after January 1, 2017

AND

2. A link to a known outbreak related exposure site (absence of an epidemiologic link to a laboratory-confirmed case)

AND

3. Absence of laboratory testing or laboratory confirmation (e.g. laboratory results are pending and or it is outside the window of laboratory testing sensitivity)

AND

4. Not linked to a travel-related exposure

Appendix 2

Contact management for Toronto mumps outbreak, January 1, 2017 to February 16, 2018

Determination of contact

Contacts were defined by fulfillment of at least one of the following criteria during the infectious period (i.e., seven days before to five days after symptom onset):

1. Household contacts of a case
2. Persons who share sleeping arrangements with the case, including shared rooms (e.g., dormitories)
3. Direct contact with the oral/nasal secretions of a case (e.g., face-to-face contact, sharing cigarettes/drinking glasses/food/cosmetics like lip gloss, kissing on the mouth)
4. Children and staff in child care and school facilities
5. Health care workers with unprotected face-to-face interaction within one metre of an infectious mumps case
6. Individuals who share the same indoor air space with the case for more than one hour (e.g., during small social gatherings, such as birthday parties and sports teams)

Management of contacts

For contacts who met the above criteria, the following were done

1. advise contacts of possible exposure to mumps and educate about disease transmission
2. determine the immunization status of all contacts; encouraging vaccination of unimmunized or under-immunized individuals
3. note any symptoms, onset and severity; and
4. consider all symptomatic contacts as probable cases and perform confirmatory testing

Notification of contacts

Contact notification was done by public health in certain situations such as health care institutions or schools and if resources permitted; however, with a large number of cases in the outbreak it was not feasible. Contact notification by the case was used. Cases informed their contacts, including workplaces, usually electronically or by phone, about their potential exposure and provided a letter from TPH and fact sheet.

Susceptible contacts

Those who may require exclusion from a health care or school setting include:

1. Those born in Canada in 1970 or later who did not receive two doses of mumps-containing vaccine (at least four weeks apart) on or after their first birthday
2. Those without past history of laboratory confirmed mumps; and
3. Those without documented immunity to mumps

OUTBREAK REPORT

Outbreak of invasive *Streptococcus pneumoniae* among an inner-city population in Victoria, British Columbia, 2016–2017

G McKee[1]*, A Choi[1], C Madill[2], J Marriott[2], P Kibsey[2], D Hoyano[2]

Abstract

Background: Invasive pneumococcal disease (IPD) is a significant cause of morbidity and mortality; however, outbreaks of IPD are relatively rare. Homelessness and substance use are known risk factors for IPD and have been associated with several outbreaks in Canada, despite national recommendations for routine childhood and targeted adult pneumococcal vaccination.

Objectives: To describe the epidemiology and public health challenges related to an outbreak of novel serotype 4 IPD in a homeless and unstably housed population in Victoria, British Columbia during the autumn and winter of 2016–2017.

Results: Prospective, enhanced surveillance was initiated for laboratory confirmed cases reported to public health, including variables recording housing status and substance use. Thirty-three cases of serotype 4 IPD within the Victoria area were reported to public health between August 1, 2016 and September 1, 2017. Compared with other serotypes, these cases were more likely to be middle-aged, homeless or unstably housed, and to have a recent history of substance use. A targeted pneumococcal vaccination campaign was initiated in collaboration with external community organizations; however, these initiatives were challenged by incomplete data and staffing constraints.

Conclusion: This report illustrates an outbreak of serotype 4 IPD among an inner-city population with multiple risk factors, including homelessness, unstable housing and substance use. Given the challenges controlling the outbreak, outreach capacity and pneumococcal vaccination coverage is needed among this marginalized population.

Affiliations

[1] School of Population and Public Health, University of British Columbia, Vancouver, BC

[2] Island Health, Victoria, BC

***Correspondence:**
gwmckee@alumni.ubc.ca

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Keywords: Pneumococcal infections, disease outbreaks, homeless persons, drug users, British Columbia, Canada

Introduction

Invasive pneumococcal disease (IPD) results from infection of a normally sterile site by the gram-positive bacterium *Streptococcus pneumoniae* (1). Commonly presenting as pneumonia, meningitis or bacteremia, the overall incidence of IPD in Canada ranges between 8.9 and 9.9 cases per 100,000 population (2). While rates among infants have declined significantly following the implementation of routine childhood vaccination, rates in adults have remained largely unchanged. IPD still represents a significant source of morbidity and mortality, particularly among under-vaccinated, at-risk populations (2).

Homeless and low-income, inner-city communities are examples of high-risk populations for IPD. While most cases of IPD are sporadic, and (rare) outbreaks are most frequently described in "closed" institutional settings, a number of community-based outbreaks have been reported in inner-city populations in Western Canada (3–5).

In 2008, the National Advisory Committee on Immunization (NACI) concluded there was sufficient evidence that homeless persons had a higher risk of IPD, whether this represented a

causal linkage or a reflection of the risk factors disproportionately present in homeless individuals (3,5–7).

Given that the serotypes attributable to these outbreaks have been among those included in widely-available pneumococcal vaccines, there are considerable opportunities for intervention (8). NACI recommends that the 23-valent pneumococcal polysaccharide vaccine be provided to homeless persons, as well as those using substances; however, accessing this population has proven challenging, particularly given its transience.

Victoria has a population of approximately 86,000, over 1,700 of whom are homeless or under-housed (9,10). A considerable portion of the homeless population is transient, with 28% having moved to Victoria within the past year (9). Outreach, street nurse and public health services are provided by Island Health, one of five British Columbia (BC) regional health authorities; however, the capacity of these services to serve a dual harm reduction and communicable disease prevention role has been limited. The confluence of rising homelessness, inadequate staffing and competing priorities due to the opioid overdose epidemic have created additional challenges, complicating the response to a serotype 4 IPD outbreak in Victoria, BC, that was detected in the fall of 2016.

The objective of this report is to describe the epidemiology of a community-based serotype 4 IPD outbreak in a homeless and unstably housed population in Victoria, BC, and to describe the associated challenges in the implementation of public health investigations and interventions.

Methods

Outbreak detection

In August 2016, the specialized communicable disease nurses who routinely receive notifications of reportable diseases observed an increase in cases of serotype 4 IPD (predominantly pneumonia), while at the same time the local hospital's medical microbiologists reported an unusually high number of intensive care unit admissions for homeless, inner-city patients with invasive pneumococcal infection. Regional routine surveillance alerts, which compare counts of reportable diseases to historical 5-year averages, noted an increase in reported cases of IPD, as did the provincial system which issues alerts based on statistical discrepancies between the observed data and historical patterns. According to regional surveillance, the number of IPD cases reported in September 2016 was eight times higher than the 5-year monthly average, while October 2016 experienced a 3-fold increase. In light of these multiple signals, the Medical Health Officer declared an outbreak of serotype 4 IPD in October 2016.

Investigation

IPD has been reportable in BC since 1999 and nationally notifiable in Canada since 2000 (1,11). In BC, a case of IPD is defined by clinical evidence of invasive disease with laboratory confirmation of *Streptococcus pneumoniae* from a normally sterile site, such as blood and CSF, but excluding the middle ear (12).

All samples were collected at Island Health facilities. *S. pneumoniae* isolates were cultured and evaluated for drug sensitivity at Royal Jubilee Hospital in Victoria, BC. Further serotyping was performed at the National Microbiology Laboratory. Cases identified by laboratory physicians that met the definition of IPD were reported to public health. Data from all cases of invasive pneumococcal disease in the surrounding region (Southern Island Health Service Delivery Area of Island Health) were collated in Microsoft Excel (Microsoft Corporation, Redmond, Washington, United States) from standardized case report forms used for routine surveillance, as well as electronic medical records.

Case report forms were expanded with additional risk factor variables not previously collected, including housing status and substance use. Although patients were not directly contacted to obtain additional information, a retrospective chart review was conducted using electronic health records from public health encounters, emergency room visits, hospital admissions, outpatient investigations, and mental health and substance use clinical profiles. Case charts were reviewed by two authors (GM and AC) and data was coded based on standardized definitions (**Appendix 1**). Cases were stratified by serotype (serotype 4 vs. non-serotype 4) for descriptive analysis in Excel. Continuous variables were compared using a non-paired Student's t test assuming unequal variance. Categorical variables were compared using a X^2 or Fisher's exact test, depending on cell size. Unadjusted odds ratios were calculated using logistic regression in R statistical software (R Foundation, Vienna, Austria).

Results

A total of 84 cases of IPD within the South Island Health Service Delivery Area (HSDA) were reported to public health between August 1, 2016 and September 1, 2017. Whereas only three cases of *S. pneumoniae* serotype 4 were reported within the prior 4.5 years, 33 were identified during the study period, comprising 39.3% of all reported cases of IPD (**Figures 1A and 1B**).

Case reports of serotype 4 peaked in September and October 2016 and persisted throughout the study period, slowing down by March 2017 (**Figure 2**).

The demographic and risk profiles of serotype 4 and non-serotype 4 cases of IPD reported during the study period are compared in **Table 1**. There was no significant difference in gender distribution between the two groups, with both serotype groups seen predominantly in males. The median age of serotype 4 cases (median=46 years, Standard Deviation [SD]=15.22 years) was significantly (p<0.001) lower than

Figure 1A: Serotype distribution of *Streptococcus pneumoniae* isolates from patients with invasive pneumococcal disease within the South Island Health Service Delivery Area (British Columbia, Canada), January 1, 2012–July 31, 2016

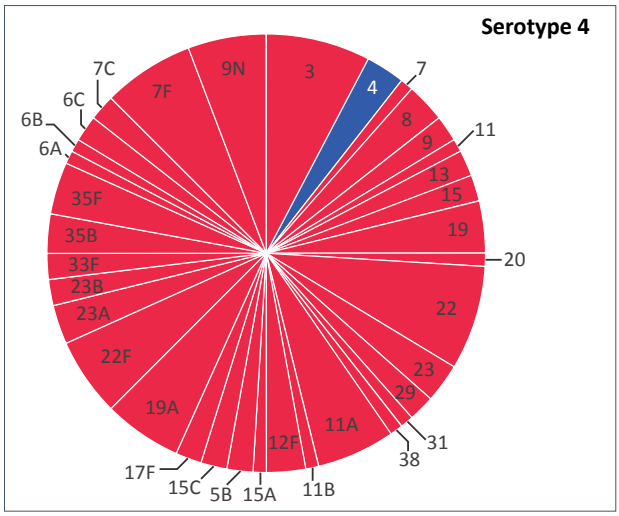
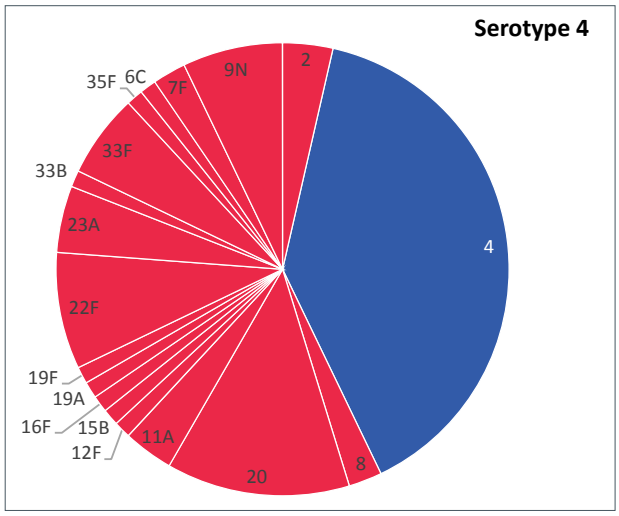


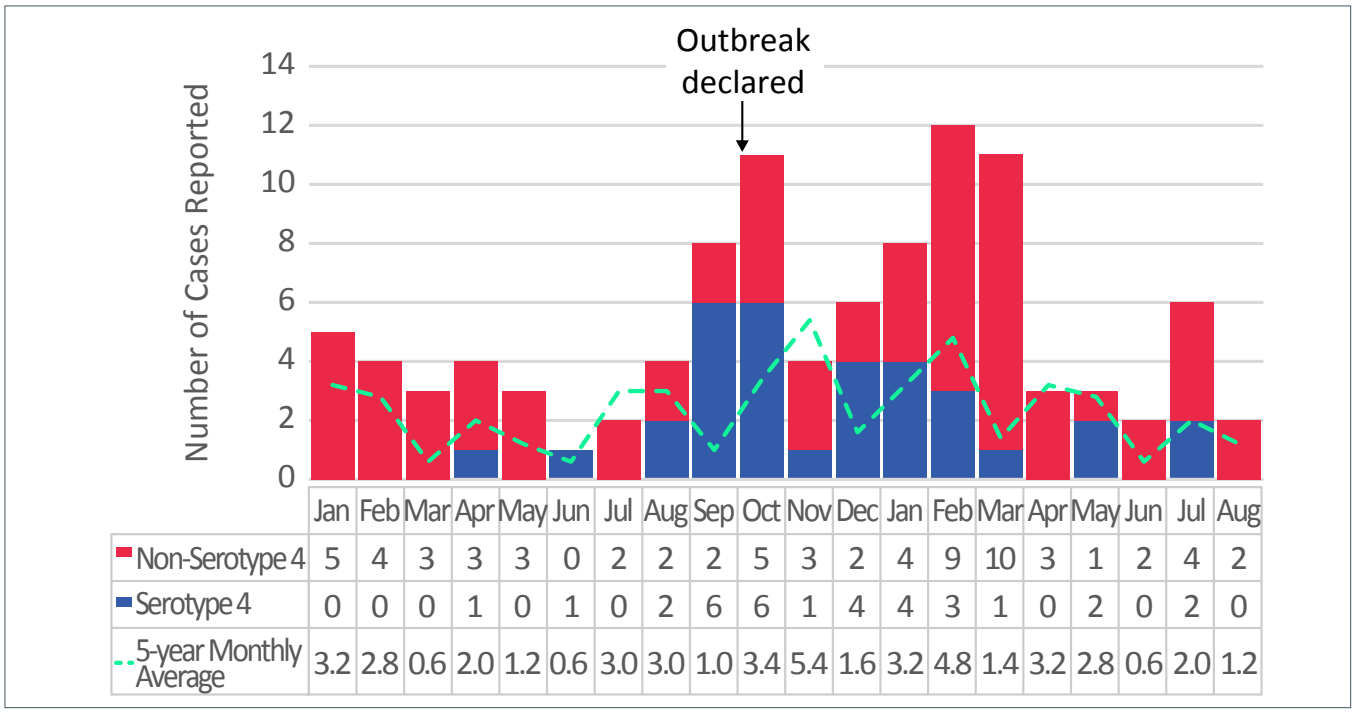
Figure 1B: Serotype distribution of *Streptococcus pneumoniae* isolates from patients with invasive pneumococcal disease within the South Island Health Service Delivery Area (British Columbia, Canada), August 1, 2016–September 1, 2017



non-serotype 4 cases (median=63 years, SD=18.21 years) and included no cases over the age of 75 years. Serotype 4 cases were also much more likely to be homeless or unstably housed (48.48% vs. 15.69%). Substance use was more prevalent among serotype 4 cases, although significant differences were only noted for methamphetamine, cannabis, opioids and tobacco smoking.

Serotype 4 cases generally reported fewer co-morbidities than other serotypes, with significant differences in cardiovascular disease, renal disease and diabetes. No significant differences in clinical presentation or hospital and Intensive Care Unit admission were observed; however, while 10 in-hospital deaths were reported among the non-serotype 4 cases, no in-hospital deaths were reported among the serotype 4 cases.

Figure 2: Number of reported cases of serotype 4 and non-serotype 4 invasive pneumococcal disease compared with a 5-year monthly average of all serotypes, South Island Health Service Delivery Area (British Columbia, Canada), January 1, 2016–September 1, 2017



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Non-Serotype 4	5	4	3	3	3	0	2	2	2	5	3	2	4	9	10	3	1	2	4	2
Serotype 4	0	0	0	1	0	1	0	2	6	6	1	4	4	3	1	0	2	0	2	0
5-year Monthly Average	3.2	2.8	0.6	2.0	1.2	0.6	3.0	3.0	1.0	3.4	5.4	1.6	3.2	4.8	1.4	3.2	2.8	0.6	2.0	1.2

Table 1: Demographics, characteristics and outcomes among serotype 4 and non-serotype 4 cases of invasive pneumococcal disease within the South Island Health Service Delivery Area of Island Health (British Columbia, Canada), August 1, 2016–September 1, 2017

Variable	Serotype 4		Non-Serotype 4		*p*-value
	n	%	n	%	
Total cases	33	100	51	100	N/A
Gender					
Male	23	69.70	29	56.86	0.34
Housing status					
Homeless or unstable housing	16	48.48	8	15.69	<0.01
Substance use					
Heavy alcohol use	13	39.39	16	31.37	0.80
Injection drug use	10	30.30	5	9.80	0.054
Cocaine	8	24.24	5	9.80	0.20
Methamphetamine	10	30.30	3	5.88	<0.05
Cannabis	18	54.55	8	15.69	<0.01
Opioids	18	54.55	7	13.73	<0.001
Tobacco smoking	27	81.82	18	35.29	<0.001
Co-morbidities					
HCV	7	21.21	9	17.65	1.00
HIV	1	3.03	3	5.88	0.64
Lung disease	9	27.27	23	45.10	0.086
Cardiovascular disease	5	15.15	21	41.18	<0.05
Renal disease	1	3.03	13	25.49	<0.01
Diabetes	1	3.03	9	17.65	<0.05
IPD presentation					
Pneumonia	28	84.85	43	84.31	1.00
Meningitis	2	6.06	3	5.88	1.00
Level of care					
Hospital admission	31	93.94	46	90.20	1.00
ICU admission	10	30.30	12	23.53	0.70
Outcome					
In-hospital death	0	0	10	19.61	<0.01
Immunization					
Previous pneumococcal vaccination[a]	3	9.09	8	15.69	0.52

Abbreviations: HCV, hepatitis C virus; ICU, intensive care unit; N/A, not applicable; n, number; <, inferior to
[a] Pneumococcal vaccination status was determined using electronic record systems that are known to be incomplete; reported numbers should be interpreted with caution
Note: Numbers rounded to the nearest decimal

As illustrated in **Table 2**, bivariate analysis of risk factors further distinguished serotype 4 cases from other serotypes. Similar to the descriptive analysis, the odds that serotype 4 cases were homeless or unstably housed was 4.82 (95% Confidence Interval [CI] [1.79, 13.97]) times higher than non-serotype 4 cases. Serotype 4 cases were also associated with a higher odds of substance use, including injection drug use (Odds Ratio [OR] 3.65; 95% CI [1.15, 12.95]), methamphetamine use (OR 6.23; 95% CI [1.71, 29.89]), cannabis use (OR 5.85; 95% CI [2.17, 17.07]), opioid use (OR 6.69; 95% CI [2.41, 20.36]) and tobacco smoking (OR 7.25; 95% CI [2.64, 22.62]). Negative associations were observed for cardiovascular disease (OR 0.22; 95% CI [0.07, 0.63]) and renal disease (OR 0.08; 95% CI [0, 0.45]).

Table 2: Bivariate analysis of risk factors among serotype 4 and non-serotype 4 cases of invasive pneumococcal disease within the South Island Health Service Delivery Area (British Columbia, Canada), August 1, 2016–September 1, 2017

Risk factor	OR	CI 95%	*p*-value
Homeless or unstable housing	4.82	[1.79, 13.97]	<0.01
Heavy alcohol use	1.26	[0.50, 3.18]	0.62
Injection drug use	3.65	[1.15, 12.95]	<0.05
Cocaine	2.62	[0.79, 9.53]	0.12
Methamphetamine	6.23	[1.71, 29.89]	<0.01
Cannabis	5.85	[2.17, 17.07]	<0.001
Opioids	6.69	[2.41, 20.36]	<0.001
Tobacco smoking	7.25	[2.64, 22.62]	<0.001
HCV	1.17	[0.37, 3.52]	0.78
HIV	0.47	[0.02, 3.85]	0.52
Lung disease	0.39	[0.15, 1.00]	0.054
Cardiovascular disease	0.22	[0.07, 0.63]	<0.01
Renal disease	0.08	[0, 0.45]	<0.05
Diabetes	0.13	[0.01, 0.76]	0.060

Abbreviations: CI, confidence interval; HCV, hepatitis C virus; OR, odds ratio; <, inferior to

Public health response

In response to the outbreak, Island Health's Street Outreach Program initiated a campaign to increase uptake of 23-valent polysaccharide vaccine containing serotype 4, which was significantly bolstered through collaborations with several inner-city service providers that had pre-existing relationships with those at highest risk of infection. Approximately 100 doses were administered between August 2016 and September 2017 by street outreach nurses, while over 80 additional doses were administered by other providers serving this at-risk population.

By April 2017, the total number of reported IPD cases had declined to levels comparable to the baseline average. Following persistent, low numbers of reported cases over the subsequent months, it was concluded that enhanced surveillance was no longer necessary; however, the proportion of IPD cases due to serotype 4 remained higher than pre-outbreak levels, suggesting persistent low-level circulation.

Discussion

Despite ongoing endemicity of pneumococcal infection in Canada, outbreaks of invasive pneumococcal disease are relatively rare. Serotype 4 is reported to have a high level of invasiveness, although some studies have suggested that this may be more strongly linked to capsular composition than serotype (13). Nonetheless, invasive serotypes are often implicated in outbreaks of IPD, such as the serotype 5 outbreaks reported in Canada (3,5). This report adds to the limited literature available on outbreaks of serotype 4 IPD. Given the characteristics of the homeless population affected by this outbreak and what is known about the risks of IPD, strengthening targeted prevention programs may be indicated.

The implication of a vaccine-preventable serotype (4) in this outbreak suggests the current approach to administering recommended vaccines among this at-risk population is not entirely effective. Despite the NACI recommendations to offer pneumococcal vaccine to homeless individuals and people who used drugs, these populations are often difficult to reach. The limited capacity for street nurses to provide outreach services to the inner-city population presented a challenge both prior to and during the outbreak. Despite pre-existing staffing constraints, this service was further challenged by competing priorities associated with the response to the opioid crisis. Transmission of pneumococcus may thus have been exacerbated by a decrease in targeted pneumococcal vaccination in the preceding year due to this limited street outreach capacity within the Victoria region. These deficiencies were recognized during the outbreak and an additional position was created to bolster the service.

The targeted pneumococcal vaccination campaign represented a core component of the public health response to the IPD outbreak. It is difficult to determine the degree to which the efforts to expand uptake contributed to the observed reduction in new onset cases. Similar vaccine campaigns designed to curtail IPD outbreaks have reported mixed results (3,5).

During the outbreak, several barriers to targeted vaccination were identified, including incomplete vaccination records, which made it difficult to identify those who required vaccination. While both public health staff and community providers within the health authority administer vaccines, they utilize different information systems. Integrated health and vaccination records could have improved both individual-level assessments of vaccination status and population-level assessments of vaccine effectiveness.

In addition to staffing constraints and incomplete vaccination records, other challenges limited the extent of the investigation. As we relied on retrospective chart review for information about case risk factors, under-reporting of risk factors may have introduced misclassification bias. While the standard practice for public health nurses within the health authority involves no direct follow-up of IPD cases, interviews may have provided additional details, allowing for better insight into potential transmission patterns. In the future, further analysis of contact networks may allow for identification of potential sites of transmission, such as a specific shelter or gathering place, which could inform targeted public health measures.

Conclusion

This report illustrates an outbreak of serotype 4 invasive pneumococcal disease among an inner-city population with multiple risk factors for transmission, including homelessness, unstable housing and substance use. It also reinforces the ongoing need to improve outreach capacity and pneumococcal vaccine coverage among this marginalized population.

Authors' statement

All authors were involved in conceptualization, analysis/interpretation of data, and drafting of the manuscript. GM, AC, CM and JM were also involved in data collection.

Conflict of interest

None.

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Appendix

Table 1: Definitions of primary variables used in analysis

Variable	Definition
Age	Age at hospital admission for IPD, as documented in electronic medical record
Gender	Gender as documented in electronic medical record
Homeless or unstable housing	No fixed address OR identified as homeless OR under-housed OR couch surfing OR living in tents OR shelters as documented in electronic medical record
Substance use	
Heavy alcohol use	Current alcohol use disorder OR alcohol use that exceeds low-risk guidelines, as documented in electronic medical record
Injection drug use	Injection drug use as documented in electronic medical record
Cocaine	Cocaine use described in chart notes OR detected on toxicological screen within last year, as per electronic medical record
Methamphetamine	Methamphetamine use described in chart notes OR detected on toxicological screen within last year, as per electronic medical record
Cannabis	Cannabis use described in chart notes OR detected on toxicological screen within last year, as per electronic medical record
Opioids	Illicit opioid use described in chart notes OR detected on toxicological screen within last year, as per electronic medical record
Tobacco smoking	Recent tobacco smoking (within previous year) described in chart notes, as per electronic medical record
Co-morbidities	
HCV	Hepatitis C virus infection described in chart notes or laboratory records, as per electronic medical record
HIV	HIV infection described in chart notes or laboratory records, as per electronic medical record
Lung disease	Co-morbid lung disease described in chart notes, as per electronic medical record
Cardiovascular disease	Co-morbid cardiovascular disease described in chart notes, as per electronic medical record
Renal disease	Co-morbid renal disease described in chart notes, as per electronic medical record
Diabetes	Co-morbid diabetes mellitus described in chart notes, as per electronic medical record
IPD presentation	
Pneumonia	Pneumococcal pneumonia as documented in electronic medical record
Meningitis	Pneumococcal meningitis as documented in electronic medical record
Level of care	
Hospital admission	Admission to hospital for IPD, as documented in electronic medical record
Length of stay in hospital	Number of days calculated from date of hospital admission (within Island Health) for IPD to date of death or discharge.
ICU admission	Admission to ICU during hospital stay for IPD, as documented in electronic medical record
Outcome	
In-hospital death	Death during hospital admission for IPD, as documented in electronic medical record
Immunization	
Previous pneumococcal vaccination	Previous pneumococcal vaccination within the last five years as documented in electronic medical record or electronic Public Health Information System

Abbreviations: HCV, hepatitis C virus; ICU, intensive care unit; IPD, invasive pneumococcal disease

HIV in Canada—Surveillance Report, 2017

N Haddad[1], JS Li[1], S Totten[1], M McGuire[1,*]

Abstract

Background: Human immunodeficiency virus (HIV) is a global public health issue with an estimated 1.8 million people newly infected in 2017.

Objective: To provide a descriptive overview of reported cases of HIV in Canada by geographic location, sex, age group, exposure category and race/ethnicity, from 1985–2017, with a focus on the most recent data.

Methods: The Public Health Agency of Canada (PHAC) monitors HIV through the national HIV/AIDS Surveillance System, which is a passive, case-based system that collates non-nominal data voluntarily submitted and validated by all Canadian provinces and territories. Additional data sources presented here include data on immigration-related medical screening for HIV by Immigration, Refugees and Citizenship Canada and data on infants perinatally-exposed to HIV submitted by the Canadian Perinatal HIV Surveillance Program. Data were collated, tables and figures were prepared and descriptive statistics were applied by PHAC and validated by each province and territory.

Results: A total of 2,402 new HIV diagnoses were reported in 2017 in Canada; an increase of 3% compared with 2016 and an increase of 17.1% since 2014. The national diagnosis rate increased slightly, from 6.4 per 100,000 population in 2016 to 6.5 per 100,000 population in 2017. In 2017, while Ontario continued to account for the highest number (n=935) and proportion (38.9%) of reported HIV cases, Saskatchewan reported the highest provincial diagnosis rate (15.5 per 100,000 population). In 2017, the diagnostic rate for males at 9.9 per 100,000 population was higher than for females at 3.2 per 100,000 population. As in 2016, the 30–39 year age group had the highest HIV diagnosis rate at 14.8 per 100,000 population. The "gay, bisexual and other men who have sex with men" exposure category continued to represent almost half (46.4%) of all reported HIV cases in adults. In 2017, the absolute number of HIV-positive migrants entering Canada increased to a total number of 835 migrants. One mother-to-child HIV transmission was confirmed in a mother who did not receive any perinatal antiretroviral therapy and two transmissions were confirmed in mothers who did receive perinatal antiretroviral therapy.

Conclusion: Similar to the annual changes that have been reported since 2014, the number and rate of reported HIV cases in Canada in 2017 increased slightly compared with 2016. Additional data and analysis are needed to determine the extent to which these findings reflect an increase in HIV transmission, an increase in HIV testing, changes in reporting practices and an increase in the number of HIV-positive people migrating to Canada.

Affiliation

[1] Centre for Communicable Diseases and Infection Control, Public Health Agency of Canada, Ottawa, ON

***Correspondence:**
phac.hass.aspc@canada.ca

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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, Indigenous

Introduction

Human immunodeficiency virus (HIV) is an important contributor to the global burden of disease and continues to be a major public health issue. In 2010, HIV was the leading cause of disability-adjusted life-years worldwide for people in the 30–44 year age group, and the fifth leading cause for all ages (1). The

Joint United Nations Programme on HIV/AIDS (UNAIDS) (2) estimated that there were 36.9 million people living with HIV at the end of 2017 globally and as of June 2017, 21.7 million people were receiving antiretroviral therapy (ART) (2,3). In the absence of a cure for HIV infection, ART has been effective in controlling the infection and minimizing transmission, thus ensuring that people living with HIV, including pregnant women and key populations at risk, can lead healthy and productive lives.

The objective of this report is to provide a descriptive overview of the epidemiology of all reported diagnoses of HIV in Canada, up to the end of 2017, by province/territory, sex, age group, exposure category and race/ethnicity. Data on immigration medical screening results for HIV, as well as the number of infants perinatally exposed to HIV and the proportion of these infants receiving ART, are also presented.

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 the Public Health Agency of Canada (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 non-nominal data on persons diagnosed with HIV infection. Details on HASS's methods, including data collection processes, data management, data quality control, analysis, and the classification and categorization of population subgroups have previously been described in detail (4). 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. Of note: Quebec does not submit exposure category or race/ethnicity information for HIV cases to PHAC; for Ontario, no race/ethnicity data were available for reported HIV cases before 2009; and race/ethnicity data for British Columbia were not submitted for the current reporting year and all historic ethnicity data have been removed at the province's request, pending a review of reporting practices of these data at the provincial level.

Cases reported to PHAC must meet the national case definition (5). Provinces and territories provide data through the *National Case Reporting Form* (4) 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 HIV cases diagnosed on or before December 31, 2017 that were submitted by provincial and territorial surveillance programs to PHAC up to July 19, 2018.

In this surveillance report, the term "cases" or "reported cases" refers to individuals diagnosed by a province or territory in a given year. Since surveillance data describe only diagnosed cases of HIV, statistical modelling and additional sources of information are used to produce estimates that describe the overall HIV epidemic in Canada, including people with diagnosed and undiagnosed HIV infection (6). The term "adult" is used throughout the report when examining specific variables such as exposure category. For the purposes of this report, an "adult" is anyone aged 15 years or older.

Immigration medical screening for HIV

All foreign nationals applying for permanent residence and some applying for temporary residence must undergo an Immigration Medical Examination (IME) administered by the IRCC, either in Canada or overseas. The IRCC conducts mandatory routine HIV screening on all applicants 15 years of age and older, as well as on those under the age of 15 years who have certain risk factors (7). The IRCC provides PHAC with non-nominal data collected during the IME on migrants who tested positive for HIV, either in Canada or abroad, and subsequently entered Canada. The term migrant is being used broadly and includes the following: immigrants (permanents residents of Canada); refugees; refugee claimants or convention refugees; and temporary residents (visitors, students or foreign workers). The data presented here includes the year of testing (for those tested in Canada) or the year the migrant entered Canada (for those tested overseas). The IME data presented here were obtained from two IRCC sources: the HIV database updated to March 2018 (for all applicants screened in Canada or overseas who tested positive for HIV); and the Health Branch Post-Arrival Health Public Health Liaison Unit Provincial Notifications — Overseas Notifications database updated to July 2018. IRCC data were submitted to PHAC in March 2018.

Of note, the results of IME testing done in Canada are available to provinces/territories where the testing is done, and IRCC also shares relevant data with the province/territory of destination for IME testing done outside of Canada. These data are subsequently 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.

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

in Canada; and HIV-infected children receiving care at any participating site (whether born in Canada or abroad). Data on the HIV status of these infants and on the infant's history of perinatal ART exposure (i.e., the infant's mother was receiving ART during pregnancy) were obtained through a national, non-nominal, confidential survey of infants known to participating pediatricians in tertiary care centres and specialists in HIV clinics across Canada. Additional information on CPHSP methodology has been described previously (4). Surveillance data for 2017, including data updates for previous years, were submitted to PHAC in March 2018.

Analysis

Microsoft Excel 2010 (Redmond, Washington, United States [US]) and SAS Enterprise Guide v5.1 (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. No statistical procedures were used for comparative analysis, nor were any statistical techniques applied to account for missing data since analyses are limited to cross-tabulations. Instead, missing data are presented in an independent row in each table (where feasible). The proportions presented in the text exclude records with missing values (unless otherwise noted). It is worth noting that different HIV reporting requirements and practices exist across the country (8) and that the completeness of some epidemiological information varies between provinces and territories. The population data source used to calculate rates was the 2017 Annual Demographic Statistics, issued by Statistics Canada (9).

With the exception of cases where data suppression was requested by the province or territory, data in tables with small cell sizes (n≤5) were not suppressed, since disclosure is not deemed to pose any risk of identifying individual cases. These procedures are in line with PHAC's *Directive for the collection, use and dissemination of information relating to public health* (*PHAC, 2013, unpublished document*). The data were verified by the provinces and territories to ensure accuracy. Key findings are summarized in this manuscript. Supplementary tables are listed in the **Appendix** and are available upon request.

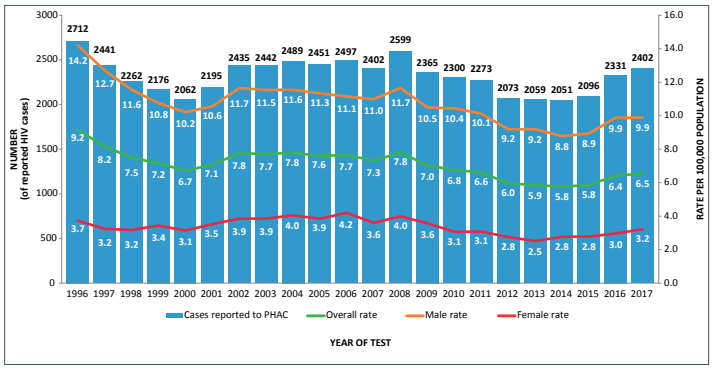
Results

Overall trends

In 2017, a total of 2,402 new HIV cases were reported in Canada, an increase of 3% compared with 2016 and an increase of 17.1% since 2014. The national diagnosis rate also increased from 5.8 per 100,000 population in 2014 to 6.5 per 100,000 population in 2017, but changed little from 2016 to 2017 (6.4 versus 6.5 per 100,000 population) (**Figure 1).**

Overall, there was a decrease in the annual diagnosis rate between 1996 and 2000, followed by an increase in 2001 and a plateau until 2008. A slight decrease of the national rate followed until 2014. Since then, a slight increase has been observed (Figure 1). Figure 1 also shows generally comparable trends for males and females. In 2017, the diagnostic rate for males (at 9.9 per 100,000 population) was higher than for females (at 3.2 per 100,000 population). The same trend was observed for all historical data since 1996.

Figure 1: Number of reported cases, including national, male and female diagnostic rates, by year of test—Canada, 1996–2017



Abbreviation: PHAC, Public Health Agency of Canada
Note: Disaggregated data by year are not available before 1995 for some jurisdictions

Geographic distribution

The geographic distribution of reported HIV cases in 2017 was comparable to that of 2016. In 2017, Ontario continued to account for the highest number and proportion of reported HIV cases (n=935, 38.9%), followed by Quebec (n=670, 27.9%), Alberta (n=282, 11.7%) and British Columbia (n=187, 7.8%).

The provincial and territorial diagnostic rates varied across the country. In 2017, Saskatchewan accounted for 7.5% of total reported new HIV cases, yet that province had the highest diagnosis rate at 15.5 per 100,000 population. Following a decrease in the rates in 2013 (11.8 per 100,000 population) and 2014 (10.8 per 100,000 population) the rates in Saskatchewan have since been increasing and are more comparable to historic years (2008 to 2012).

In 2017, Quebec accounted for 27.9% of total reported new HIV cases and had the second highest diagnosis rate of HIV at 8.0 per 100,000 population. Manitoba, Alberta and Ontario each had the third highest rate at 6.6 per 100,000 population.

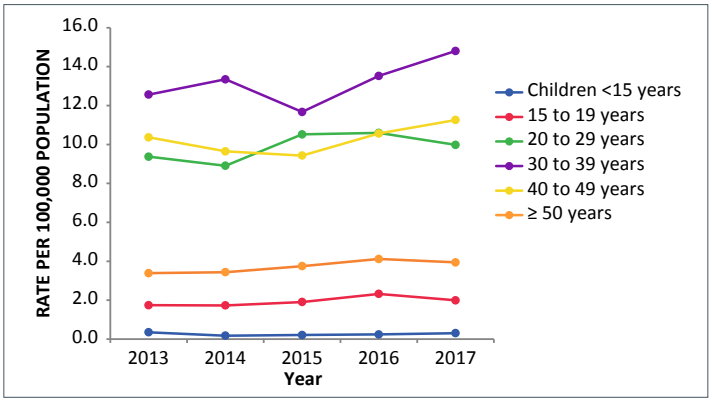
Age group and sex distribution

Data on age groups were available for nearly 100% of reported HIV cases for 2017 (n=2,397). The 30–39 year old age group continued to represent the highest number of new HIV cases (31.2%), a finding that has been observed since the beginning of the reporting period. In 2017, the 50 years and older age group represented the second highest proportion of new HIV cases at 22.9%, followed closely by the 40–49 year old age group at 22.4%.

Figure 2 shows the trends in the diagnostic rates for each age group, between 2013 and 2017. In 2017, the 30–39 year old

age group had the highest rate of reported HIV cases (14.8 per 100,000 population), followed by the 40–49 year old age group (11.3 per 100,000 population); in addition, rates in these age groups have been increasing since 2015 (Figure 2). Although there was an overall increase in the rates for the 15–19 year old age group and the 50 years and older age group since 2014, the rates decreased in 2017 (2.0 per 100,000 population and 3.9 per 100,000 population, respectively). Children (<15 years of age) had the lowest average rate over the five-year range.

Figure 2: HIV diagnosis rate, by age group and year of test—Canada, 2013–2017



Abbreviation: <, less than
Population data source: Annual Demographic Statistics, Statistics Canada (9)

Data on sex were available for nearly 100% of reported HIV cases in 2017 (n=2,395). Since the beginning of HIV surveillance, males have accounted for a larger percentage of diagnosed HIV cases among adults (≥15 years). In 2017, 75.2% of reported HIV cases were male and 24.8% were female.

Rates for reported HIV cases by sex for 2017 indicate that the 30–39 year age group had the highest rate for both males (21.3 per 100,000 population) and females (8.2 per 100,000 population). Similarly in both sexes, the 40–49 year age group had the second highest rate for males (16.2 per 100,000 population) and females (6.3 per 100,000 population).

Exposure category distribution

In 2017, information on exposure category was available for 60.2% of reported HIV cases (n=1,446). The gay, bisexual and other men who have sex with men (gbMSM) exposure category continued to represent the largest number and proportion of all reported adult cases with known exposure category (46.4%) (**Table 1**). The second most frequently reported exposure category was heterosexual contact at 28.7%. The latter exposure category includes three exposure profiles: HIV infected individuals born in a country where HIV is endemic (11.5%); heterosexual contact with a person at risk (7.2%); and heterosexual contact with no identifiable risk (10.0%). People who inject drugs (PWID) exposure category accounted for 16.3% of all reported HIV cases in adults (Table 1).

As in 2016 (10), the distribution of HIV cases among adult males and females varied by exposure category. In 2017, the gbMSM exposure category continued to account for the greatest proportion of reported HIV cases among adult males (60.9%), while among adult females, history of heterosexual contact, origin from an HIV-endemic country (30.9%) and PWID (27.6%) exposure categories accounted for the greatest proportion of reported HIV cases (Table 1).

Table 1: Number and percentage distribution of HIV cases by sex and exposure category among adults ≥ 15 years of age—Canada 2017[a]

Exposure category	Sex					
	Male		Female		Total[b]	
	n	%	n	%	n	%
gbMSM	667	60.9	0	0	667	46.4
gbMSM/PWID	40	3.6	0	0	40	2.8
PWID	139	12.7	94	27.6	234	16.3
Heterosexual contact						
a) origin from an HIV-endemic country	61	5.6	105	30.9	166	11.5
b) sexual contact with a person at risk	54	4.9	49	14.4	104	7.2
c) no identified risk	90	8.2	54	15.9	144	10.0
Other[c]	45	4.1	38	11.2	83	5.8
Subtotal	**1,096**	**100.0**	**340**	**100.0**	**1,438**	**100.0**
No identified risk	75	4.2	19	3.2	94	4.0
Exposure category unknown or not reported ("missing")[d]	616	34.5	228	38.8	847	35.6
Total	**1,787**	**n/a**	**587**	**n/a**	**2,379**	**n/a**

Abbreviations: gbMSM, Gay, bisexual and other men who have sex with men; n/a, not applicable; n, number; PWID; people who inject drugs; ≥, superior or equal to
[a] Excludes cases (n=5) where age is unknown
[b] Total column includes transsexual, transgender cases as well as cases where sex was not reported, where as "male" and "female" columns exclude these cases
[c] Includes cases from Alberta identified through Immigration Refugees and Citizenship Canada
[d] Includes all cases where exposure category was unknown or not reported. Note: exposure category information was not submitted by Quebec

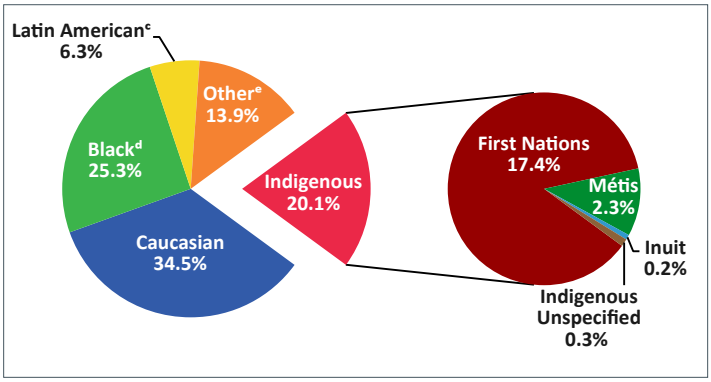
Race/ethnicity distribution

In 2017, information on race/ethnicity was available for 49.3% of reported HIV cases (n=1,184). Since 1999, the Caucasian race/ethnicity category has accounted for the largest proportion of new HIV cases in Canada for all ages and sexes (43.1% of cases where ethnicity/race was reported). In 2017, of the reported HIV cases with a known race/ethnicity, 34.5% were reported as Caucasian, 25.3% were reported as Black and 20.1% were reported as Indigenous. The Indigenous race/ethnicity category was further subdivided into the following subgroups: First Nations (17.4%); Métis (2.3%); Inuit (0.2%); and Indigenous unspecified (0.3%) (**Figure 3**).

As in 2016, variations were observed in the race/ethnicity distribution by sex. In 2017, in males, the Caucasian race/ethnicity accounted for 41.7% of reported HIV cases with available race/ethnicity data. The Black and Indigenous race/ethnicities accounted for 17.9% and 16.3%, respectively. In comparison, in females, the Black race/ethnicity accounted for

46.3% of reported HIV cases, followed by the Indigenous race/ethnicity at 30.9% and Caucasian at 14.1% (**Table 2**).

Figure 3: Proportion of reported HIV cases (n=1,184) by race/ethnicity and Indigenous subgroups—Canada, 2017[a,b]



Abbreviation: n, number
[a] Race/ethnicity information was not available for Quebec and British Columbia
[b] Excludes cases where race/ethnicity was not reported
[c] For example, Mexican, Central American and South American
[d] For example, Somali, Haitian and Jamaican
[e] "Other" includes, for example, Pakistani, Sri Lankan, Bangladeshi, Armenian, Egyptian, Iranian, Lebanese, Moroccan, Chinese, Japanese, Vietnamese, Cambodian, Indonesian, Laotian, Korean, Filipino

Race/ethnicity and exposure category distribution

In 2017, information on both race/ethnicity and exposure category was available for 49.2% of reported cases. Among 2017 gbMSM cases, the majority were reported as Caucasian (49.9%). The majority of cases attributed to PWID were reported as Indigenous (68.1%). The Black race/ethnicity accounted for 48.6% of cases attributed to heterosexual contact (**Figure 4**).

Immigration medical screening for HIV

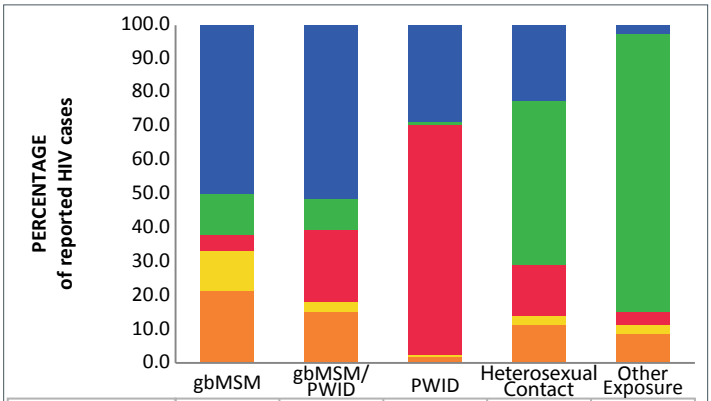
Data from IRCC indicate that over the last five years, the HIV diagnosis rate among migrants to Canada relative to the total number of IMEs undertaken in the same calendar year has remained relatively stable at 0.14% (2013–2017); however, Canada has seen an overall increase in the volume of immigration over the years and the absolute number of migrants entering Canada who tested positive for HIV on an IME has increased over the last three years. In 2017, there were 835 migrants identified who tested positive for HIV compared with 751 in 2016, and 550 in 2015. Among these 835 migrants in 2017, 549 underwent an IME in Canada and 286 underwent an IME overseas (**Figure 5).**

Table 2: Number and percentage distribution of HIV cases by sex and race/ethnicity, all ages—Canada, 2016–2017[a,b]

Race/ethnicity	Sex/year of test											
	2016						2017					
	Male		Female		Total[c]		Male		Female		Total[c]	
	n	%	n	%	n	%	n	%	n	%	n	%
Indigenous, total	128	15.4	113	35.6	243	21.1	142	16.3	96	30.9	238	20.1
First Nations	114	13.7	102	32.2	218	19.0	122	14.0	84	27.0	206	17.4
Métis	11	1.3	7	2.2	18	1.6	16	1.8	11	3.5	27	2.3
Inuit	2	0.2	1	0.3	3	0.3	2	0.2	0	0.0	2	0.2
Unspecified	1	0.1	3	0.9	4	0.3	2	0.2	1	0.3	3	0.3
South Asian/West Asian/Arab[d]	39	4.7	7	2.2	46	4.0	45	5.2	6	1.9	51	4.3
Asian[e]	63	7.6	4	1.3	67	5.8	76	8.7	10	3.2	86	7.3
Black[f]	137	16.5	116	36.6	253	22.0	156	17.9	144	46.3	300	25.3
Latin American[g]	51	6.1	3	0.9	54	4.7	70	8.0	4	1.3	74	6.3
Caucasian	396	47.7	67	21.1	463	40.3	364	41.7	44	14.1	408	34.5
Other	16	1.9	7	2.2	23	2.0	20	2.3	7	2.3	27	2.3
Subtotal	**830**	**100.0**	**317**	**100.0**	**1,149**	**100.0**	**873**	**100.0**	**311**	**100.0**	**1,184**	**100.0**
Race/ethnicity not reported ("missing")[h]	948	53.3	226	41.6	1,182	50.7	927	51.5	284	47.7	1,218	50.7
Total	**1,778**	**n/a**	**543**	**n/a**	**2,331**	**n/a**	**1,800**	**n/a**	**595**	**n/a**	**2,402**	**n/a**

Abbreviations: n/a, not applicable; n, number
[a] Consider data limitations regarding ethnicity/race information when interpreting these data
[b] Reporting of HIV cases for individuals younger than two years of age varies among provinces and territories
[c] Total column includes transsexual, transgender cases as well as cases where sex was not reported, where as "male" and "female" columns exclude these cases
[d] For example, Pakistani, Sri Lankan, Bangladeshi, Armenian, Egyptian, Iranian, Lebanese and Moroccan
[e] For example, Chinese, Japanese, Vietnamese, Cambodian, Indonesian, Laotian, Korean and Filipino
[f] For example, Somali, Haitian and Jamaican
[g] For example, Mexican, Central American and South American
[h] Includes all cases where race/ethnicity was not reported. Note: race/ethnicity information is not submitted by Quebec or British Columbia

Figure 4: Proportion of reported HIV cases (all ages) by exposure category and race/ethnicity—Canada, 2017[a-f]



	gbMSM	gbMSM/ PWID	PWID	Heterosexual Contact	Other Exposure
Caucasian	49.9	51.5	28.6	22.4	2.5
Black	12.2	9.1	1.0	48.6	82.5
Indigenous	4.7	21.2	68.1	14.9	3.8
Latin American	12.0	3.0	0.5	2.9	2.5
Other Ethnicity	21.2	15.2	1.9	11.2	8.8

Abbreviations: gbMSM, gay, bisexual and other men who have sex with men; PWID, people who inject drugs

[a] Race/ethnicity information is not available for Quebec and British Columbia

[b] Excludes HIV cases where race/ethnicity or exposure category was "not reported"

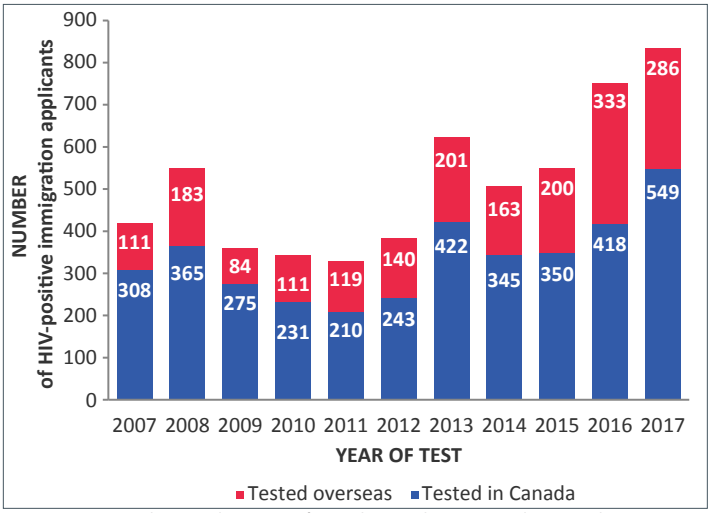
[c] "Latin American" includes, for example, Mexican, Central American and South American

[d] "Black" includes, for example, Somali, Haitian and Jamaican

[e] "Other Ethnicity" includes, for example, Pakistani, Sri Lankan, Bangladeshi, Armenian, Egyptian, Iranian, Lebanese, Moroccan, Chinese, Japanese, Vietnamese, Cambodian, Indonesian, Laotian, Korean, Filipino

[f] "Other Exposure" category includes unspecified exposure routes

Figure 5: Number of HIV-positive migrants by testing location and year of test, 2007–2017[a]

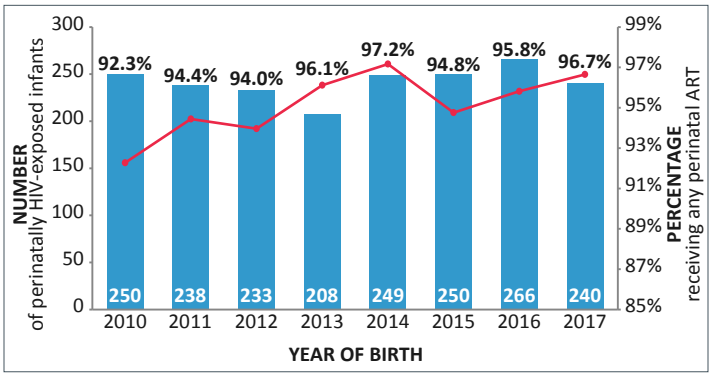


[a] For migrants tested in Canada, "year" refers to the year the test was administered. For migrants tested overseas, "year" refers to the year the migrant landed in Canada

Canadian Perinatal HIV Surveillance System

There were 240 infants perinatally-exposed to HIV in 2017. In total, three HIV transmissions were confirmed—one in an infant whose mother did not receive any perinatal ART prophylaxis and two in infants whose mothers did receive perinatal ART prophylaxis. The percentage of HIV-positive mothers receiving ART decreased slightly in 2015 but increased in the subsequent two years, reaching 96.7% in 2017 (**Figure 6).**

Figure 6: Number of perinatally HIV-exposed infants and proportion of perinatally HIV-exposed infants whose mothers were receiving perinatal antiretroviral therapy by year of birth—Canada, 2010–2017



Abbreviation: ART, antiretroviral therapy

Heterosexual contact continued to be the most frequently reported maternal exposure category in 2017 (69.5%), followed by PWID (23.6%). In 2017, 50.0% of perinatally HIV-exposed infants were from the Black race/ethnicity, while 23.3% were reported as Caucasian and 18.1% as Indigenous. In 2017, the maternal region of birth for the majority of infants was North America (42.3%), followed by Africa (38.6%). In 2017, the highest proportions of perinatally HIV-exposed infants were reported in Ontario (34.4%) and Quebec (25.3%).

Discussion

In 2017, a total of 2,402 newly diagnosed cases of HIV were reported to PHAC, which corresponded to a 3% increase since 2016 and a 17.1% increase since 2014; however, the national diagnosis rate of 6.5 per 100,000 population changed very little from the rate of 6.4 per 100,000 in 2016.

The highest proportions of cases among males diagnosed with HIV were Caucasian and attributed to the gbMSM exposure category, while among females the cases were more likely to be Black and attributed to heterosexual exposure. Although Caucasians accounted for the majority of reported diagnoses in 2017, both Indigenous and Black people were disproportionately represented, each making up less than 5% of the Canadian population but each accounting for more than 20% of new diagnoses (Table 2) (11,12).

Nationally, gbMSM remained the most frequently reported exposure category in 2017 and accounted for 46.4% of all reported HIV cases in adults with known exposure category, the second highest being heterosexual contact at 28.7%. There are many drivers that may contribute to the HIV epidemic in gbMSM such as therapeutic optimism since the introduction of effective ART, the dynamics of sexual networks, the high transmission efficiency of receptive anal intercourse and stigma limiting access to services (13–15).

Substantial progress has been made with respect to risk reduction of perinatal HIV transmission in Canada. This has been attributed to universal access to antenatal care, routine HIV screening of pregnant women and provision of treatment to those who test positive (16). In 2017, one HIV transmission was confirmed in an infant whose mother was not receiving any perinatal ART and two transmissions were confirmed in infants whose mothers were receiving perinatal ART.

Based on these surveillance data alone, it is not known why there has been an increase in the number of new HIV diagnoses in Canada between 2014 and 2017. A number of explanations are possible including an increase in HIV transmission (i.e., increased HIV incidence), an increase in HIV testing, changes in reporting practices and an increase in the number of HIV positive people migrating to Canada. The most recent estimates of HIV incidence in Canada provide some indication of a small increase in incidence between 2014 and 2016; however, it remains unclear if this represents a true increase in the underlying number of new infections because of the wide plausible ranges around these estimates (6). An increase in the number of people coming forward for HIV testing is another possibility. In recent years, multiple provinces have cited an increase in overall testing rates (17–19). Changes in reporting practices may also, in part, account for some of the increase; for example, in 2016, the reported increase in the province in Quebec can, in part, be explained by a partial shift to nominal testing from non-nominal testing as not all non-nominal cases were historically captured in national reporting. Finally, the observed increase may also, in part, reflect an increase in the number of HIV-positive people migrating to Canada (who are either testing positive for HIV for the first the time in Canada or who are re-testing in Canada) and who are subsequently being counted in Canada as a new diagnosis. Data from IRCC indicate that while the proportion of HIV-positive diagnoses among all IME applicants has been stable in recent years, the overall number of people migrating to Canada has increased and, thus, the number of HIV-positive migrants to Canada has also increased. In Ontario, for example, an increase in the number of new HIV diagnoses between 2016 and 2017 has, to some extent, been attributed to "out-of-province" diagnoses, defined as individuals who were initially diagnosed outside of Ontario (including people diagnosed outside of Canada) and then moved to Ontario where they were re-tested and counted as a new diagnosis in Ontario (20).

Strengths and limitations

The main strength of this report is that it is the primary source of national data on newly diagnosed cases of HIV in Canada in 2017.

While details regarding the limitations of the HASS have been described elsewhere (4,10), several key limitations should be highlighted. HASS is a passive case-based surveillance system that collates data submitted annually on a voluntary basis to PHAC from all provincial and territorial public health authorities, as opposed to active case solicitation. As a result, it is difficult to ascertain the degree of coverage of the system. There are additional uncertainties due to reporting delays, the potential for including duplicate cases due to the non-nominal nature of HIV reporting in some jurisdictions, and the lack of a standardized approach to handling HIV cases previously diagnosed outside of Canada or outside of the province/territory with some jurisdictions counting them as new cases and others excluding them. In addition, there is incomplete exposure category and ethnicity information from several provinces: incomplete exposure category and ethnicity information (Ontario); no ethnicity information (British Columbia); and no exposure category or ethnicity information (Quebec). Thus, the exposure category and ethnicity data presented in this report are not nationally representative.

Finally, it is important to recognize that the data in this report are considered provisional and, as it continues to be updated annually, it 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

Similar to annual changes that have been reported since 2014, the number and rate of reported HIV cases in Canada in 2017 increased slightly compared with 2016. Additional data and analysis are needed to determine why the numbers are increasing. PHAC will continue to work with its national partners to collect, analyze and disseminate HIV surveillance data to help clarify and explain these increases and to monitor progress toward reducing the burden of HIV infection in Canada.

Authors' statement

NH — Conceptualization, writing, original draft, final draft, review, editing, validation, visualization
SL — Conceptualization, validation, visualization, review, editing
ST — Review, editing, supervision
MM — Review, editing, final draft.

Conflict of interest

None.

Contributors

The Public Health Agency of Canada would like to acknowledge the following individuals from the provincial and territorial HIV/AIDS programs for their contribution and participation:

Sumana Fathima, Alberta Health
Rosa Maheden, Alberta Health
Mariam Osman, Alberta Health

Clinical Prevention Service, Surveillance and Epidemiology, BC Centre for Disease Control
Carla Loeppky, Manitoba Health
Rita RaaFat Gad, New Brunswick Department of Health
Shelley Landsburg, New Brunswick Department of Health
Patricia Samms New Brunswick Department of Health
Sophie Wertz, New Brunswick Department of Health
Beth Halfyard, Health and Community Services, Population Health Branch, Newfoundland and Labrador
Heather Hannah, Department of Health and Social Services, Northwest Territories
Bev Billard, Nova Scotia Department of Health and Wellness
Sarah Fleming, Nova Scotia Department of Health and Wellness
Andrea Schertzer, Nunavut Department of Health
Sean Waites, Nunavut Department of Health
Abigail Kroch, Ontario Treatment Network
Juan Liu, Public Health Ontario
Alex Marchand-Austin, Public Health Ontario
Dr. Michelle Murti, Public Health Ontario
Andrea Saunders, Public Health Ontario
Michael Whelan, Public Health Ontario
Dr. Shamara Baidoobonso, Prince Edward Island Department of Health and Wellness
Stacey Burns, Prince Edward Island Department of Health and Wellness
Constance Cheverie, Prince Edward Island Department of Health and Wellness
Raphaël Bitera, Direction des risques biologiques et de la santé au travail, Institut national de santé publique du Québec
Micheline Fauvel, Laboratoire de santé publique du Québec, Institut national de santé publique du Québec
Maureen Hastie, Laboratoire de santé publique du Québec, Institut national de santé publique du Québec
Raymond Parent, Direction des risques biologiques et de la santé au travail, Institut national de santé publique du Québec
Bouchra Serhir, Laboratoire de santé publique du Québec, Institut national de santé publique du Québec
Diane Sylvain, Laboratoire de santé publique du Québec, Institut national de santé publique du Québec
Helen Bangura, Saskatchewan Ministry of Health
John Manalo, Saskatchewan Ministry of Health
Rachelle Wallace, Yukon Communicable Disease Control
Sabrina Plitt, Public Health Agency of Canada (Alberta)
Elsie Wong, Public Health Agency of Canada (British Columbia)
Jillian Waruk, Public Health Agency of Canada (Manitoba)
Ashleigh Sullivan, Public Health Agency of Canada (Ontario)
Tara Schellenberg, Public Health Agency of Canada (Saskatchewan)

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

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Vaccine safety surveillance in Canada: Reports to CAEFISS, 2017

K Johnson[1]*, H Anyoti[1], C Coulby[1]

Abstract

Background: Canada has a comprehensive vaccine safety surveillance system that includes both passive and active surveillance of vaccines administered in Canada.

Objectives: To provide 1) a descriptive analysis of the adverse events following immunization (AEFI) reports for vaccines administered in Canada, 2) a descriptive review of health care utilization and outcome following an AEFI and 3) an analysis of serious adverse events (SAEs).

Methods: Data was obtained from the Canadian Adverse Events Following Immunization Surveillance System (CAEFISS), which includes both passive and active surveillance. Descriptive analyses were conducted of AEFI reports arising from vaccines administered from January 1, 2017 to December 31, 2017 and received by April 30, 2018. Data elements included AEFIs, demographics, health care utilization, outcome, and seriousness of adverse events.

Results: There were 2,960 AEFI reports submitted to CAEFISS from across Canada for vaccines administered in 2017. The AEFI reporting rate was 12.6/100,000 doses distributed (8.1/100,000 population) in Canada for vaccines administered in 2017 and was found to be inversely proportional to age. The majority of reports (91%) were non-serious events, primarily involving vaccination site reactions such as rash, and allergic events. Overall, there were 253 SAE reports, for a reporting rate of 1.1/100,000 doses distributed in 2017. Of the SAE reports, the most common primary AEFIs were seizure (n=58, 23%) followed by anaphylaxis (n=33, 13%). There were no unexpected vaccine safety issues identified or increases in frequency or severity of expected adverse events.

Conclusion: Canada's continuous monitoring of the safety of marketed vaccines in 2017 did not identify any increase in the frequency or severity of AEFIs, previously unknown AEFIs or areas that required further investigation or research. Vaccines marketed in Canada continue to have an excellent safety profile.

Affiliation

[1] Canadian Adverse Events Following Immunization Surveillance System (CAEFISS), Centre for Immunization and Respiratory Infectious Diseases, Public Health Agency of Canada, Ottawa, ON

***Correspondence:**
phac.aefi-essi.aspc@canada.ca

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Keywords: vaccine safety, adverse events, immunization, surveillance, CAEFISS

Introduction

Post-market vaccine safety surveillance is essential to detect any emerging vaccine safety issues and to maintain public confidence in vaccines. The Public Health Agency of Canada (PHAC) works together with Health Canada, the regulator, to ensure a comprehensive post-market vaccine safety surveillance system.

The Canadian Adverse Events Following Immunization Surveillance System (CAEFISS) is a federal, provincial and territorial (FPT) public health post-market vaccine safety surveillance system. CAEFISS is managed by PHAC and is unique in that it includes both passive (spontaneous reports from FPTs) and active surveillance. Active surveillance is conducted by Immunization Monitoring Program ACTive (IMPACT); a network

of 12 pediatric hospitals across Canada that screens hospital admissions for specific adverse events following immunizations (AEFIs). The primary objectives of CAEFISS are to:

- Continuously monitor the safety of marketed vaccines in Canada
- Identify increases in the frequency or severity of previously identified vaccine-related reactions
- Identify previously unknown AEFIs that could possibly be related to a vaccine
- Identify areas that require further investigation and/or research and
- Provide timely information on AEFI reporting profiles for vaccines marketed in Canada, which could help inform immunization programs and guidelines (1)

In Canada, health care providers, manufacturers and the public each have a role to play in vaccine pharmacovigilance (2). The FPT public health officials monitor vaccine safety through the Vaccine Vigilance Working Group (VVWG) of the Canadian Immunization Committee (CIC). The VVWG includes representatives from all FPT immunization programs across the country as well as Health Canada regulators and IMPACT. This report was developed with input and support from the VVWG.

National reports on vaccine safety surveillance data have been published periodically (3,4). The objective of this report is to provide a) a descriptive analysis of AEFI reports for vaccines administered in Canada in 2017, b) a descriptive review of health care utilization and outcome following an AEFI and c) an analysis of serious adverse events (SAEs).

Methods

Definitions

An AEFI is defined as any untoward medical occurrence that follows immunization but that does not necessarily have a causal relationship with the administration of the vaccine. The adverse event may be a sign, symptom or defined illness (5).

A SAE in CAEFISS is identified based on the International Conference on Harmonization of Technical Requirements for Registration of Pharmaceuticals for Human Use as an event that results in death, is life-threatening, requires in-patient hospitalization or prolongation of existing hospitalization, results in persistent or significant disability/incapacity or results in a congenital anomaly/birth defect. Any medical event which may not be immediately life-threatening but requires intervention to prevent one of the outcomes listed above may also be considered as serious (6).

Data sources

The CAEFISS is an FPT collaborative process that includes submission of AEFI reports from both passive and active surveillance. Passive surveillance is initiated at the local public health level. Completed reports are first sent to provincial and territorial (PT) health authorities and are then submitted on a voluntary basis to PHAC for inclusion into CAEFISS (7). In addition, CAEFISS also receives reports from federal authorities (Indigenous Services Canada, Correctional Services Canada, Royal Canadian Mounted Police, National Defence and the Canadian Armed Forces). These reports are entered into CAEFISS and a copy and/or reporter information is sent to the health authorities of the jurisdiction of origin.

Active surveillance is conducted by IMPACT nurse monitors, under the supervision of pediatric and/or infectious disease medical specialists, who screen hospital admissions for target AEFIs that may have followed vaccination and that led to a hospital admission (8,9).

All AEFI reports are entered into CAEFISS and serious AEFIs are identified and coded using the International Medical Dictionary for Regulatory Activities (MedDRA version 17, McLean, Virginia, United States [US]) (10). A systematic medical case review is conducted by trained health professionals who assign a primary reason for reporting using national case definitions for AEFI classification from the CAEFISS user guide (11). For more detailed information on CAEFISS and report processing and quality assurance, please refer to previous published reports (3,4).

Reporting rates are calculated with two different denominators. When possible, vaccine doses distributed data, which is provided by Market Authorization Holders, is used to calculate the doses distributed-based rate. This is not adjusted for doses returned or wastage. When the doses distributed data is not available, annual population estimates from Statistics Canada are used to calculate a population-based rate (12).

Data analysis

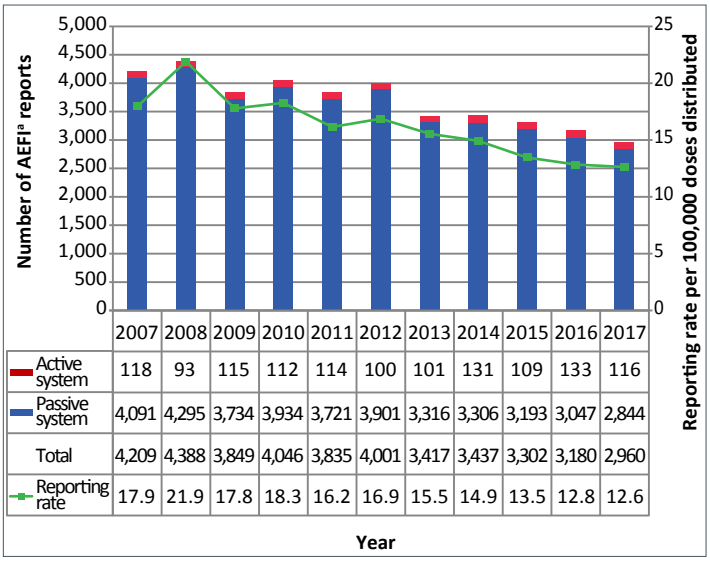
All AEFI reports submitted to CAEFISS by April 30, 2018 with a date of vaccine administration from January 1, 2017 through December 31, 2017 were included in this report. In addition, all AEFI reports following vaccines administered from 2007 onwards were included to assess trends over time. Data were extracted from CAEFISS on May 27, 2018. Of note, reports submitted to CAEFISS for 2017 are known to be incomplete due to data entry delays in one region of one jurisdiction (which accounts for less than 2% of the total reports submitted to CAEFISS in 2017).

Descriptive analyses are conducted using SAS Enterprise Guide software, Version 5.1 (Cary, North Carolina, US) (13). Calculations were presented for all vaccines combined to calculate the overall rate by doses distributed for the year 2017 as well as rates by year (2007–2017), type of surveillance, primary reason for reporting, primary AEFI by seriousness and health care utilization and outcome for vaccines administered in 2017. Sex- and age-specific rates were calculated using population estimates as the denominator. Missing data were excluded from the calculations.

Results

The CAEFISS received a total of 2,960 AEFI reports from 13 provinces and territories for vaccines administered in 2017. Over 23 million vaccine doses (public and private) were distributed, representing a reporting rate of 12.6 per 100,000 doses distributed. Over the last 11 years, the AEFI reporting rate decreased ($p<0.01$) with reporting rates ranging from 12.6 to 21.9 per 100,000 doses distributed (**Figure 1**). While only 7% (n=116) of all submitted AEFI reports in children less than 18 years of age were through active surveillance, they represented 56% (n=116) of all SAE reports submitted for this age group (*Note: Data not shown; numbers do not completely correspond to the percentages as the percentages have been rounded to the nearest integer*). This distribution is consistent with previous years (4).

Figure 1: Total number of adverse events following immunization reports and reporting rate by reporting source and year, 2007–2017[a]



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Active system	118	93	115	112	114	100	101	131	109	133	116
Passive system	4,091	4,295	3,734	3,934	3,721	3,901	3,316	3,306	3,193	3,047	2,844
Total	4,209	4,388	3,849	4,046	3,835	4,001	3,417	3,437	3,302	3,180	2,960
Reporting rate	17.9	21.9	17.8	18.3	16.2	16.9	15.5	14.9	13.5	12.8	12.6

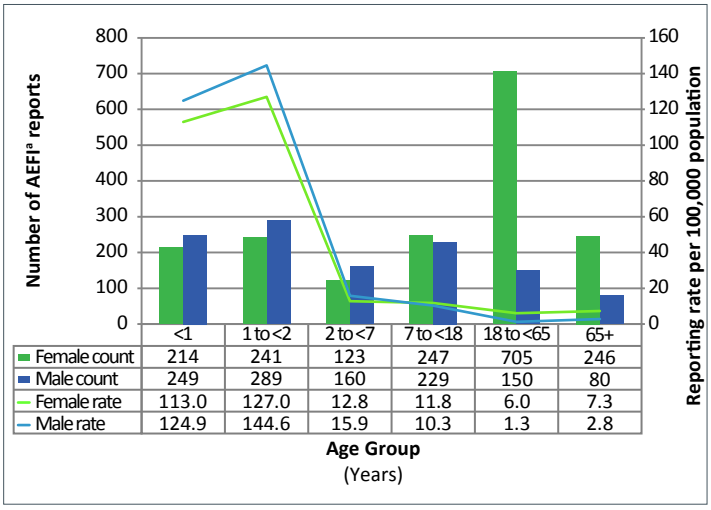
Abbreviation: AEFI, adverse event following immunization
[a] Does not include the H1N1-09 pandemic influenza AEFI reports

Age and sex distribution

The number of reports and the reporting rates per 100,000 population by age group and sex are presented in **Figure 2**. The median age of all reports during the reporting period was 10 years (range: one day to 97 years). The majority (60%) of AEFI reports were for children and adolescents under 18 years of age. The highest reporting rates were seen in children one to less than two years of age (136.5/100,000 population), followed by infants less than one year of age (119.6/100,000 population).

Decreases in the reporting rate were seen in all age groups less than seven years of age ($p<0.01$) between 2007 and 2017, with the greatest decreases seen in the one to less than two year age group (302.5 versus 136.5/100,000 population respectively) and the less than one year age group (182.8 vs 119.6/100,000 population respectively) (*data not shown*).

Figure 2: Number and reporting rate of adverse events following immunization reports by age group and sex, 2017[a]



	<1	1 to <2	2 to <7	7 to <18	18 to <65	65+
Female count	214	241	123	247	705	246
Male count	249	289	160	229	150	80
Female rate	113.0	127.0	12.8	11.8	6.0	7.3
Male rate	124.9	144.6	15.9	10.3	1.3	2.8

Abbreviations: AEFI, adverse event following immunization; <, less than; +, and above
[a] Eighteen reports with missing age, nine reports with missing sex and one report indicating sex as "other" were excluded

Of the 2,960 reports, 60% of reports were in females. As shown in Figure 2, male predominance was observed for children under seven years of age and female predominance was observed among those seven years of age and older. Two age groups had a significant difference between female and male reporting rates: the 18 to 64 year age group had a rate ratio (RR) of 4.6 (95% confidence interval [CI] 3.86 to 5.49; $p<0.05$) and the 65 and older age group had a RR of 2.6 (95% CI 2.02 to 3.35; $p<0.05$), indicating that submitted AEFI reports were over four and a half times and two and half times more likely to be in females, respectively.

Primary reason for reporting

During the medical case review process, a primary AEFI category is assigned as the main reason for reporting and is further classified to a sub-category. Excluding the 'other' category, the most common primary AEFIs reported for vaccines administered in 2017 were vaccination site reactions (n=1,339, 45%) followed by allergic reaction (n=417, 14%) and rash alone (n=346, 12%) (**Table 1**).

The proportion of serious events was highest for the neurological event category (44%), followed by infection/syndrome/systemic symptoms (ISS) (22%). Of note, vaccination errors included only a small number of reports (fewer than five AEFI reports) and no serious reports.

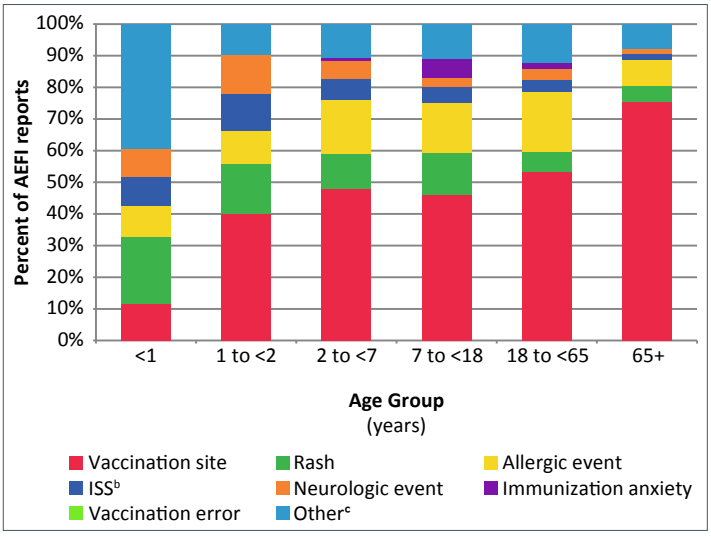
Figure 3 shows the distribution of AEFIs by primary reason by age group. Vaccination site reactions represented the greatest number of AEFIs for all the age groups except for children less than one year of age. Excluding the "other" event category for

Table 1: Frequency of reports and percent that is serious for each primary adverse event following immunization sub-category, 2017

Primary AEFI category	Primary AEFI sub-category	Number of reports (N=2,957)[a]	Serious event (%)
Allergic or allergic-like events	Anaphylaxis	33	100
	Other allergic events[b]	355	1
	Oculo-respiratory syndrome (ORS)	28	0
	Rash	1	0
	TOTAL	417	9
Infection/ syndrome/ systemic symptoms (ISS)	Fever only	11	27
	Infection	28	36
	Influenza-like illness (ILI)	10	0
	Rash with fever and/or other illness	61	10
	Syndromes (e.g., Kawasaki)	16	88
	Systemic (when several body systems are involved)	55	11
	TOTAL	181	22
Neurologic events	Aseptic meningitis	3	67
	Ataxia/cerebellitis[c]	2	50
	Bell's palsy	6	17
	Encephalitis / acute disseminated encephalomyelitis (ADEM) / myelitis	5	100
	Guillain-Barré syndrome (GBS)	2	50
	Other paralysis lasting more than one day	1	100
	Seizure	111	52
	Other neurologic event[d]	47	17
	TOTAL	177	44
Rash alone	Generalized	291	0
	Localized	35	0
	Location not specified/ extent unknown	20	0
	TOTAL	346	0
Immunization anxiety	Presyncope	6	0
	Syncope	33	6
	Other anxiety-related event[e]	7	0
	TOTAL	46	4
Vaccination site reactions	Abscess (infected or sterile)	13	31
	Cellulitis	329	5
	Extensive limb swelling (ELS)[f]	136	2
	Pain in the vaccinated limb of seven days or more	56	0
	Other local reaction[g]	804	2
	Rash	1	0
	TOTAL	1,339	3
Vaccination error	Vaccination error TOTAL	3	0
Other	Arthralgia	16	0
	Arthritis	5	20
	Gastrointestinal event	169	5
	Hypotonic-hyporesponsive episode (HHE)	17	24
	Intussusception	6	83
	Anaesthesia/ paraesthesia	22	5
	Parotitis	9	0
	Persistent crying	16	6
	Sudden infant death syndrome (SIDS)	0	N/A
	Sudden unexpected/ unexplained death syndrome (SUDS)	0	N/A
	Thrombocytopenia	25	80
	Other events[h]	163	12
	TOTAL	448	13

Abbreviations: AEFI, adverse events following immunization; N/A, not applicable; N, total number
[a] Three reports with missing primary AEFI sub category are excluded
[b] "Other" includes, but is not limited to, hypersensitivity and urticarial
[c] Cerebellar ataxia is defined as sudden onset of truncal ataxia and gait disturbances (14). Of note, this assumed absence of cerebellar signs appearing with other evidence of encephalitis or acute disseminated encephalomyelitis (ADEM), in which case it would be classified according to the Brighton-Collaboration case definition (15)
[d] "Other" includes, but is not limited to, seizure-like phenomena and migraine
[e] "Other" includes, but is not limited to, dizziness and dyspnea
[f] Extensive limb swelling of an entire proximal and/or distal limb segment with segment defined as extending from one joint to the next (16)
[g] "Other" includes, but is not limited to, vaccination site pain and vaccination site swelling
[h] "Other" includes, but is not limited to, lymphadenopathy and arthralgia

Figure 3: Distribution of primary adverse events following immunization reported by age group, 2017[a]



Abbreviations: AEFI, adverse events following immunization; ISS, infection/syndrome/systemic symptoms; <, less than; +, and above
[a] Eighteen reports with missing age and three reports with missing primary AEFI are excluded
[b] The ISS are primarily events involving many body systems often accompanied by fever. They include sub-categories such as recognized syndromes (e.g. Kawasaki syndrome, fibromyalgia, etc.), fever alone, influenza-like illness and systemic events (such as fatigue, malaise and lethargy). They also include evidence for infection in one or more body parts
[c] "Other" includes arthralgia, arthritis, hypotonic-hyporesponsive episode, intussusception, gastrointestinal diseases, anaesthesia/paraesthesia, parotitis, persistent crying, thrombocytopenia, sudden infant death syndrome and sudden unexpected/unexplained death syndrome

children under one year of age, the most commonly reported AEFI was rash alone, followed by vaccination site reactions (Figure 3).

Health care utilization

Table 2 shows the reported highest level of care sought following an AEFI. The most frequently reported highest level of health care usage was non-urgent health care visit (40%), followed by emergency visit (24%). Most people with a reported AEFI (93%) did not require hospitalization. In 23% of cases, no health care was sought.

Table 2: Highest level of health care sought for adverse events following immunization, 2017

Highest level of care sought (N=2,709)[a]	n	%[b]
Required hospitalization (≥24 hrs)	197	7
Resulted in prolongation of existing hospitalization	1	<0.1
Emergency visit	639	24
Non-urgent visit	1,088	40
Telephone advice from a health professional	127	5
None	623	23
Unknown	34	1

Abbreviations: n, number; N, total number; <, inferior to; ≥, superior or equal to
[a] Two hundred fifty-one cases with missing information on highest level of care sought were excluded
[b] Percentages in table do not total 100% due to rounding

Outcome

The outcome at time of reporting for all AEFI reports is shown in **Table 3**. Full recovery was reported in 75% of the reports and less than 0.1% of reports reported death as an outcome. For those not fully recovered at the time of reporting, the reports are revised if updated information is received by CAEFISS from the provinces and territories.

Table 3: Outcome at time of reporting for all adverse events following immunization reports, 2017

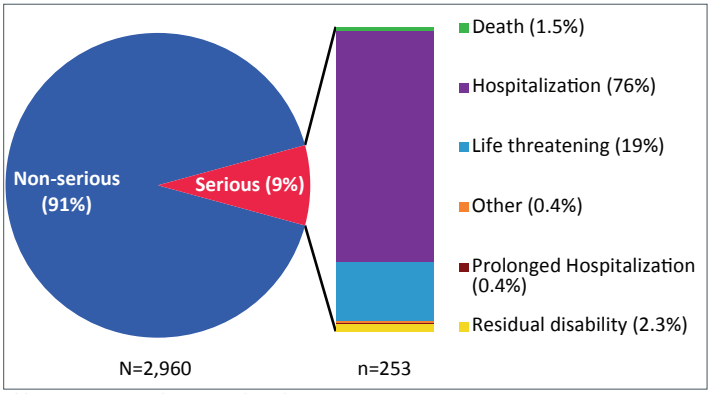
Outcome (N=2,878)[a]	n	%[b]
Fully recovered	2,154	75
Not yet recovered at time of reporting	589	20
Permanent disability / incapacity	1	<0.1
Death	4	0.1
Unknown	130	5

Abbreviations: n, number; N, total number; <, inferior to
[a] Eighty-two cases were missing information on outcome, therefore were excluded
[b] Percentages in table do not total 100% due to rounding

Serious adverse event reports

Overall there were 253 SAE reports out of over 23 million vaccine doses distributed during the reporting period. This represents a reporting rate of 1.1/100,000 doses distributed and 9% of all AEFI reports for the 2017 time period. **Figure 4** shows the distribution of SAE reports by reason for seriousness, with hospitalization (n=192) and life threatening events (n=49) being the most common reasons.

Figure 4: Classification of serious adverse events reports, 2017[a]



Abbreviations: n, number, N, total number
[a] Percentages in figure do not total 100% due to rounding

Among the SAE reports, the most frequently reported primary AEFI was seizure (n=58, 23%), followed by anaphylaxis (n=33, 13%). The majority (n=183, 72%) of SAE reports had fully recovered at the time of reporting. For those patients who had not fully recovered at the time of reporting, these reports were revised if updated information was received by CAEFISS from the provinces and territories. Other outcomes for SAE reports included fatal outcome (n=4, 2%), permanent disability/ incapacity (n=1, 0.4%), unknown outcome (n=15, 6%) and missing information on outcome (n=5, 2%).

The majority of SAEs were in children and adolescents less than 18 years of age (81%), with almost three quarters (74%) of these SAEs being reported in children under the age of two years.

There were two deaths in those less than two years of age and two deaths in those 18 years of age and older. After careful review, all deaths were considered to be a result of pre-existing conditions (heart surgery, serious injury, cardiovascular disease, diabetes and hypertension) and not to the vaccines administered. There was also one reported outcome of disability that occurred in an individual. The medical history was reviewed for this individual and it was concluded, based on the information provided, that the disability was not considered to be related to the administered vaccine.

Discussion

In 2017, the overall annual AEFI reporting rate was 12.6/100,000 doses distributed or 8.1/100,000 population, with a statistically significant downward trend in reporting rates over the last 11 years. There are several possible explanations for the declining overall rate of AEFI reporting. It may be due to under-reporting,

variations in the reporting of expected milder events, or differences in vaccine uptake.

The majority of reports (91%) was due to non-serious events and differed with age, with rash being more common in infants and vaccination site reactions more common in the elderly. Male predominance was observed for children under seven years of age and female predominance was observed among those seven years and older. The results of a greater proportion of reports involving females is similar to other findings where females in the adult population were found to consistently report more adverse events (3,4,17). The reported sex differences by age may also be explained in part by higher vaccine coverage in female adults (18). The majority of SAEs occurred in children and adolescents, which may in part be explained by IMPACT, which actively searches for specific surveillance targets in children admitted to 12 pediatric tertiary care hospitals (9,19). The greater proportion of SAEs seen in children under two years of age is likely due in large part to the number of vaccines provided to this age group to protect them when they are most vulnerable to vaccine-preventable diseases. Although the percentage of SAEs increased from 8% (between 2013 and 2016) to 9% (in 2017), this increase may be due to a decrease in the reporting of non-serious AEFIs. The 2017 SAE reporting rate was consistent with previously reported rates and there were no unexpected vaccine safety issues identified (4).

Limitations

Passive surveillance for AEFIs is subject to limitations such as underreporting, over reporting, lack of certainty regarding the diagnostic validity of a reported event, missing information regarding other potential causes such as underlying medical conditions or concomitant medications and the differing AEFI reporting practices by jurisdictions within Canada.

There are also limitations associated with active surveillance. The IMPACT uses predetermined AEFI targets (such as seizure), which may limit its ability to identify new adverse reactions to immunizations. In addition, IMPACT focuses on admitted pediatric cases, which means that only the most serious cases are detected. Lastly, IMPACT is not comprehensive, as it covers only 90% of Canada's tertiary care pediatric beds and hospital admissions (19,20). Despite these limitations, IMPACT is able to fulfill an important role in vaccine safety surveillance by actively identifying targeted serious AEFIs in the pediatric population.

In addition, the number of doses administered in the population is not available at the national level; therefore, the denominator used in rate calculations is estimated either from doses distributed or from population statistics. The use of doses distributed is the best available denominator. However, it does have certain limitations:

- It does not equal the number of doses administered
- It does not take wastage into account
- It may not be complete at time of publication, due to reporting delays by the Market Authorization Holders

A population-based denominator was used for demographic analysis (sex-specific and age-specific rates) for this report. A limitation of using a population-based denominator is that it assumes similar distribution of vaccine doses across population subgroups and geographic areas, even though this may not be true in all cases.

Conclusion

Canada's continuous monitoring of the safety of marketed vaccines in 2017 did not identify any increase in the frequency or severity of AEFIs, or identify previously unknown AEFIs. The majority of reported AEFIs were both expected and mild in nature. Vaccines marketed in Canada continue to have an excellent safety profile.

Authors' statement

KJ — Formal analysis, validation, writing-original draft, writing-review and editing
CC — Software, formal analysis, validation, writing-original draft, writing-review and editing
HA — Validation, writing-review and editing, supervision

Conflict of interest

None.

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Appendix 1: Supplementary figures (available upon request)

Figure A1: Proportion of adverse events following immunization reports by active versus passive surveillance in children less than 18 years of age, 2017

Figure A2: Annual reporting rate of adverse event following immunization reports by age group, 2007–2017

Evidence for optimal HIV screening and testing intervals in HIV-negative individuals from various risk groups: A systematic review

K Timmerman[1]*, M Weekes[2], G Traversy[2], P Prabakhar[3], T Austin[1], S Ha[1], B Anwar[1]

Abstract

Background: Human immunodeficiency virus (HIV) testing plays a crucial role in Canada's HIV prevention and treatment efforts and is the first step to achieving the Joint United Nations Programme on HIV/AIDS (UNAIDS) 90-90-90 targets; however, how often Canadians, including populations at increased risk of HIV exposure, should be tested is unclear. We conducted a systematic literature review to determine the optimal HIV screening and testing intervals.

Objective: To examine the current evidence on HIV testing intervals in HIV-negative individuals from various risk groups and to assess the potential harms and patients' values and preferences associated with different testing frequencies.

Methods: We searched MEDLINE/PubMed, Scopus, Embase, the Cochrane Library, PsychINFO and EconLit for studies on different frequencies of HIV testing published between January 2000 and September 2016. An additional search was conducted for grey literature published between January 2000 and October 2016. Data extraction included study characteristics, participants, exposure, outcomes and economic variables. The quality of the studies was assessed and results summarized.

Results: Of the 2,702 articles identified from the searches, 27 met the inclusion criteria for review. This included assessments of HIV testing intervals among the general population, men who have sex with men, people who use injection drugs and sex workers. Optimal testing intervals across risk groups ranged from one-time testing to every three months. Data from modelling studies may not be representative of the Canadian context. Few studies identified potential harms of increased screening, specifically an increase in both false positive and false negative results. There were only two studies that addressed patient values and preferences concerning HIV screening, which suggested that the majority of participants were amenable to routine screening through their primary care provider.

Conclusion: There was insufficient evidence to support optimal HIV screening and testing intervals for different populations. Context-specific factors, such as budget allocation, human resources, local epidemiology, socioeconomic factors and risk behaviours, along with clinical judgement, inform whom and how often to screen, suggesting the need for research specific to Canada. Research on patient preferences as well as the benefits and harms of more frequent screening are also indicated.

Affiliations

[1] Centre for Communicable Diseases and Infection Control, Public Health Agency of Canada, Ottawa, ON

[2] Centre for Chronic Disease Prevention and Health Equity, Public Health Agency of Canada, Ottawa, ON

[3] Dalla Lana School of Public Health, University of Toronto, Toronto, ON

***Correspondence:**
karen.timmerman@canada.ca

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Keywords: HIV screening, HIV testing intervals, men who have sex with men, sex workers, high risk populations

Introduction

Human immunodeficiency virus (HIV) screening is essential to HIV prevention and treatment efforts, as early detection allows people living with HIV to access appropriate care and treatment that can help improve their health and prevent onward transmission (1–3). For this reason, the Joint United Nations Programme on HIV/AIDS (UNAIDS) 90-90-90 global strategy ambitiously aims to have 90% of all people living with HIV diagnosed and 90% of those diagnosed consistently receiving antiretroviral therapy by 2020, with 90% of those receiving treatment achieving viral suppression (4). Canada has committed to achieving these targets.

In 2016, an estimated 14% of the 63,110 Canadians living with HIV were unaware of their infection (5). HIV infection is concentrated in specific sub-groups, such as men who have sex with men (MSM), persons who inject drugs (PWID) and Indigenous populations (accounting for 49.3%, 15.3% and 9.1% of people living with HIV in 2014, respectively) (6–8).The 2012 Public Health Agency of Canada's *HIV Screening and Testing Guide* suggests that individuals involved in high risk practices should be screened for HIV infection at least annually (1). At the time of publication of this guide, insufficient evidence was available to provide recommendations on the optimal testing frequency for specific risk populations.

Evidence-informed guidance on testing frequencies for populations with distinct risk profiles may optimize and promote testing among healthcare providers; however, only one systematic review has been conducted on HIV screening and testing intervals specifically among MSM (9) and none has been published on other populations. To inform potential revisions to the *HIV Screening and Testing Guide*, we decided to conduct a systematic review to assess evidence for different HIV screening and testing intervals among various populations. Patient harms, values and preferences were also examined to understand whether increased HIV screening intervals would be feasible and acceptable in at risk populations.

The objectives of the systematic review were to examine and synthesize the current evidence on different HIV testing intervals in HIV-negative individuals from various risk groups, and, if possible, to include information on potential harms and patient values and preferences regarding screening intervals.

Methods

The systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) statement (10). It follows a peer-reviewed *a priori* protocol registered with the International Prospective Register of Systematic Reviews (PROSPERO; registration number CRD42016046575) and published in the Canada Communicable Disease Report (11,12). Some amendments to the protocol were made following publication (primarily related to quality assessment) and are reflected in the revised PROSPERO entry.

Search strategy

A comprehensive search strategy was developed with the assistance of a Health Canada research librarian and peer-reviewed by an external research librarian prior to execution. The full search strategy is available in the previously published protocol (12).

We searched the MEDLINE/PubMed, Scopus, Embase, Cochrane Library, PsycINFO and EconLit databases, as well as Open Grey, ClinicalTrials.gov and relevant sources from the CADTH Grey Matters checklist (13). Searches were conducted for quantitative and qualitative studies published in English and French between January 2000 and September 2016. A search for grey literature for reports published between January 2000 and October 2016. Studies were eligible for inclusion if they investigated the frequency of HIV screening and testing among persons of unknown or previously-confirmed negative serostatus. Case studies, narrative summaries and commentaries were excluded. There were no restrictions on the country of study.

Study selection, data collection and quality assessment

Two reviewers (MW and PB) independently performed title/abstract and full-text screening using standardized, piloted forms on the systematic review software, DistillerSR (Evidence Partners Incorporated, Ottawa, ON). Disagreements were resolved by a third reviewer (KT or GT).

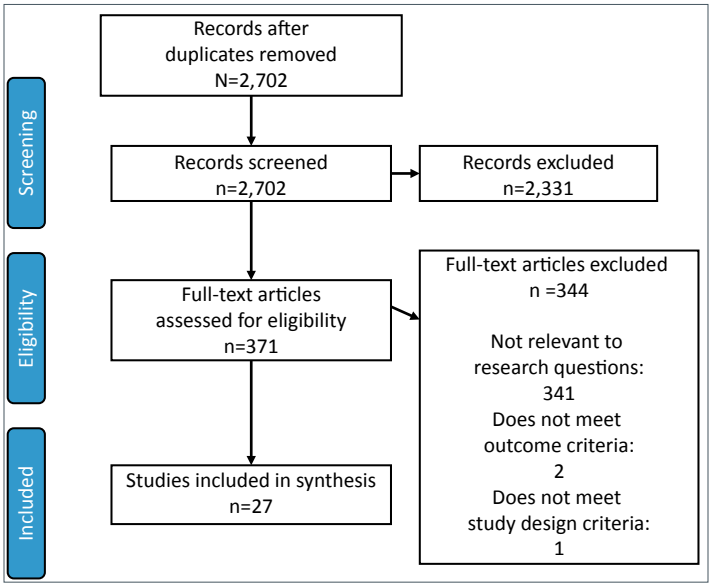
Data extraction was carried out by one reviewer (PB) and quality assessments were completed by two reviewers (MW and PB). Data extraction was verified by two reviewers (TA and SH) and disagreements were resolved by a third reviewer (KT). Data extraction included the following: study characteristics (e.g., study design, setting); type of participants (e.g., risk group); exposure (e.g., testing intervals being compared, type of HIV test used); outcomes (e.g., number of new HIV diagnoses, average CD4 cell count and/or viral load at diagnosis, number of new HIV diagnoses, and change in number/percent of individuals with undiagnosed HIV infection); and economic variables (e.g., time horizon, currency) as appropriate. The quality of the descriptive studies was assessed using the *Public Health Agency of Canada's Infection Prevention and Control Guidelines: Critical Appraisal Tool Kit* (14,15). The quality of the economic modelling studies was assessed using a unique checklist that combined key items from the *British Medical Journal checklist for economic evaluations* and the *Eddy checklist on mathematical models* (16,17). These quality appraisal tools were selected in light of the systematic review findings and were judged appropriate for the types of studies identified (13). Although we intended to use the GRADE methodology to rate the certainty of evidence, the majority of the studies included in this review were modelling studies so it was not feasible to apply GRADE. In addition, the

wide range of assumptions and inputs in the modelling studies lead to heterogeneity of findings, so meta-analysis was also not possible. For these reasons, we summarized the conclusions of the studies regarding the optimal testing frequency. For details on the protocol amendment, refer to the PROSPERO record (11). As *a priori*, we qualitatively summarized outcomes on patient harms, values and preferences to represent the descriptive nature of the data.

Results

The literature search initially identified 2,702 articles (after the removal of duplicates), of which 27 met the systematic review inclusion criteria (**Figure 1**). A total of 344 studies were excluded after full-text review; mostly because they did not concern the topic of the systematic review (n=341). Two additional studies did not meet the outcome criteria and one study did not meet the study design criteria.

Figure 1: PRISMA flow chart



Abbreviations: n, number; N, total number; PRISMA, Preferred Reporting Items for Systematic Review and Meta-Analyses

The majority of the evidence came from 20 modelling studies (18-37). There was one descriptive study (38); three non-economic modelling studies (39-41); one cohort study (42); one cross-sectional study (43); and one mixed-methods study (descriptive and modelling) (44). The included studies were conducted in various countries, including 14 in the United States (US), three in Australia and two in the United Kingdom (UK). Third and fourth generation enzyme-linked immunosorbent assays (ELISA) were the most commonly-used tests in the studies.

Optimal HIV testing frequency by population group

General population

Thirteen studies, all of which were cost-effectiveness models, addressed optimal testing frequencies in the general population considered at low risk for HIV, with incidence ranging from 0.0084% to 4% per year (20,23,24,27–30,32–34,36,37,45). Recommended testing frequencies ranged from a one-time test to annual testing, with the largest proportion (n=5) advocating for a one-time test (23,24,30,36,37).

Sanders et al. proposed an economic model set in the US (30). They concluded that routine screening would be cost-effective if the prevalence of undiagnosed HIV infection were as low as 0.05%. Similarly, Long et al. reported that one-time screening of low risk populations coupled with annual screening of high risk populations would result in a low incremental cost-effectiveness ratio (ICER) and 2,555 HIV infections averted over 10 years (24). They concluded that one-time screening was the optimal testing frequency for a population with an HIV prevalence of 0.033% rather than the status quo of targeted risk-based testing (24). Special consideration was placed on the other variables that affect screening effectiveness, such as reduction in risk behaviors, with authors stating that the ICERs and HIV infections averted were contingent upon concurrent reduction of overall risk behaviors by 25%, even amongst low risk populations.

Nine studies were considered to be of high quality (23,24, 27–30,32,37,45), with thorough backgrounds and rationales, robust methods and data collection procedures, and strong justifications for the analysis plans. In addition, one study was deemed moderate/high quality (46), two studies were considered moderate quality (23,34) and one was low/moderate quality (20). Of the studies that were assessed as low/moderate quality, some variables (e.g., discount rates) were not reported and some studies did not provide justification for the selection of variables.

Men who have sex with men

The search identified 14 studies that addressed the optimal HIV screening interval among MSM. Eight studies were economic modelling studies (19,20,22–25,32,37) and five were modelling studies without economic inputs (38,40-42,44). Recommended testing frequencies ranged from one-time only, to annually and to once every three months.

In the economic modelling studies from France and the UK (23,37), screening one-time and/or annually was found to be cost-effective. Among MSM in France (incidence: 0.99%/ person-year), one-time screening was the most cost-effective strategy compared with risk-based screening; annual screening was also considered cost-effective in this population with a lower ICER (37).

Among the modelling studies on MSM, the majority (n=8) were assessed as high quality (19,22,24,32,36,37,44,45). Three studies were rated as moderate quality (23,40,41) and one was low/moderate quality (20). Modelling studies that scored low/moderate quality did not provide strong rationales for the background and analysis. The study by Baker et al. reported the only descriptive study and it received only a moderate score due to the lack of generalizability to the target population, data collection sources and methods used, analysis plan and strength of study design (38).

People who inject drugs

Nine economic modelling studies (18,19,22–24,32,36,37,46) investigated the cost-effectiveness of HIV testing intervals among PWID. The majority of studies (n=6) stated that annual screening of PWID (usually coupled with less frequent screening of the general population) was economically justifiable (22–24,32,36,37). Of note, Yazdanpanah et al. found that one-time, every three years, every five years and annual screenings of PWID were comparably cost-effective screening strategies in France (incidence: 0.17%/person-year) (36,37); however, three US studies recommended semi-annual testing versus annual testing (18,19,46).

Among the studies with PWID, seven studies were rated as high quality (18,19,22,24,32,36,37). In addition, one study was rated as moderate/high quality (46) and one as moderate quality (23); these two studies scored moderate quality due to the strength of the rationale and lack of clarity around the data collection methods.

Sex workers

Four of the included studies discussed the optimal frequency of HIV testing among sex workers operating in various settings (21,22,32,35). Kaplan and Satten (21) explored HIV screening intervals among legal commercial sex workers using mathematical modelling and found the optimal screening frequency is every month when the annual cost of infection is $360,000. Another study assessed HIV testing intervals among sex workers in jurisdictions where sex work was legal (35). The cost-effectiveness analysis of HIV testing intervals of legal commercial sex workers in Victoria, Australia (incidence rate of 0.1% HIV cases per person-year) concluded that implementing the current approach (testing once every three months) costs over $4,000,000 AUD for every HIV infection averted (35) and for HIV testing to be cost-effective among these Australian sex workers, there should be at least 42 weeks between HIV tests. Moreover, Wilson et al. found that decreasing the frequency of testing to once a year did not greatly impact the likelihood of transmission, as the expected number of HIV cases remained less than one (35). Studies set in China (22) and India (32) also concluded that annual testing would be the most cost-effective testing interval for sex workers.

These four studies varied in quality: two were assessed as high quality (22,32), one as moderate quality (35) and one as low quality (21). The two studies that received moderate and low ratings scored low in multiple domains (e.g., data collection, analysis and results) due to lack of details around price adjustments or currency conversions and clarity around justification of variables used.

Table 1 summarizes the economic modelling studies on optimal HIV testing and their quality scores.

Table 1: Optimal HIV testing frequencies of included studies

First author, year (ref)	Population	Model input parameters; HIV prevalence/ incidence	Testing frequencies considered	Optimal HIV screening frequency (conclusion)
HIGH QUALITY				
Cipriano, 2012 (18)	PWID	Prevalence: Overall: 0.47% PWID: 6.5%	Ab test with or without confirmatory RNA testing: • Once upon entry to ORT program • Once on entry followed by annually • Once on entry followed by every six months • Once on entry followed by every three months No screening	Using Ab test and confirmatory RNA screening, testing once upon entry to ORT program and every six months among those in the ORT program was most cost-effective
Gray, 2013 (44)	MSM	N/A	Testing frequencies: • One-time • Annually • Twice a year • Four times a year	Increasing HIV testing frequency results in a 13.8% reduction in HIV infections (or 208.7 infections averted) over 10 years if the 55–75% of men who test at least annually start testing every three months
Hutchinson, 2016 (19)	MSM, PWID	Prevalence: MSM: 1.27% PWID: 0.62%	Ag/Ab or rapid test: • Every three months • Every six months • Annually	Testing every three or six months using either an Ag/Ab or rapid test is cost-effective for MSM. Testing greater than annually using an Ag/Ab test is cost-effective for PWID

Table 1 (*continued*)**: Optimal HIV testing frequencies of included studies**

First author, year (ref)	Population	Model input parameters; HIV prevalence/ incidence	Testing frequencies considered	Optimal HIV screening frequency (conclusion)
HIGH QUALITY *(continued)*				
Li, 2012 (22)	MSM, PWID, sex workers, clients of sex workers, low-risk women	Prevalence: Male PWID: 9.3% Female PWID: 9.3% MSM: 5% Female sex workers: 0.6% Clients of female sex workers: 0.4% Low-risk men: 0.025% Low-risk women: 0.025%	Ab testing/confirmatory western blot: • One time low-risk and annual high-risk • Low-risk every three years and annual high-risk • Everyone screened every three years • Everyone screened annually • The above interventions with expanded ART and harm reduction access Current annual testing rates of 37% for high-risk groups and 2% for low-risk groups with an ART utilization rate of 30% and without harm reduction programming	Low-risk groups: one-time screening High-risk groups: annually
Long, 2010 (24)	MSM, PWID, general population	Prevalence: MSM:12.6% MSM/PWID:18.8% Male PWID: 12.9% Female PWID: 17.3% Low-risk men: 0.10% Low-risk women: 0.22%	ELISA and confirmatory western blot: • Low risk individuals once, high-risk annually • Low risk every three years, high risk annually • Everyone screened every three years • Everyone screened annually • The above interventions in combination with increased ART utilization from 50% at CD4 >350 cells/mL to 75% No screening	One-time HIV screening of low-risk individuals coupled with annual screening of high-risk individuals
Lucas, 2013 (46)	General population	Incidence: Low-risk: 0.01%/year Medium-risk: 0.1%/year High-risk: 1%/year	Ab tests over varied HIV screening intervals (from 0–8 years)	Low risk groups: Every 2.4 years;, Moderate-risk groups: every nine months; High risk groups: every three months
Martin, 2010 (27)	General population	Incidence: 0.09%/year	ELISA or rapid test: • Every five years • Every 10 years	Testing every 10 years is more cost-effective than an expanded HIV screening program (testing every five years)
Paltiel, 2005 (29)	General population, high-risk	Incidence: High-risk: 1.20%/year CDC threshold population: 0.12%/year General population: 0.01%/year	Testing intervals: • Current practice (five years to the detection of HIV on average) (29) • Current practice and one-time ELISA • Current practice and ELISA every five years • Current practice and ELISA every three years • Current practice and annual ELISA	Screening every 3–5 years is cost-effective among "all but the lowest-risk populations"
Paltiel, 2006 (28)	General population	Incidence: Baseline population: 1.0%/year US general population: 0.10%/year Low-risk population: 0.0084%/year	Rapid test: • One-time • Every five years • Every three years • Annually No specific screening program	One-time screening is the most cost-effective in all settings where the HIV prevalence was <0.20%
Sanders, 2005 (30)	General population	Incidence: 0.03%/year	ELISA and confirmatory western blot: • One-time • Every five years • No screening	One-time screening is the most cost-effective strategy in a population with a 1% prevalence of unidentified HIV infections. Screening every five years may be more appropriate in settings with high infection incidences
Soorapanth, 2006 (31)	Infants	Prevalence among pregnant women: 29.5% Incidence during pregnancy: 2.3%/year	Rapid test: • At 20 and 28 weeks gestation • At 20 and 34 weeks gestation • At 20 and 36 weeks gestation • Only at 20 weeks gestation	The minimum time interval between the initial and repeat screens should be from three to 18 weeks, depending on prophylactic and treatment regimens, for HIV rescreening to be cost saving

Table 1 (*continued*)**: Optimal HIV testing frequencies of included studies**

First author, year (ref)	Population	Model input parameters; HIV prevalence/ incidence	Testing frequencies considered	Optimal HIV screening frequency (conclusion)
HIGH QUALITY *(continued)*				
Venkatesh, 2013 (32)	MSM, PWID, general population, migrants, from HIV + country, sex workers	National population: Prevalence: 0.29% Incidence: 0.032%/year High prevalence districts: Prevalence: 0.8% Incidence: 0.088%/year High-risk groups: Prevalence: 5.0% Incidence: 0.552%/year	Testing intervals: • One-time • Every five years • Annually	Screening the national population every five years and people in high-risk groups and high prevalence districts annually is cost-effective
Walensky, 2011 (33)	General population	Prevalence: 16.9% Incidence: 1.3%/year	Rapid test: • One-time at age 33 years • Every five years • Annually • Every 10 years as well as upon presentation with an AIDS-defining	Annual testing is the most cost-effective strategy
Yazdanpanah, 2010 (37)	MSM, PWID, general population	Incidence: General population: 0.01%/year PWID: 0.17%/year French Guyana: 0.35%/year MSM: 0.99%/year Heterosexual population: 0.01%/year	ELISA: • One-time plus risk-based screening • Every five years plus risk-based screening • Annually plus risk-based screening • Risk-based screening only	One-time screening is recommended in addition to risk-based screening; however, more frequent screening in higher-risk subpopulations is justified
Yazdanpanah, 2013 (36)	MSM, PWID, general population	Incidence: National population: 0.03%/year PWID: 1.08%/year MSM: 0.43%/year	Rapid test: • One-time plus risk-based screening • Every three years plus risk-based screening • Annually plus risk-based screening • Risk-based screening only	One-time screening is recommended in addition to risk-based screening; however, more frequent screening in higher-risk subpopulations is justified
MODERATE QUALITY				
Baker, 2013 (38)	MSM	N/A	Testing intervals: • every three months • every six months	Screening high risk groups every three months is associated with an increase in the potential for earlier HIV diagnoses
Brown, 2008 (39)	Infants	N/A	Comparing assays at three, six, nine, and 12 months of age to the current practice of assays at birth, at 4–8 weeks, 15–18 months of age	Testing one month after weaning or 12 months of age (whichever comes first), identified 81% of those infected during the late postnatal period (after 4–8 weeks) through breastfeeding HIV-1 diagnostic testing should be performed at 4–8 weeks of age to capture early HIV-1 transmission, AND at the first of one month after weaning or 12 months of age to capture late postnatal transmission
Delaney, 2015 (40)	MSM	N/A	Testing intervals: • Annual testing • every three months	Current practice (testing "almost annually") is sufficient
Katz, 2014 (41)	MSM	N/A	Home-based testing • Annual testing • 2.9 times a year	Home-based testing resulted in increased HIV testing and HIV prevalence

Table 1 (*continued*)**: Optimal HIV testing frequencies of included studies**

First author, year (ref)	Population	Model input parameters; HIV prevalence/ incidence	Testing frequencies considered	Optimal HIV screening frequency (conclusion)
MODERATE QUALITY				
Long, 2011 (25)	MSM, PWID, low-risk	Prevalence: Male PWID: 12.9% MSM: 12.6% MSM/PWID: 18.8% Male other: 0.10% Female PWID: 17.3% Female other: 0.22%	Ag/Ab or Ab test (alone or with pooled NAAT): • Every three months • Every six months • Annually Current annual testing rates of 23% for high-risk groups and 10% for low-risk groups	Testing every six months using the Ag/Ab test is more cost-effective than annual pooled NAAT screening
Long, 2014 (23)	MSM, PWID, general population, migrants from HIV + country	Prevalence: Men from endemic countries: 2.5% Women from endemic countries: 5.0% PWID: 1.2% MSM: 5.0% Male other: 0.033% Female other: 0.033%	Testing intervals: • All adults tested every one, two, or three years • MSM, PWID, and people from endemic countries are tested annually, with other adults being tested either one-time or every two years • Annual testing	High-risk groups: annual testing Low-risk groups: one-time
Waters, 2011 (34)	General population	Incidence: 0.8, 1.3, or 4.0%/ year	Testing intervals: • Every three and six months • Every 1, 2, 3, 4.29, 5, 6, 7.5, 10 or 15 years • One-time 30 years from model start	"Accounting for secondary infections averted, the most cost-effective testing frequency was every 7.5 years for 0.8% incidence, every five years for 1.3% incidence, and every two years for 4.0% incidence"
Wilkinson, 2015 (42)	Sex workers	Incidence: 0.1%/year	ELISA over varied HIV screening intervals (from 0–55 weeks) • Testing every 12 weeks is the comparator interval	"At an assumed willingness to pay of $50 000 AUS per QALY gained, HIV testing should not be conducted less than approximately every 40 weeks[…]"
Wilson, 2010 (35)	Sex workers	Incidence: 0.1%/year	ELISA over varied HIV screening intervals (from 0–55 weeks) • Testing every 12 weeks is the comparator interval	"At an assumed willingness to pay of $50 000 AUS per QALY gained, HIV testing should not be conducted less than approximately every 40 weeks […]"
LOWER QUALITY				
Hutchinson, 2010 (20)	General population, MSM, high risk	Prevalence:1.0-1.8% Incidence: 0.01-0.21%/year	Ab or rapid test with NAAT: • HIV diagnosis one year after infection • HIV diagnosis six months after infection • HIV diagnosis five years after infection	"NAAT screening was cost-effective in targeted to settings with very high HIV incidence, such as the community clinic, where it remained cost-effective compared with retesting for HIV antibody as often as every three months"
Kaplan, 2000 (21)	Sex workers, active duty soldiers	Incidence: Sex workers: 0.004/year Soldiers: 0.0003/year	ELISA over varied HIV screening intervals (from 0–4 months)	Sex workers: every month when the annual cost of infection is $360,000.W Soldiers: every 1.4 years when the annual cost of infection is $8,570

Abbreviations: Ab, antibody; Ag, antigen; ART, antiretroviral therapy; $ AUS, Australian dollar; CDC, Centers for Disease Control and Prevention; ELISA, enzyme-linked immunosorbent assay; HIV + country, HIV endemic country; MSM, gay, bisexual, and other men who have sex with men; NAAT, nucleic acid amplification testing; N/A, not applicable; ORT, opioid replacement therapy; PWID, persons who inject drugs; QALY, quality-adjusted life year; ref, reference; RNA, ribonucleic acid; US, United States; <, inferior to; >, superior to

Potential harms, patient values and preferences

Two studies identified the potential harms associated with HIV screening intervals (23,24). Both studies found that the implementation of more frequent screening (within the general population, MSM, PWID and migrants from HIV-endemic country population groups) resulted in an increase in the number of false positive and negative results. However, it was reported that the number of false positive/negative results decreased as fewer people remain undiagnosed (23,24). No studies reported on the other outcomes of interest for harms (e.g., psychosocial harms, stigmatization, etc.).One study was assessed as high quality (24) and the other was assessed as moderate quality (23) due to a

lack of specificity and reporting of the rationale, data collection and method of analysis.

Two studies examined patients' values and preferences associated with HIV testing intervals (43,44). In an Australian study, the authors surveyed self-identified MSM living in New South Wales and found that 25% were "very likely" to accept more frequent (i.e., every three months) HIV testing (44). The setting of the second study was in American primary care clinics in underserved and low-income neighbourhoods. The authors reported that 86% of African American and Latino respondents value HIV testing on a regular basis, with 77% of respondents expressing interest in annual or semi-annual testing and 80% of respondents indicating a preference to have the HIV test performed by their primary care provider rather than an HIV-specific counsellor. One was assessed as moderate quality (44) and the other assessed with a lower quality (43) due to concerns about the data collection methods.

Table 2 summarizes the findings from descriptive studies of optimal HIV testing frequency and related findings.

Table 2: Results on potential harms, patient values and preferences of included studies

First author, year	Population	Objective	Potential harms, patient values and preferences	Rating
Gray, 2013 (44)	MSM	Assess whether increases in HIV testing would be acceptable to gay men in New South Wales and model the potential impact of increases in testing coverage and/or frequency	Increasing HIV testing would be acceptable if testing was more convenient. Only 25% of men surveyed were 'very likely' to increase their level of HIV testing	High
Long, 2010 (24)	MSM, PWID, general population	To evaluate the effects of expanded ART, HIV screening, or interventions to reduce risk behavior	Annual screening in high risk populations and one-time screening in the general population will result in false-positive and false-negative diagnoses. These will decrease over 20 years.	High
Long, 2014 (23)	MSM, PWID, general population, migrants from HIV endemic countries	Estimate the effectiveness and cost-effectiveness of HIV testing in the United Kingdom	False-positives and false-negatives would occur with annual high-risk screening and one-time low risk screening. Over time, the occurrences will decrease.	Mod
Simmons, 2005 (43)	General population (African Americans and Latinos)	Determine the attitudes of patients who attend urban primary-care clinics towards HIV testing	77% of study participants said that they wanted to be tested annually or semi-annually for HIV. Participants also indicated their desire to be tested for HIV routinely by their primary care provider, as opposed to an HIV counsellor.	Low

Abbreviations: ART, antiretroviral therapy; Mod, moderate; MSM, men who have sex with men; PWID, persons who inject drugs; HIV, Human immunodeficiency virus

Discussion

This systematic review of 27 studies found there was insufficient high quality evidence and a lack of consistency in the findings to identify an optimal HIV testing interval for specific risk populations. Optimal screening and testing frequencies ranged widely from once in a lifetime for the general population to every three months for high-risk populations, depending on the type of study and the population studied. There were only two studies addressing potential harms that identified the risk of false positives or negatives. In addition, there were limited data on patients' values and preferences, although it appeared in high risk groups that more frequent testing would be acceptable.

The results of our systematic review are consistent with those of a recent review conducted by the Centers for Disease Control and Prevention (CDC) on HIV screening for gay, bisexual and other MSM. The CDC concluded that the evidence, programmatic experiences and expert opinions did not warrant changing the recommendations for HIV testing in MSM from once per year to more frequent intervals.

Strengths and limitations

This is the first review to assess HIV screening and testing intervals in risk populations other than MSM and to summarize potential harms and patient preferences. Other strengths of this study include the comprehensiveness of the review, the robustness of the search strategy and the systematic nature of the analysis.

There are some limitations to consider. Although this study included 20 modelling studies, they were difficult to interpret for a Canadian population. Although some of the studies had an overall high quality and modelling studies may be useful for supporting the development of clinical guidelines in the absence of experimental evidence (47), the modelling studies examined included numerous assumptions that were not directly applicable to Canada. In addition, there was an absence of studies for other high-risk groups, such as Indigenous and incarcerated populations (6,7,48) and very little data on patients' values and preferences. In all the studies, it was difficult to control for context-specific factors such as budget allocation, human resources, local epidemiology and socioeconomic factors.

Conclusion

Determining the optimal screening intervals for HIV in different risk populations is challenging due to the paucity of applicable, consistent, high quality evidence. In light of the inconsistency of findings and the limitations of modelling studies, population-based experimental studies could be done for different risk populations and Canadian-specific modelling studies may be helpful.

Authors' statement

KT – Conceptualisation, methodology, investigation, writing – review and editing, supervision, project administration
MW – Investigation, writing – original draft, writing – review and editing, visualisation
GT – Conceptualisation, methodology, investigation, writing – review and editing
PP – Investigation, writing – original draft, writing – review and editing, visualisation
TA - Conceptualisation, methodology, investigation, writing – reviewing and editing
SH – Conceptualisation, methodology, writing – review and editing
BA – Investigation, writing – review and editing

Conflict of interest

None.

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OVERVIEW

What is new in the Canadian Immunization Guide: November 2016 to November 2018

A Fleurant-Ceelen[1], M Tunis[1], A House[1], on behalf of the National Committee on Immunization (NACI)*

Abstract

The Canadian Immunization Guide is an online resource that provides evidence-based recommendations on the use of vaccines and vaccine administration practices to health care providers and public health practitioners in Canada. Its contents are based on the most up-to-date recommendations of the National Advisory Committee on Immunization (NACI) and the Committee to Advise on Tropical Medicine and Travel (CATMAT). The Canadian Immunization Guide (CIG) is frequently updated online in response to new evidence and changing product indications. Between November 2016 and November 2018, new and updated recommendations were published for the chapters on Vaccine Administration Practices, Immunization of Immunocompromised Persons, and Immunization During Pregnancy and Breastfeeding and on seven active vaccines (for cholera and traveller's diarrhea, influenza, hepatitis A, hepatitis B, herpes zoster, human papillomavirus and pertussis), as well as a recent update on measles post-exposure prophylaxis.

Affiliation

[1] Centre for Immunization and Respiratory Infectious Diseases, Public Health Agency of Canada, Ottawa, ON

***Correspondence:**
phac.naci-ccni.aspc@canada.ca

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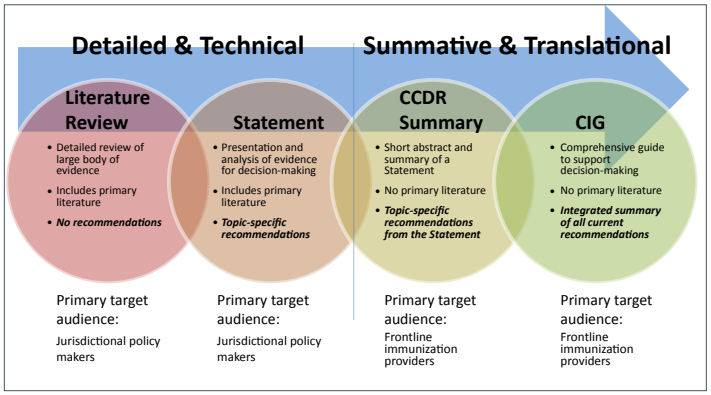
Keywords: Immunization, NACI, Canada, update, vaccine

Introduction

The National Advisory Committee on Immunization (NACI) has been providing advice on vaccines to governments and health care professionals in Canada and internationally since 1964 (1). It does this by providing a variety of information products to meet the needs of different audiences. NACI develops detailed and technical products, such as literature reviews and NACI statements, for immunization experts and policy makers. NACI also develops summative and translational products, such as statement summaries in the Canada Communicable Disease Report and updates in the Canadian Immunization Guide (CIG), for front line public health and clinical care. **Figure 1** provides an overview of NACI's production process.

CIG has been providing clinically-relevant information on immunization to front line immunization providers since 1979 (2). CIG transformed into an evergreen online format in 2012 (3) and is now updated on an ongoing basis as new recommendations from NACI are completed. It also includes vaccine and related recommendations from the Committee to Advise on Tropical Medicine and Travel (CATMAT). CIG does not address economic and societal considerations related to immunization; however, it does highlight changes in disease epidemiology, safety signals and vaccine supply issues.

Figure 1: National Advisory Committee on Immunization: Production process



Abbreviations: CCDR, Canada Communicable Disease Report; CIG, Canadian Immunization Guide

CIG is divided into five parts: key immunization information; vaccine safety; vaccination of specific populations; active vaccines; and passive immunization.

The purpose of this update is to provide an overview of the changes that have been made to CIG between November 2016 and November 2018. This includes changes to key immunization information, vaccination of specific populations, active vaccines and measles postexposure prophylaxis (PEP).

Key immunization information

The chapter on *Vaccine Administration Practices* (4) was updated. It now has a *Needle Selection Guide* that emphasizes the importance of selecting needle length for intramuscular injection on a case-by-case basis that includes an assessment of the viscosity of the immunizing agent as well as the recipient's age, weight and muscle mass. The use of filter needles is not recommended as active ingredients such as adjuvants may be filtered out during the injection process. It notes that injections may be provided through a tattoo or a superficial birthmark; however, injections sites with potentially impaired lymphatic drainage should be avoided. There is a new table that provides immunization pain management strategies for clients of all ages. Regarding the combination of contents of multi-dose vials, health care providers are advised to adhere to jurisdictional or organizational policies.

Vaccination of specific populations

Two chapters were updated: immunization of immunocompromised persons; and immunization during pregnancy and breastfeeding.

Throughout the *Immunization of Immunocompromised Persons* chapter (5), tables have been included that outline immunization recommendations by vaccine and primary immunodeficiencies, acquired (secondary) immunodeficiencies, transplant recipients/candidates and HIV-infected persons. New information has been added on defects in innate immunity, criteria for consideration of measles-mumps-rubella and varicella vaccines in those with partial T cell defects, contraindications for live viral vaccines in some types of phagocytic cell defects and immunosuppressive therapy.

The *Immunization in Pregnancy and Breastfeeding* chapter (6) was updated to reflect the new recommendation to administer pertussis vaccine during every pregnancy between 27 and 32 weeks. It also clearly states that vaccines containing thimerosal are safe in pregnancy and should be used if indicated. Additional considerations during pregnancy have been added for the administration of Rhesus (Rh) immunoglobulin and other blood products and for the administration of the following vaccines: conjugate quadrivalent meningococcal; meningococcal B vaccine; yellow fever; and Japanese encephalitis.

Active vaccines and passive immunization

Seven active vaccine chapters were updated, along with an update on measles PEP using immune globulin.

Cholera and *Enterotoxigenic* Escherichia coli (*travellers' diarrhea*)

Due to the limited benefits associated with this vaccine, the oral cholera vaccine should no longer be routinely recommended to prevent travellers' diarrhea. CATMAT notes that it may be considered for those who are at highest risk of infection, health complications or serious inconveniences, such as humanitarian workers, health care workers in endemic countries, travellers at high risk of exposure to contaminated water or food, immunocompromised persons and those with chronic illnesses for whom there is an increased risk of serious consequences from travellers' diarrhea. In addition, CATMAT recommends that all other clients follow hand hygiene, food and water safety practices and consider over-the-counter medication for the management of travellers' diarrhea (7,8).

Influenza

Seasonal influenza vaccine recommendations are updated annually in advance of the influenza season (9).

Hepatitis A

The recommended dosages for intramuscular immune globulin (IM Ig) as pre- and postexposure prophylaxis for hepatitis A have been increased to reflect new product monograph indications (10).

Hepatitis B

Based on vaccine immunogenicity and safety data, NACI has revised its recommendation for the dosage of Recombivax HB® for infants (of hepatitis B-negative mothers) to children less than 11 years of age from 0.25 mL to 0.5 mL. For children, previously-received doses of 0.25 mL are still considered valid and do not need to be repeated. For immunocompromised individuals, initial annual monitoring of hepatitis B antibody levels may be considered after primary immunization (11).

Herpes zoster (shingles)

Following Canadian authorization of the new recombinant herpes zoster vaccine (RZV), Shingrix®, NACI now recommends that RZV should be offered to adults 50 years and older without contraindications, including those who have previously received the live zoster vaccine (LZV), Zostavax®, at least one year prior. NACI recommends that individuals without contraindications who have had a previous episode of herpes zoster may be offered two doses of RZV, at least one year after the last episode. When RZV is contraindicated, unavailable or inaccessible, the previously-approved LZV may still be considered for immunocompetent individuals who are at least 50 years old and who have no contraindications. RZV (but not LZV) may be considered in immunocompromised adults who are at least 50 years old on a case-by-case basis (12–14). Two tables have been added to the guidelines that summarize the key considerations for the choice of a herpes zoster vaccine and its administration (12).

Human papillomavirus

The human papillomavirus (HPV) vaccine, HPV9, is now recommended for immunocompetent males and females who are nine to 14 years old using either a two- or three-dose immunization schedule, while it continues to be recommended using only a three-dose immunization schedule for males and females 15–26 years of age and may be used in those over 26 years of age who are at risk of ongoing exposure. This is similar to HPV2 (females only) and HPV4 vaccines. Any HPV vaccine

(HPV 2, HPV4, or HPV9 vaccine) should allow at least 24 weeks between the first and last dose in either a two- or three-dose schedule. Immunocompromised individuals should continue to receive the vaccine on a three-dose immunization schedule with at least 24 weeks between the first and last dose of vaccine (15).

Pertussis (whooping cough)

Recent evidence suggests that infants can effectively be protected against pertussis (whooping cough) through maternal immunization with the tetanus-diphtheria-pertussis (Tdap) vaccine during pregnancy. The Tdap vaccine is now recommended for every pregnancy between 27 and 32 weeks of gestation. When unique patient considerations preclude vaccination during this period, it is possible to offer the Tdap at any time from 13 weeks to the time of delivery (16).

Measles

New evidence suggests that the previously recommended dosage of immune globulin (Ig) no longer provides optimal protection for measles PEP. For NACI has updated recommendations for Ig PEP dosage, indications and routes of administration (17) as follows:

- Immunocompetent individuals six months of age and older who have been exposed to measles and who have no contraindications should be offered a measles-mumps-rubella vaccine within 72 hours of the exposure
- If injection volume is not a major concern, infants younger than six months of age should be given IM Ig at a concentration of 0.5 mL/kg, to a maximum dose of 15 mL, administered over multiple injection sites
- If injection volume is not a major concern, infants six to 12 months old who are identified after 72 hours and within six days of measles exposure should receive IM Ig (0.5 mL/kg), to a maximum dose of 15 mL, administered over multiple injection sites
- If injection volume is not a major concern, contacts who are pregnant or immunocompromised can receive IM Ig at a concentration of 0.5 mL/kg, understanding that recipients 30 kg or more will not receive the measles antibody concentrations that are considered to be fully protective
- In cases where injection volume is a major concern or for recipients 30 kg or more, intravenous immunoglobulin (IV Ig) can be provided at a dose of 400 mg/kg (17); and
- NACI does not recommend that susceptible immunocompetent individuals older than 12 months of age receive Ig PEP for measles exposure due to the low risk of disease complications and the practical challenges of administration for case and contact management

A summary of the updated recommendations on the active vaccines is presented in **Table 1.**

Table 1: Summary of updates on active vaccines and postexposure prophylaxis, November 2016 to November 2018

Vaccine-preventable disease	Previous recommendation	New recommendation
Cholera and travellers' diarrhea	Not routinely recommended for travellers	May be considered for those who are at highest risk of infections, complications or inconveniences
Influenza	New seasonal recommendations are issued every year in preparation of the upcoming influenza season	
Hepatitis A	For protection lasting less than three months IM Ig is 0.02 mL/kg of body weight If protection is required for three months or longer, 0.06 mL/kg of body weight should be administered and repeated every six months	IM Ig standard dose with a dosage of 0.1 mL/kg is recommended for household and institutional hepatitis A case contacts For travellers to high risk areas, prophylactic doses are as follows: Up to one month travel = 0.1 mL/kg Up to two months two months or longer = 0.2 mL/kg Repeat dose of 0.2 mL/kg every two months
Hepatitis B	Recombivax HB® dosage for children 0–10 years old of hepatitis B negative mothers: 0.25 mL	Recommended dosage for Recombivax HB increased to 0.5 mL
Herpes zoster (shingles)	LZV (Zostavax®) is recommended for adults 50 years and older without contraindication	The RZV (Shingrix®) is recommended for adults 50 years old and over without contraindications, including those who received LZV at least one year prior If RZV is contraindicated, unavailable or inaccessible, then LZV may be considered for immunocompetent individuals ≥50 years of age without contraindications RZV (not LZV) may be considered for immunocompromised adults ≥50 years of age based on a case-by-case assessment of the benefits versus risks
Human papillomavirus	HPV9 vaccine recommended using a three-dose schedule, compared to HPV2 and HPV4 vaccine which may be used in a two- or three-dose schedule in some populations	HPV9 vaccine now recommended as a two-dose or three-dose schedule in some populations, similar to HPV2 and HPV4 vaccines
Pertussis (whooping cough)	Tdap vaccine should be offered to pregnant women during pertussis outbreaks	Tdap vaccine should be offered to every woman during every pregnancy, ideally between weeks 27 and 32 of gestation to protect infants

Table 1 (*continued*)**: Summary of updates on active vaccines and postexposure prophylaxis, November 2016 to November 2018**

Vaccine-preventable disease	Previous recommendation	New recommendation
Measles	Dosage: when indicated, IM Ig at a concentration of 0.25 mL/kg should be administered or 0.5 mL/kg for immunocompromised individuals Populations: IM Ig provided to susceptible individuals of all ages presenting between 72 hours and six days post-exposure; and provided to infants under six months of age, pregnant women, or immunocompromised individuals presenting anytime up to six days postexposure	Increased IM Ig dosage: When indicated, IM Ig at a concentration of 0.5 mL/kg, up to a maximum dosage of 15 mL where injection volume is not a concern Route of administration: IV Ig can be considered at a dose of 400 mg/kg when injection volume is a major concern or for individuals ≥30 kg Change to recommended populations: NACI no longer recommends that susceptible immunocompetent individuals older than 12 months of age receive Ig PEP for measles exposure due to the low risk of disease complications and the practical challenges of administration for case and contact management

Abbreviations: HPV, human papillomavirus; Ig, immune globulin; IM Ig, intramuscular immune globulin; IV Ig, intravenous immune globulin; kg, kilogram; LZV, live herpes zoster vaccine; mg, milligram; mL, milliliter; NACI, National Advisory Committee on Immunization; N/A, not applicable; PEP, postexposure prophylaxis; RZV, recombinant herpes zoster vaccine; Tdap, tetanus toxoid, diphtheria toxoid, acellular pertussis; ≥, at least

Summary and conclusion

CIG continues to provide practical, evidence-based recommendations, based on the advice provided by NACI and CATMAT, to health care professionals to inform front line immunization practices. Summaries of changes are highlighted in Canada Communicable Disease Report from time to time. There is also a list of the changes made to CIG available online, and this list is updated in close to real time (18). Notices of new NACI recommendations, statements, NACI updates and updates to CIG chapters are also available by subscribing to NACI and CIG mailing lists (19).

Authors' statement

AFC — Writing original draft, review and editing
MT — Review and editing
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Conflict of interest

None.

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Correction for Can Commun Dis Rep 2018;44(11)

CCDR Editorial team[1]

Affiliation

[1] CCDR Editorial Office, Infection Prevention and Control Branch, Public Health Agency of Canada, ON

***Correspondence:** phac.ccdr-rmtc.aspc@canada.ca

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In the article "CPHLN recommendations for the laboratory detection of Shiga toxin-producing Escherichia coli (O157 and non-O157)" published on November 1, 2018 there was an error in Figure 1: Recommendations for the detection of Shiga toxin-producing Escherichia coli in stool specimens (1). Under Nucleic acid testing (NAT) for Shiga toxin gene (stx), the two boxes on the reporting of positive and negative stx were inadvertently switched.

This was corrected on November 6, 2018. The figure now indicates that positive NAT results for stx should be reported and then provincial procedures for culture submissions followed.

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CCDR Editorial team[1]

Affiliation

[1] CCDR Editorial Office, Infection Prevention and Control Branch, Public Health Agency of Canada, ON

***Correspondence:** phac.ccdr-rmtc.aspc@canada.ca

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In the article "Vaccine safety surveillance in Canada: Reports to CAEFISS, 2013—2016" published on September 6, 2018, the exact number corresponding to the percentages identified in the sentence following Figure 4 were incorrect (1). It should have read:

"For children less than 18 years of age, 7% (n=407) of all submitted AEFI reports were through active surveillance. Even though the proportion is small, they represented 56% (n=401) of all serious AEFI reports submitted for this age group, reflecting the contribution of the hospital-based active surveillance system. (*Note: Data not shown; numbers do not completely correspond to the percentages as the percentages have been rounded to the nearest integer.*)

This was corrected on December 4, 2018.

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CANADA COMMUNICABLE DISEASE REPORT

Public Health Agency of Canada
130 Colonnade Road
Address Locator 6503A
Ottawa, Ontario K1A 0K9
phac.ccdr-rmtc.aspc@canada.ca

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