Public Health Ontario | Santé publique Ontario

Infectious Diseases Trends in Ontario, 2019

Technical Notes

December 2020

Public Health Ontario

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Reporting

In Ontario, over 70 diseases are specified as diseases of public health significance (formerly reportable diseases) under Regulation 135/18: Designation of Diseases pursuant to the *Health Protection and Promotion Act* (HPPA), R.S.O 1990.[1-2] Regulation 135/18 replaced Regulation 559/91: Specification of Reportable Diseases on May 1, 2018.[3]

Health care providers, laboratories and other individuals (including school principals and superintendents of institutions) with a duty to report diseases specified under Regulation 135/18 must make such reports to the Medical Officer of Health in the local public health unit (PHU) within which they operate, as outlined in Ontario Regulation 569.[4] PHUs provide case management services to individuals suspected of having a disease of public health significance in their jurisdiction in accordance with the HPPA, the Ontario Public Health Standards and the Infectious Diseases Protocol.[5-6] Required case data are subsequently reported to the province through the integrated Public Health Information System (iPHIS).

integrated Public Health Information System

The main source for disease data in the Infectious Disease Trends in Ontario interactive tool (previously known as the Reportable Disease Trends in Ontario tool) is the integrated Public Health Information System (iPHIS), the electronic reporting system used by all local PHUs to report cases of diseases of public health significance in Ontario.[7] iPHIS replaced the Reportable Diseases Information System (RDIS) and was implemented in phases throughout 2005 starting on April 1, with full implementation by all local PHUs by the end of that year.

The data presented in the Infectious Disease Trends in Ontario tool are based mainly on cases with individual records in iPHIS. Aggregate counts and case-level data are used for both *Clostridium difficile* infection (CDI) outbreaks in hospitals and varicella (chickenpox). The iPHIS data used in this tool were extracted on June 29, 2020 except as noted:

- Data on CDI outbreaks and Carbapenemase-producing *Enterobacteriaceae* (CPE) were extracted from iPHIS on July 21, 2020.

Public Health Ontario's Laboratory Data

Laboratory detection and confirmation of diseases of public health significance often occurs at Public Health Ontario's (PHO) laboratory. For some diseases, identification can take place at hospitals or private laboratories. In other instances, reference services and specialized testing of clinical specimens take place at other reference laboratories across Canada, including the National Microbiology

Laboratory (NML) and these results are reported back to PHO. The main source for laboratory test data in the 2019 Infectious Disease Trends in Ontario interactive tool is the Laboratory Information Management System (LIMS) from PHO's laboratory. The LIMS data used in this tool were extracted on the following dates:

- Data for calculating percent positivity for chlamydia and gonorrhea were extracted from LIMS on July 13, 2020.
- Data for calculating percent positivity for influenza and legionellosis were extracted from LIMS on July 21, 2020.
- Resistance data for tuberculosis (TB) were extracted from LIMS on July 22, 2020.

Population and Live Birth Data

IntelliHEALTH Ontario is a repository of health-related data that describes the population and delivery of health care services in Ontario. Population and live birth counts for Ontario are originally sourced from Statistics Canada and Service Ontario, respectively and were obtained through IntelliHEALTH Ontario. These two sources of population data were used as denominators to calculate overall, age-, sex-, PHU- and Local Health Integration Network (LHIN)-specific crude incidence rates, where applicable. Population estimates up to 2017 were extracted from IntelliHEALTH Ontario on November 26, 2019 and population projections for 2018 and 2019 were extracted from IntelliHEALTH Ontario on November 26, 2019.

Live births are used as the denominator for calculating incidence rates for three neonatal and congenital diseases included in this tool: congenital rubella syndrome, neonatal group B streptococcal disease and ophthalmia neonatorum. Live births are used as the denominator for these diseases, as neonatal population counts (infants up to 28 days old) could not be determined from available vital statistics data. The live birth data available to PHO are current up to 2015; as such, incidence rates for congenital or neonatal diseases for 2015 to 2019 are based on the 2015 live birth data. Data on live births were extracted from IntelliHEALTH Ontario on July 10, 2018 for years prior to 2013 and on May 15, 2019 for the years 2013 to 2015.

National Comparator Data

Comparator incidence rates for Canada are provided in the tool whenever available. These data were obtained directly from the Notifiable Disease Charts of the Public Health Agency of Canada (PHAC) website on September 21, 2020.[8]

For most diseases in this tool, comparator incidence rates for Canada are presented for the years 2010 to 2019 in trend over time graphs. Depending on the disease and when it became nationally notifiable, national incidence rates may not be available for all or a part of this period. As a result, comparisons between trends in provincial and national incidence rates are made only for years in which national incidence rates are provided. National rates are also not provided for diseases where the data provided do not distinguish between different forms of the disease (e.g., infectious and non-infectious syphilis

and acute and chronic hepatitis B) or between aggregate and individual data on cases (i.e., varicella, CDI). Differences between national and Ontario case definitions also exists and these differences should be considered when comparing trends in provincial and national incidence rates. A list of diseases that are nationally notifiable can be found on PHAC's website.[9]

Incidence rates for Canada presented in this tool may differ from reports published by PHAC. Where such discrepancies exist, incidence rates published in more recent national reports supersede those in this tool.

Case Definitions

Appendix 1 lists diseases of public health significance and associated case classifications that were reportable in Ontario in 2019. Cases are classified in iPHIS according to the provincial surveillance case definitions in use at the time the case was identified. PHUs are responsible for ensuring that cases reported to the province meet the relevant case definition. The most recent provincial case definitions are available in Appendix B of the Infectious Diseases Protocol.[10]

It is important to consider changes in provincial case definitions and associated case classifications (see section below) over time when interpreting disease trends presented in this tool. The changes have occurred over the years to reflect the changing epidemiology of infectious diseases and the use of more current laboratory diagnostic practices and technology. Changes to the reportable diseases case definitions from 1991 to 2016 are documented in the Factors affecting Reportable Diseases in Ontario (1991-2016) report and its accompanying appendix.[11-12]

Case Classifications

Unless otherwise stated, case counts presented in this tool include only the confirmed case classification. Reporting of probable cases is only required for some diseases, as specified in the provincial case definitions outlined in Appendix B of the Infectious Diseases Protocol.[10]

Probable cases are included in the total counts presented in the Infectious Disease Trends in Ontario tool for select diseases: amebiasis, Lyme disease, mumps, pertussis, invasive meningococcal disease (IMD), invasive *Haemophilus influenzae* (Hi) disease all types and West Nile virus (WNV) illness. Reporting of probable cases for these diseases, with the exception of WNV illness, was instituted following case definition changes in 2009 because some cases that previously met the confirmed case definition were subsequently required to be reported as probable. As a result, probable case counts reported since 2009 (see Table 1 for specific dates) are included in total counts for these diseases to ensure valid comparisons over time.

Table 1. Diseases that include probable cases in total counts

Disease	Case classifications
Amebiasis	Probable cases of amebiasis have been included in total counts since January 1, 2009 owing to the change in interpretation of laboratory test results that previously reported the causative agent as *Entamoeba histolytica*/*E. dispar* with no distinction between the two. Cases with test results that do not differentiate between the non-pathogenic *E. dispar* and the pathogenic *E. histolytica* are now counted as probable, whereas they were previously counted as confirmed. The impact of this change was substantial. As a result, probable cases have been included in total counts since 2009 to ensure valid comparisons over time for amebiasis.
Haemophilus influenzae (Hi)	Probable cases have been included in total counts since April 28, 2009 to facilitate trending over time. As of May 1, 2018, all types of invasive Hi disease were designated as a disease of public health significance in Ontario. Previously, only type b was reportable. Thus, serotype information should be considered when comparing trends over time.
invasive meningococcal disease (IMD)	Probable cases have been included in total counts since April 28, 2009 to facilitate interpretation of trends over time.
Lyme disease	The impact of the change in case definition was substantial given that probable cases reported since 2009 constituted a substantial proportion of total case counts. As a result, probable Lyme diseases cases have been included in total counts since January 1, 2009 in order to ensure valid comparisons over time.
Mumps	Probable cases have been included in total counts since April 28, 2009 to facilitate interpretation of trends over time.
Pertussis	Probable cases have been included in total counts since April 28, 2009 to facilitate interpretation of trends over time. Changes to laboratory testing may also impact temporal trends; testing by polymerase chain reaction (PCR), a more sensitive diagnostic tool, was first implemented in 1998, followed by real-time PCR in 2005. Effective 2009, the minimum threshold used to determine a positive PCR result was increased, leading to a reduction in the number of positive cases of pertussis identified via PCR.
West Nile virus (WNV) illness	Both confirmed and probable cases have been included in provincial counts since the disease became reportable in 2003.

For the vast majority of other diseases that were similarly impacted by the 2009 case definition changes, the impact on overall counts was negligible. As such, probable cases for these diseases are not routinely included in provincial counts.

For **measles**, **rubella** and **congenital rubella syndrome (CRS)**, probable cases are excluded from the historical temporal trend despite being reportable at the provincial level, since these diseases have been declared eliminated from Canada and strict criteria are required to confirm or rule out cases. Since 2012, these criteria have been entrenched in provincially-enhanced surveillance activities to document the elimination of measles and rubella, which may impact the interpretation of trends in the incidence of these diseases. Despite elimination, Ontario continues to have cases due to importation from parts of the world where these diseases remain endemic.

For **hepatitis B**, confirmed acute cases are captured under the Classification Description of confirmed in iPHIS, while confirmed chronic hepatitis B cases are captured under the Classification Description of carrier. When a case progresses from acute to chronic infection, PHUs create a chronic carrier case, in addition to the existing acute confirmed case. Therefore, counts of acute and chronic hepatitis B cases are not mutually exclusive and have not been summed, as this would result in double-counting of some cases.

Both **AIDS** and **HIV** cases are reported under the Disease field in iPHIS as HIV/AIDS. HIV cases that have not progressed to AIDS have an Encounter Type and a Diagnosis Status of carrier. HIV cases that have progressed to AIDS have an updated Encounter Type of case and an updated Diagnosis Status of confirmed. To determine accurate counts, cases of HIV/AIDS with either an Encounter Type of carrier and a Diagnosis Status of carrier or an Encounter Type of case and a Diagnosis Status of confirmed are counted as HIV cases using the Encounter Date (the date the HIV encounter was reported). HIV/AIDS encounters with an Encounter Type of case and a Diagnosis Status of confirmed are counted as AIDS cases based on the Diagnosis Status Date (the date the case was diagnosed with AIDS). Therefore, counts of AIDS and HIV cases are not mutually exclusive and have not been summed, as this would result in double-counting of some cases.

Data Management

Reference Period

iPHIS allows the entry of multiple dates relevant to the case. In Ontario, cases of most diseases of public health significance are classified by time using the episode date, which is a field that estimates the symptom onset date of disease for a case. The episode date is determined using the following hierarchy of date fields in iPHIS:

1. Symptom Onset Date
2. Specimen Collection Date
3. Lab Test Date (date laboratory testing was performed)

4. Reported Date (date the case was reported to the PHU)

During data extraction, the earliest available date in the hierarchy is selected as the episode date for each case. For example, if an Onset Date is available for a case, it is selected as the episode date instead of the Specimen Collection Date and so on. In some situations, the episode dates captured can be much later than the actual date of symptom onset, which can result in larger margins of error when deriving the symptom onset date from the Reported Date or the Specimen Collection date. For congenital rubella syndrome, the episode date is the date of birth of the case.

Cases are attributed to a particular year based on their episode date. There are some exceptions to reporting of incident cases; for example, HIV, chronic hepatitis B, hepatitis C, TB, late latent syphilis and neurosyphilis are often undiagnosed for extended periods and their detection by public health is generally not indicative of the actual date the infection was acquired. Therefore in some instances, cases included in this tool for a particular year are individuals who acquired their infections in earlier years and the data represent rates of new diagnoses rather than rates of new infection.

HIV/AIDS and TB are not classified by time based on the Episode Date. For HIV, incident case counts are based on the Encounter Date (i.e., Reported Date), defined as the date a case became known to public health. AIDS and TB incident case counts are based on the Diagnosis Status Date and Diagnosis Date, which is the date of a case's diagnosis for AIDS and TB, respectively.

Aggregate varicella counts are attributed to a year based on the year the outbreak was reported as entered in the Outbreak Reported Year Name. If the Outbreak Reported Year Name was incomplete, the year indicated in the Outbreak Name (users are instructed to name outbreaks using the year of report) was used to attribute the cases to a particular year. If the Outbreak Name did not contain a year in the specified format, the year the outbreak was classified (the Outbreak Classification Year Name) was used.

CDI outbreaks are allocated to onset year based on the onset date of the index case in the outbreak. Where onset date of the index case was missing, the date the outbreak was created in iPHIS was used.

CPE case counts are based on the earliest specimen collection date. Where specimen collection date was missing, report date was used. CPE outbreaks are counted based on report date.

Unless otherwise specified, the Infectious Disease Trends in Ontario tool cover the period from 2010 to 2019 for most diseases. Some exceptions include:

- Data for Blastomycosis, CPE infection or colonization and *Echinococcus mutilocularis* infection are presented from 2018 onwards, as these diseases were designated as diseases of public health significance in Ontario on May 1, 2018.
- Data for malaria and yellow fever are presented up to and including 2017, as these diseases were removed from the list of diseases of public health significance on May 1, 2018.

Case Ascertainment Criteria

This tool includes all confirmed (and probable, as applicable) cases of diseases of public health significance reported through iPHIS with an episode date from 2010 to 2019 (or other appropriate date fields, as noted above in the Reference Period section), with the following exclusions:

1. Cases who were not residents of Ontario at the time of diagnosis.
2. Cases reported with a Disposition Status of entered in error, does not meet definition, duplicate – do not use, or any variation on these values.
3. Events reported as adverse events following immunization (AEFIs) and related data, which are published in a separate annual vaccine safety report and online tool.[13-14]
4. Cases reported as acute flaccid paralysis, encephalitis, meningitis, food poisoning or severe acute respiratory syndrome (SARS).
5. Institutional outbreaks of gastroenteritis (where the Aetiologic Agent was not *Clostridium difficile* in a hospital) and respiratory illness.
6. Cases with a missing outbreak number in iPHIS (i.e., sporadic cases should also have a sporadic outbreak number assigned in iPHIS).

Appendix 1 provides a list of diseases of public health significance in Ontario in 2019 and notes the diseases that are excluded from this tool.

Re-Infection and Co-Infections

For many of the diseases of public health significance, immunity is not conferred following infection or wanes over time, resulting in continued susceptibility and potential for re-infection. It is assumed that cases representing re-infection, as opposed to relapse, were assessed by PHUs before entry into iPHIS based on several factors, including the time period between the two episodes and the incubation period for the disease in question. As a result, data for most diseases in this tool are assumed to be new episodes of a disease or true re-infections. Thus, a single person with more than one episode of the same disease in a single year may contribute more than one case of a particular disease to the total provincial count for that year. For example, this may occur for individuals with chlamydia, gonorrhea or salmonellosis. For diseases caused by *Salmonella*, co-infections with two different serotypes (e.g., *Salmonella* Typhimurium and *Salmonella* Hadar) are reported as two separate episodes of salmonellosis. In addition, co-infections with more than one aetiologic agent at the same time (e.g., *Mycobacterium tuberculosis* complex and HIV) are reported as two different episodes, one for each disease caused by the co-infecting agents.

Descriptive Measures

The descriptive measures used throughout the tool to characterize the epidemiology of diseases of public health significance in Ontario are listed below.

Case Counts

This measure refers to the number of confirmed (and probable, as applicable) cases of a disease reported during a specified time frame and within a sub-group (if applicable) that meet the case ascertainment criteria outlined above. The diseases outlined in Table 2 are exceptions that require additional ascertainment based on the listed criteria.

Table 2. Additional ascertainment criteria for CDI outbreaks in hospitals, CPE, influenza, syphilis, tuberculosis and varicella (chickenpox)

Disease	Additional ascertainment criteria
CDI outbreaks in hospitals	On September 1, 2008, Ontario amended regulations to make CDI outbreaks in public hospitals reportable to PHUs under the HPPA.[1,15] CDI outbreaks in long-term care homes that are reported as institutional outbreaks of gastroenteritis were excluded. For outbreak-level analyses, where discrepancies were observed between reported CDI aggregate case counts and line listed cases for the outbreak, counts of cases (and deaths) were determined based on the higher number. For case-level analyses, only individual confirmed case records associated with confirmed CDI outbreaks in hospitals were included for demographic and risk factor analyses. Cases with a non-reportable classification (e.g., probable cases) were excluded.
CPE	Case counts include infection, colonization and unspecified. Where multiple reports with the same carbapenemase are entered in iPHIS for a client, only the first report is included.
Syphilis	Includes only infectious cases (i.e., primary, secondary, early latent and infectious neurosyphilis).
TB	Includes only active cases in counts of confirmed cases (i.e., latent TB infections are not included).
Varicella (chickenpox)	Varicella is reported provincially as both individual and aggregate cases. For individually-reported cases, which typically represent the more severe spectrum of disease (e.g., laboratory-confirmed cases, hospitalized cases, cases with complications), only confirmed cases are included. Aggregate cases represent the total number of cases reported in a PHU jurisdiction broken down by predefined age groups. They do not contain individual case details and may include cases that have been entered as individual cases, as well as those that do not meet the criteria for individual

Disease	Additional ascertainment criteria
	case reporting. For aggregate cases, only cases with Outbreak Classification field was entered as confirmed were included.[16]

Rates

In general, incidence rate is defined as the number of new cases of disease (or newly reported/diagnosed cases for some diseases) occurring in a specified time period. Throughout the tool, the term "Rate" refers to an annual rate (e.g., the number of cases observed for every 100,000 Ontarians per year), unless otherwise specified. Crude incidence rates were calculated by dividing the total case count in a year by the total number of people in the population in that year. As specified in the Case Classifications section above, the total case count for some diseases may include confirmed and probable cases. The formulas for calculating overall and population-specific rates used throughout the tool are noted below (using the example of rates presented in a specified time period per 100,000 population).

$$\frac{\text{Number of cases in specified time period and population}}{\text{Total number of people in that population during the same time period}} \times 100{,}000$$

- **Overall rate**: Number of all new cases in a specified time period divided by the Ontario population for that time period, multiplied by 100,000.
- **Group-specific rate**: Number of new cases in a sub-group (e.g., age group, sex, PHU or LHIN) in a specified time period divided by the population for that sub-group for that time period, multiplied by 100,000.
- **Neonatal rate**: Number of new congenital or neonatal cases of a disease (cases occurring in infants up to 28 days old) in a specified time period divided by the total number of live births for that time period, multiplied by 100,000.

Live births are used as the denominator to calculate incidence rates for neonatal and congenital diseases (CRS, neonatal group B streptococcal disease and ophthalmia neonatorum), as the neonatal population count (infants up to 28 days old) could not be determined from available vital statistics data. Live births with unknown geographic area are included in the Ontario live birth counts for that time period.

> Note: When data are downloaded using this interactive tool, zero values to the right of the decimal are lost (e.g., 5.0 appears as 5). Please ensure when using these data that all rate values are expressed to one decimal place (e.g., a value of 5 should be transformed to 5.0).

Geographic Distribution

A public health unit (PHU) is a geographic area served by a Board of Health with the authority to deliver public health programs. A local health integration network (LHIN) is a geographic area served by a corporation that plans, integrates and funds local health care. Case counts and rates by PHU are available under the Trends and Maps tabs for all years available for the disease. Case counts and rates by LHINs are only available under the Maps tab from 2012 to 2019, as the geographic indicators in iPHIS required to assign cases to LHINS are incomplete for years prior to 2012.

PUBLIC HEALTH UNIT ALLOCATION

CASES

Allocation of case counts by geography is based on Diagnosing Health Unit (DHU). The DHU is the PHU where the case resided when first detected. It does not necessarily reflect the location of exposure or diagnosis. iPHIS Bulletin #13 provides additional detail on scenarios in which a PHU is considered the DHU.[17]

Incidence rates by PHU presented in the Maps tab are grouped into five categories: a category representing the lowest incidence (often zero) and four strata determined by dividing the range between the lowest and the highest PHU incidence rate into four equal intervals. These rate ranges are determined based on the entire time period included in the tool for the disease (i.e., 2010 to 2019 for most diseases) and the same categories are applied to all years of data. Rate range categories change when different sex and/or age group options are selected.

In 2020, Huron County Health Unit and Perth District Health Unit merged into one new PHU (Huron Perth Public Health), bringing the total number of PHUs in Ontario to 34. Data in this tool will present data for 34 PHUs for all years.

CDI AND CPE OUTBREAKS

Allocation of CDI cases and outbreaks is based on the Primary Health Unit, which is the PHU where the hospital reporting the outbreak is located. While CPE case counts are allocated based on DHU, CPE outbreaks are allocated based on the Primary Health Unit where the hospital reporting the outbreak is located.

LOCAL HEALTH INTEGRATION NETWORK ALLOCATION

CASES

For cases in DHUs that fall completely within the boundaries of one LHIN, that corresponding LHIN was assigned to the case. For cases in DHUs that map to multiple LHINs, allocation of cases to LHINs was based on two address fields in iPHIS: Client address at time of illness postal code (postal code) and Client address at time of illness city (city). This approach resulted in the allocation of greater than 95% of all cases to a LHIN, with some variability by PHU and disease. A case was not assigned to a LHIN if:

- The case's DHU mapped to more than one LHIN **and**
- The case's city also mapped to more than one LHIN or the case had missing city and postal code information

The number of cases that could not be assigned to a LHIN is shown in the description box under the Maps tab for each disease.

The following data files/information were used in combination with the data extracted from iPHIS to allocate LHIN boundaries to cases:

- The Postal Code Conversion File (PCCF) 2015 and Health Regions: Boundaries and Correspondence with Census Geography 2015 from Statistics Canada to convert postal codes to dissemination areas (DAs) and then to LHIN boundaries
- The Canada Post data file, extracted from iPHIS on December 5, 2017, to identify the postal codes associated with each city
- The list of PHUs attributed to each LHIN boundary to identify PHUs that are located entirely within a single LHIN boundary[18]

Incidence rates by LHIN presented in the Maps tab are grouped into five categories, using the same methodology as determining the rate range categories for PHU incidence rates (see above section).

CDI AND CPE OUTBREAKS

Allocation of CDI and CPE outbreaks to a LHIN is based on information provided in the Outbreak name (the master number and facility name components) and the Exposure address fields in iPHIS. The Patient Safety Reporting list maintained by PHO was used to identify historical changes to the master numbers and facility names over time. The Master Numbering System Codes from the Ministry of Health was used to identify the LHIN within which each outbreak occurred based on the master number code or facility name.[19] Using this approach, LHIN boundaries were allocated for 100% of the CDI and CPE outbreaks included in the tool.

Age Distribution

Age groups for most diseases are based on standard five- and 10-year age groupings. For vaccine-preventable diseases, age groups are constructed with consideration of the epidemiology of the disease, and in some cases, the age of recommended vaccination. Cases with an unknown date of birth or a calculated age of less than 0 or greater than 120, were classified as having unknown age. Cases of unknown age are included when calculating total counts and rates, but were excluded in the calculation of age-specific rates.

Sex

This tool uses the terminology "sex" to reference the reported values for the "gender" field in iPHIS. Three values for sex are captured in iPHIS: Male, Female and Did Not Specify Male or Female. Information from all three fields are combined when presenting total counts or rates. For sex-specific rates, only male and female data are presented.

Monthly Incidence

For selected diseases, the number of cases that occurred during each month is available as an option for the Trends graph. For CDI, the number of outbreaks each month is compared to the monthly average outbreak count for the previous five years.

Hospitalizations

This measure refers to the number of cases that were reported as hospitalized due to their disease, at the time of data extraction. In this tool, a case is considered hospitalized if at least one hospital admission date was recorded and the hospital admission date occurred 60 days or less before the episode date or 90 days or less after the episode date. The intention of applying an interval is to exclude hospital admission dates that are outside the reasonable range from the episode date to be attributed to the disease. The interval was selected to serve as cut points that could be applied in a uniform fashion across all diseases while including the majority of hospital records that fall within a reasonable range of the episode date. It should be noted that under-reporting of hospitalizations may occur in iPHIS, particularly if hospitalization occurred after completion of follow-up by the PHU.

Hospitalization status is not reported for all diseases in this tool and is available only for the years 2015 to 2019.

Deaths

This measure refers to the number of cases that were reported as having died due to their disease, at the time of data extraction. For most diseases included in this tool, a case is counted as having died if at least one fatal outcome was recorded at the case level and the type/cause of death is a value other than "reportable disease was unrelated to cause of death." Cases that have multiple types/causes of death, are counted as fatal if there is at least one value in this field other than "reportable disease was unrelated to cause of death." For TB, any case with a Date of Death entered in iPHIS is counted as fatal, except when the only cause of death entered in the iPHIS case record is "reportable disease was unrelated to cause of death." The criteria for TB are different from those of most other diseases because the TB module is set up differently in iPHIS and the general criteria could not be applied. It should be noted that variations in follow-up may exist among PHUs in determining outcomes for all reportable diseases, as well as how the deaths are entered in the type/cause of death fields in iPHIS. Deaths are not reported for all diseases in this tool and are available only for the years 2015 to 2019.

Under-reporting of deaths may occur in iPHIS, particularly if deaths occurred after completion of follow-up by the PHU. Cases occurring in 2019 for whom treatment is ongoing or if the disease is chronic may

become fatal at a point in time after the extraction of data; these deaths would not be reflected in this tool. Case fatality data in 2019 for hepatitis B, hepatitis C, HIV/AIDS and TB are likely to be impacted by this issue.

For CDI outbreak associated cases reported prior to 2015, any confirmed cases that were reported with an outcome of fatal or that had a date of death that occurred during the outbreak period, are counted as a fatal case. For CDI outbreak associated cases reported in 2015 and onwards, any confirmed cases reported with an outcome of fatal are counted as a fatal case. All reported deaths are classified as "all-cause" and may or may not be directly attributable to CDI.

Organism Details

The number and proportion of cases that represent distinct variations of a specific species, subtype, serotype, serogroup or genotype of a pathogen that causes a disease are provided for select diseases for the years 2015 to 2019.

Immunization Status

For vaccine-preventable diseases, immunization status is determined through an assessment of immunization records entered in iPHIS. In the absence of any immunization records, cases designated as unimmunized in the risk factor section of iPHIS are classified as unimmunized. When a case has no immunization records or information about whether or not they are unimmunized in the risk factor section in iPHIS, the case is classified as having an unknown immunization status. Immunizations are reported for cases who have received at least one dose of a vaccine related to the relevant disease prior to their illness onset. Not all immunizations recorded are considered valid; for example, vaccines administered prior to the minimum indicated age or vaccines that do not protect against the disease-causing serotype/serogroup would be excluded from the analysis. Comments on the validity/fit of immunizations are included in the immunization status section of the tool. Immunization status is reported for Hi, measles, IMD, mumps, rubella and tetanus and only for the years 2015 to 2019.

Importation Status

Importation status is reported for cases of measles, rubella and CRS for the years 2015 to 2019. A case of measles or rubella is considered imported if the person travelled outside Canada 7 to 21 and 14 to 21 days prior to symptom onset for measles and rubella, respectively.[20] For CRS, an imported case is one whose mother was outside of Canada during the period when she may have had exposure to rubella that affected her pregnancy (from 23 days prior to conception or until week 24 of gestation).[21] Importation status is determined through a review of information entered in the risk factor field in iPHIS. In addition, data sent to the Canadian Measles/Rubella Surveillance System as part of the national enhanced surveillance of measles and rubella were consulted to validate the travel information in iPHIS.

Risk Factors

For CPE case and case-level analyses of CDI outbreaks in hospitals, the number and proportion of cases that reported each risk factor are provided. Only cases reporting at least one risk factor were included in

the risk factor analyses. Cases may report more than one risk factor. Risk factors are reported for CDI starting in 2015.

For CPE cases, as result of changes in iPHIS field configurations, risk factor variables that captured the same or similar concepts were combined as follows:

1. The risk factor 'Inpatient hospitalization in the last 12 months' includes cases reporting 'Yes' to the following risk factors:
    - Previous hospitalization at the reporting hospital in the last 12 months
    - Hospitalization in Canada in the last 12 months
    - Other inpatient hospitalization in Canada in the last 12 months
2. The risk factor 'Received health care outside of Canada in the last 12 months' includes cases reporting 'Yes' to the following risk factors:
    - Medical/Surgical procedure outside of Canada in the last 12 months
    - Hospitalization outside of Canada in the last 12 months
3. For consistency, the assumption was made that if cases had indicated they had received health care outside of Canada as a risk factor (see above) then cases also travelled outside of Canada in the last 12 months.

Resistance Types

Reported carbapenemases were extracted from the Subtype Name field. Carbapenemase categories include New Delhi metallo-β-lactamase (NDM), oxacillinase-48 carbapenemase (OXA-48), *Klebsiella pneumoniae* carbapenemase (KPC), Verona integron-encoded metallo-β-lactamase (VIM) and 'Other' for all other carbapenemases, such as Serratia marcescens enzyme (SME) or Guiana extended-spectrum enzyme (GES). A CPE case may have more than one carbapenemase reported, which is reported as a single episode of CPE with multiple carbapenamases (e.g., KPC and OXA-48).

Specimen Testing – PHO Laboratory

Specimen testing data from PHO's laboratory were used to calculate the percent positivity for chlamydia, gonorrhea, legionellosis and influenza. Unless otherwise stated, these calculations were based on specimens received and tested at PHO's laboratory from January 1, 2019 to December 31, 2019.

For chlamydia and gonorrhea, the number of positive, negative and total tests performed at PHO's laboratory is provided. Only nucleic acid amplification tests (NAAT) from cervical, urine, urethral, rectal and pharyngeal specimen sites are included. Rectal and pharyngeal specimens have been accepted for NAAT since April 2018. These data do not include testing performed at private laboratories throughout

the province, which conduct a majority of testing for both chlamydia and gonorrhea in Ontario. Percent positivity for chlamydia is calculated as the number of specimens positive for *Chlamydia trachomatis* divided by the total number of specimens tested for this pathogen. Percent positivity for gonorrhea is calculated as the number of specimens positive for *Neisseria gonorrhoeae* divided by the total number of specimens tested for this pathogen.

For legionellosis, the percent positivity and number of total patients tested at PHO's laboratory are provided. The month associated with each test was calculated based on the date PHO's laboratory received the specimen. Data represents unique patients tested for *Legionella* by urine antigen, PCR or culture. Percent positivity is calculated as the number of patients positive for *Legionella* divided by the total number of patients tested for this pathogen.

For influenza, the percent positivity and the total number of specimens tested at PHO's laboratory for influenza A (H3 and H1N1 pdm09) and influenza B are provided. Data represents unique specimens tested for influenza by culture, PCR or multiplex. The week associated with each specimen was calculated as Sunday to Saturday (FluWatch weeks) and was based on the date the specimen was received at PHO's laboratory. Percent positivity is calculated as the number of specimens positive for influenza A or B divided by the total number of specimens tested for influenza.

Drug Resistance

Drug resistance data for tuberculosis from PHO's laboratory were used to provide the number of multidrug-resistant TB cases and extensively drug-resistant TB cases. The numbers were based on specimens received and tested at PHO's laboratory from January 1, 2019 to December 31, 2019.

Analysis

The data analyses and presentation for the online tool was completed using SAS 9.4 and custom JavaScript code. Identified differences in rates and counts from one period to another, between Ontario and Canada and between sub-groups are population based and hence not subjected to analysis for statistical significance.

Data Limitations

Accuracy of Data

PHO coordinates a data cleaning exercise with PHUs for data from the previous calendar year starting in February. The cleaned data are subsequently extracted in May/June and reported to PHAC as Ontario's case counts for the previous year; however, iPHIS is a dynamic disease reporting system, which allows ongoing updates to data previously entered. As a result, any data extracted from iPHIS, including the data used in this tool represent a snapshot at the time of extraction and may differ from previous or subsequent reports. Discrepancies in disease counts and rates provided in this tool and other published data may exist due to:

- Enhanced data cleaning for select analyses, such as the linkage of iPHIS and laboratory data and subsequent reconciliation in iPHIS
- Late reporting
- Local and/or provincial-led data cleaning initiatives
- Differences in data extraction dates

Where such variability exists, data provided in the most recent release of this tool, other PHO surveillance tools and products (e.g., Monthly Infectious Diseases Surveillance Report) or published research may be a more appropriate source depending on how the methodology, data caveats and/or extraction dates align with the intended use of the data.[22]

LHIN

In some instances, cases were not assigned to a LHIN. A case was not assigned to a LHIN if:

- The case's DHU mapped to more than one LHIN **and**
- The case's city also mapped to more than one LHIN **or** the case had missing city and postal code information

In this tool, more than 95% of all cases were assigned to a LHIN, but with some variability by PHU and disease.

Small Counts

For some diseases, the observed variability in population-specific incidence rates should be interpreted with caution owing to small counts, which may be exacerbated by small denominators (population). For this reason, users of this tool should be aware that these rates may be unstable.

Under-Reporting

Passive surveillance systems, such as iPHIS, that rely primarily on mandatory health care provider and laboratory reports of illness can be characterized by under-reporting of the true burden of illness. Case counts only represent known cases reported to PHUs and recorded in iPHIS. The resulting degree of under-reporting may vary from disease to disease due to a variety of factors, such as disease awareness, health care seeking behaviours, availability of health care, severity of illness, clinical practice, methods of laboratory testing and reporting behaviours; however, the extent of under-reporting for individual disease of public health significance is unknown.

Asymptomatic individuals who are colonized with CPE are only identified and reported if they are screened at a health care facility. As a result, colonized cases captured by provincial surveillance are more likely to have chronic underlying medical conditions that predispose their access to health care while asymptomatic cases in the community are likely underrepresented. Currently, health care facilities

are in the process of implementing CPE screening programs and robustness may vary. Given the heterogeneity in CPE screening practices among health care facilities in Ontario, colonizations are likely underreported. In addition, there is a potential for misclassification of colonizations and infections due to variability in the interpretation of symptomatic presentation.

Duplicates

The potential for duplicates exists, as duplicate sets were not identified and excluded unless they were resolved prior to data extraction either at the local or provincial level. Inclusion of duplicates would result in over-reporting.

Missing Data (Data Not Reported by PHUs)

Data quality (completeness) for some fields is lower than others. Hospitalization and death are underreported in iPHIS, with the degree of underreporting influenced by the severity of illness and associated outcomes (e.g., less underreporting if illness or outcomes are more severe) and the timing of the event (i.e., there is likely less underreporting if hospitalization or death occurs shortly after symptom onset or before investigation of the case by the PHU is completed). Underreporting of risk factors, immunization status and specific laboratory data (e.g., serotype, genotype) can also occur. In general, the degree of underreporting is influenced by a combination of factors, including incomplete follow-up of cases (e.g., case is not reachable), incomplete or late entry of data in iPHIS and the occurrence of outcomes after follow-up has been completed. A high proportion of missing or incomplete data may result in conclusions or interpretations that are not representative of the underlying epidemiology of the disease.

> **The 2019 annual data cleaning process led by Public Health Ontario in collaboration with public health units was interrupted due to the COVID-19 pandemic. As a result, there may be limitations related to the completeness of 2019 data and trends over time should be interpreted with caution.**

Suggested Citations

Citation for the Infectious Disease Trends in Ontario Tool

Ontario Agency for Health Protection and Promotion (Public Health Ontario). Infectious disease trends in Ontario [Internet]. Toronto, ON: Queen's Printer for Ontario; 2020 [cited YYYY Mon DD]. Available from: https://www.publichealthontario.ca/en/data-and-analysis/infectious-disease/reportable-disease-trends-annually

Citation Tips

- It is important to include a cited date in order to transparently reflect the currency of the data.
- Use the URL specific to the disease rather than the main report. URLs are not included for graphs or maps because the URLs are unique to each disease, not the specific selections made to generate a particular graph or map.
- The details about the data sources are available in the Data Sources section of this document.

Citation for a Specific Disease

Generic Citation Format

Author. Interactive tool name: specific disease [Internet]. Toronto, ON: Queen's Printer for Ontario; Year [cited date]. Available from: URL

Example

Ontario Agency for Health Protection and Promotion (Public Health Ontario). Infectious disease trends in Ontario: chlamydia [Internet]. Toronto, ON: Queen's Printer for Ontario; 2020 [cited 2020 Dec 18]. Available from: https://www.publichealthontario.ca/en/data-and-analysis/infectious-disease/reportable-disease-trends-annually#/11

Source Statement for a Graph

Generic Citation Format

Source: Author. Interactive tool name: specific title as it appears on the graph [Internet]. Toronto, ON: Queen's Printer for Ontario; Year [cited date].

Example

Source: Ontario Agency for Health Protection and Promotion (Public Health Ontario). Infectious disease trends in Ontario: gonorrhea cases by age, for all sexes, in Ontario [Internet]. Toronto, ON: Queen's Printer for Ontario; 2020 [cited 2020 Dec 18].

Source Statement for a Map

Generic Citation Format

Source: Author. Interactive tool name: specific title as it appears on the map [Internet]. Toronto, ON: Queen's Printer for Ontario; Year [cited date].

Example

Source: Ontario Agency for Health Protection and Promotion (Public Health Ontario). Infectious disease trends in Ontario: tuberculosis rates for all ages, by males, 2010 [Internet]. Toronto, ON: Queen's Printer for Ontario; 2020 [cited 2020 Dec 18].

Source Statement for Downloaded Data

Generic Citation Format

Source: Data source as extracted and/or received by author. Interactive tool name: specific title as it appears on the source graph or map or other tab [Internet]. Toronto, ON: Queen's Printer for Ontario; Year [cited date].

Example

Source: Data sources as extracted and/or received by Ontario Agency for Health Protection and Promotion (Public Health Ontario). Infectious disease trends in Ontario: West Nile virus illness rates and cases for all ages, for all sexes, Ontario [Internet]. Toronto, ON: Queen's Printer for Ontario; 2020 [cited 2020 Dec 18].

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Appendix 1: Diseases of Public Health Significance and Reportable Classifications: Ontario, 2019

Table 1 summarizes the diseases of public health significance, as specified under Ontario Regulation 135/18 and amendments under the *Health Protection and Promotion Act* and the associated reportable case classifications, as outlined in Appendix B of the Infectious Diseases Protocol.

Table 1. Diseases of public health significance and reportable case classifications in Ontario, 2019

Disease of public health significance	Reportable case classifications
Acquired immunodeficiency syndrome (HIV/AIDS)	Confirmed
Acute Flaccid Paralysis (AFP)[1,2]	Confirmed
Adverse events following immunization (AEFIs)[1]	Confirmed
Amebiasis[3]	Confirmed, probable
Anthrax	Confirmed, probable, suspect
Blastomycosis[4]	Confirmed, probable
Botulism	Confirmed, probable, suspect
Brucellosis	Confirmed, probable
Campylobacter enteritis	Confirmed, probable
Carbapenemase-producing *Enterobacteriaceae* (CPE) infection or colonization[4]	Confirmed
Chancroid	Confirmed, probable
Chickenpox (Varicella)	Confirmed
Chlamydia trachomatis infections	Confirmed, probable
Cholera	Confirmed, probable

Disease of public health significance	Reportable case classifications
Clostridium difficile associated disease (CDAD) Outbreaks in Public Hospitals[5]	Confirmed
Cryptosporidiosis	Confirmed, probable
Cyclosporiasis	Confirmed, probable
Diphtheria	Confirmed, probable
Echinococcus mutilocularis infection[4]	Confirmed, probable
Encephalitis[1] • Primary, viral • Post-infectious • Vaccine-related • Subacute sclerosing panencephalitis • Unspecified	Confirmed, probable
Food poisoning, all causes[1]	Confirmed, probable
Gastroenteritis, institutional outbreaks[1]	Not applicable
Giardiasis, except asymptomatic cases	Confirmed, probable
Gonorrhea	Confirmed, probable
Group A Streptococcal disease, invasive	Confirmed, probable
Group B Streptococcal disease, neonatal	Confirmed, probable
Haemophilus influenzae disease, all types, invasive[3,4]	Confirmed, probable
Hantavirus pulmonary syndrome	Confirmed
Hemorrhagic fevers, including: • Ebola virus disease • Marburg virus disease • Other viral causes	Confirmed, probable
Hepatitis A	Confirmed, probable
Hepatitis B[6]	Confirmed, probable
Hepatitis C	Confirmed
Influenza	Confirmed

Disease of public health significance	Reportable case classifications
Lassa fever	Confirmed, probable
Legionellosis	Confirmed, probable
Leprosy	Confirmed, probable
Listeriosis	Confirmed, probable
Lyme disease[3]	Confirmed, probable
Measles	Confirmed, probable
Meningitis, acute[1] • Bacterial • Viral • Other	Confirmed, probable
Meningococcal disease, invasive[3]	Confirmed, probable
Mumps[3]	Confirmed, probable
Ophthalmia neonatorum	Confirmed, probable
Paralytic Shellfish Poisoning (PSP)[2]	Confirmed, probable
Paratyphoid fever	Confirmed, probable
Pertussis (whooping cough)[3]	Confirmed, probable
Plague	Confirmed, probable
Pneumococcal disease, invasive	Confirmed
Poliomyelitis, acute	Confirmed, probable
Psittacosis/Ornithosis	Confirmed, probable
Q-fever	Confirmed, probable
Rabies	Confirmed, probable
Respiratory infection outbreaks in institutions[1]	Not applicable
Rubella	Confirmed, probable
Rubella, congenital syndrome	Confirmed, probable

Disease of public health significance	Reportable case classifications
Salmonellosis	Confirmed, probable
Severe acute respiratory syndrome (SARS)[1]	Confirmed, probable
Shigellosis	Confirmed, probable
Smallpox	Confirmed, probable, suspect
Syphilis, infectious	Confirmed
Tetanus	Confirmed
Transmissible spongiform encephalopathy, including: Creutzfeldt-Jakob disease, all types	Confirmed, probable, suspect
Trichinosis	Confirmed, probable
Tuberculosis	Confirmed, suspect
Tularemia	Confirmed, probable
Typhoid fever	Confirmed, probable
Verotoxin-producing *E. coli* infection indicator conditions, including Haemolytic Uremic Syndrome	Confirmed, probable
West Nile Virus illness[3]	Confirmed, probable
Yersiniosis	Confirmed, probable

Source: MOHLTC. Infectious Diseases Protocol, 2018. Appendix B: Provincial Case Definitions.

1. Disease not included in this tool.
2. These diseases became reportable on December 4, 2013.
3. Both confirmed and probable cases of these diseases are included in this tool, whereas only confirmed cases are included for other diseases.
4. Disease became designated as a disease of public health significance on May 1, 2018. For invasive *Haemophilus influenzae* disease, all types of Hi were designated as a disease of public health significance, as of May 1, 2018, prior to which only type b was reportable.
5. *Clostridium difficile* associated disease is now more commonly referred to as *Clostridium difficile* infection (CDI).
6. Chronic case (carrier) classification added in 2012.

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