Ministry of Health

Ontario Public Health Standards:
Requirements for Programs, Services and Accountability

Infectious Disease Protocol

Appendix 1: Case Definitions and Disease-Specific Information

Disease: Measles

Effective: March 2024

Ontario

Measles

☒ Communicable
☐ Virulent

Health Protection and Promotion Act **(HPPA):**[1]
Ontario Regulation (O. Reg.) 135/18 (Designation of Diseases)[2]

Provincial Reporting Requirements

☒ Confirmed case
☒ Probable case

There are enhanced surveillance activities undertaken for measles to support the continued monitoring and documenting of the elimination status of Canada. A confirmed case of measles identified by the board of health should be reported via the IVPD email address of Public Health Ontario (PHO) within one business day of receipt of initial notification at ivpd@oahpp.ca. After-hours notifications should also occur using the standard on-call process.

As part of elimination documentation, it is essential to document travel history and other exposure history to assess source of infection, as well as immunization status, on every measles case.

As per Requirement #3 of the "Reporting of Infectious Diseases" section of the *Infectious Diseases Protocol, 2023* (or as current), the minimum data elements to be reported for each case are specified in the following:

- O. Reg. 569 (Reports) under the HPPA;[3]
- The disease-specific iPHIS User Guides published by Public Health Ontario (PHO); and
- For certain vaccines, information to be entered into the applicable provincial inventory system (i.e., Panorama or COVaxON); and Bulletins and enhanced surveillance directives issued by PHO.

Type of Surveillance

Case-by-case

All provincially reported cases of measles that meet the confirmed definition are reported weekly by PHO (including zero-notification) to the Canadian Measles/ Rubella Surveillance System (CMRSS) at the Public Health Agency of Canada (PHAC) and from PHAC to the Pan-American Health Organization, in accordance with the goal of documenting the elimination of measles in the World Health Organization Region of the Americas.[4]

Case Definition

Confirmed Case

Laboratory confirmation of infection with clinically compatible signs and symptoms (see Clinical Features section) in the absence of recent immunization with measles-containing vaccine in the last 5 – 42 days*, with at least one of the following conditions:

- Isolation of measles virus from an appropriate clinical specimen (e.g., nasopharyngeal swab/throat swab, CSF, urine) (i.e., positive measles virus culture);

OR

- Detection of measles virus RNA using a Nucleic Acid Amplification Test (NAAT) (i.e., PCR) from an appropriate clinical specimen (e.g., nasopharyngeal swab/throat swab, CSF, urine);

OR

* For individuals with suspect measles who have been immunized with a measles-containing vaccine in the last 5-42 days, measles virus genotyping is required to differentiate wild-type versus vaccine-associated measles. Genotyping requires collection of specimens for NAAT (PCR) PHO's laboratory will implement a measles vaccine genotype PCR on all positive specimens to distinguish the vaccine strain. Vaccine-associated measles illness (genotype A) is not reportable and should be reported as an adverse event following immunization (AEFI).

- Measles immunoglobulin G (IgG) seroconversion by any standard serologic assay between acute and convalescent sera[†];

OR

- Detection of measles immunoglobulin M (IgM) antibody using a recommended assay in a person who is either epidemiologically linked to a laboratory-confirmed case OR has recently travelled[§] to an area of known measles activity.[5]

OR

In the absence of appropriate laboratory tests, clinically compatible signs and symptoms (see Clinical Features section) in a person with a known epidemiologic link to a laboratory-confirmed case of measles.

Probable Case

Clinically compatible signs and symptoms (see Clinical Features section) in the absence of immunization with measles-containing vaccine in the last 5 – 42 days with at least one of the following conditions:

- A positive serologic test for measles IgM antibody using a recommended assay in a person who is neither epidemiologically linked to a laboratory-confirmed case nor has recently travelled to an area of known measles activity;

OR

- In a person who has recently travelled to an area of known measles activity, in the absence of appropriate laboratory tests.

Outbreak Case Definition

The outbreak case definition varies with the outbreak under investigation. Please refer to the *Infectious Diseases Protocol, 2023* (or as current) for guidance in

[†] Please see further details on the limitations of measles serology in the Laboratory Evidence – Indications and Limitations section

[§] Recent travel is defined as travel within 21 days of rash onset.[5]

developing an outbreak case definition as needed.

The outbreak case definitions are established to reflect the disease and circumstances of the outbreak under investigation. The outbreak case definitions should be developed for each individual outbreak based on its characteristics, reviewed during the outbreak, and modified, if necessary, to ensure that the majority of cases are captured by the definition. The case definitions should be created in consideration of the outbreak definitions.

Outbreak cases may be classified by levels of probability (i.e., confirmed and/or probable).

Clinical Information

Clinical Features

Clinically compatible signs and symptoms are characterized by:

- Fever ≥ 38.3 degrees Celsius (oral), and
- Generalized maculopapular, erythematous rash for at least three days, and
- At least one of: cough, runny nose (coryza) or red eyes (conjunctivitis).

Clinical Presentation

Measles is characterized by a prodrome of fever (≥ 38.3°C oral), cough, coryza (runny nose) and conjunctivitis which usually begin 10 to 12 days after exposure (range 7 to 21 days).[6,7] Koplik spots (tiny blue-white spots on the buccal mucosa) may also be present during the prodromal period.[7] Then, 3 – 7 days after the start of these prodromal symptoms, a red maculopapular, non-itchy rash appears on the face and then spreads downward to the neck, trunk, arms, legs and feet.[6] The rash usually appears about 14 days after exposure (range 7 to 21 days).[6,7] Individuals who have received one or two doses of measles vaccine may develop an attenuated infection with milder symptoms.

The most frequent complications are viral pneumonitis, otitis media and diarrhea.[7] Secondary bacterial and viral bronchopneumonia following measles is also common.[8] Complications include diarrhea, pneumonia, and blindness.[6]

A rare complication, measles encephalitis, occurs in approximately 1 of every 1,000

reported cases and may result in permanent brain damage.[8]

Subacute sclerosing panencephalitis (SSPE) is a very rare complication of measles that presents several years after infection with progressive neuro-cognitive symptoms and is typically fatal. The risk of SSPE is highest in children who acquire measles before the age of one year.[9]

Persons at Increased Risk of Disease

Unvaccinated or under-vaccinated individuals (i.e., those who have not had two doses of measles-containing vaccine) are at increased risk of measles.

Individuals at risk of more severe disease include:[9,10]

- Immunocompromised individuals, especially those who have severely impaired cell-mediated immunity, such as individuals who have recently undergone bone marrow transplantation, individuals with primary T-cell dysfunction, individuals with acute lymphoblastic leukemia (ALL), and people living with AIDS in whom measles can be severe, atypical and prolonged. The risk of severe disease is also high for individuals with other forms of immunosuppression (e.g., other forms of malignancy), and those receiving high dose steroids or other types of immunosuppressive drugs.
- Children younger than 5 years of age and adults 20 years of age and older.
- Malnourished children, particularly those with vitamin A deficiency.
- Susceptible pregnant individuals in whom infection is associated with risk of fetal loss and prematurity; there is no evidence that infection leads to congenital defects.[11,9]

Laboratory Evidence

Approved/Validated Tests

- Commercial tests for measles IgM and IgG by enzyme immunoassay (EIA), multiplex flow immunoassay, chemiluminescence immunoassay (CLIA).
- NAAT (i.e., PCR) for measles virus RNA.

Indications and Limitations

Virus Isolation (culture) and Molecular RNA (PCR) Detection

- Testing of multiple specimens increases the overall sensitivity.
- Specimens for virus isolation or RNA (i.e., PCR) detection include:
    - Nasopharyngeal swab or aspirate and/or throat swabs collected within 7 days of rash onset;

    and

    - Urine (minimum 50 mL collected in a sterile container) collected within 14 days of rash onset.
- Note: In certain situations, such as when there is a high index of suspicion for measles it may be warranted to test beyond the above time periods if specimens could not be collected earlier in the illness. This can be discussed with PHO's laboratory (PHOL) on a case by case basis.
- Isolation of measles virus and/or NAAT (i.e., PCR) detection is strongly recommended and should be attempted on all persons suspected of having measles so that genotyping can be conducted. Genotyping requires the collection of specimens for viral detection (i.e., NAAT, PCR).
- A person recently vaccinated with measles-containing vaccine requires genotyping to differentiate wild-type versus vaccine-associated measles.
    - PHO's laboratory will perform Measles Vaccine Genotype PCR on all PCR positive specimens. This assay serves to distinguish between vaccine-associated (Genotype A) and wild-type measles strains.
    - All PCR and culture positive specimens are routinely forwarded to the National Microbiology Laboratory (NML) for further genotyping.
- Genotyping at NML may provide information on the geographic region of imported and import-associated cases.

Serology

- It is NOT recommended that serology be ordered as the only test for measles diagnosis.
- IgM serology for measles is most useful in primary infection and may be of limited use in an individual who has a history of measles vaccination.

- Measles IgM and IgG serology may be negative if blood is collected very early in infection. False negative results may also occur if the specimen is taken later than 28 days after rash onset. See Figure 1 for a graph depicting the antibody response to measles virus infection.
- IgM serology has the potential for false positive findings. Further confirmation (i.e., IgG seroconversion in paired sera, measles virus isolation or detection of measles virus RNA) is required to meet the confirmed case definition, especially if there is no established epidemiological link or travel exposure. The first acute sample should be collected within 7 days after the onset of the rash. Collect the convalescent sample a minimum of 7-10 days after the acute; preferably 10 to 30 days after the acute sample. In previously vaccinated individuals, IgG antibodies will already be present in the acute sample and thus one cannot detect seroconversion.

Cerebrospinal Fluid (CSF)

- In the presence of the clinical and neurological signs of measles encephalitis or subacute sclerosing panencephalitis (SSPE), the diagnosis can be confirmed by detecting an increase of measles IgG titre in the CSF relative to the titre in serum.
    - Refer to NML's SSPE Diagnosis webpage for more information on accepted sample type and testing methodology.
    - Contact PHOL at 416-235-6556 or 1-877-604-4567 prior to sample submission.

For further information about human diagnostic testing, contact the Public Health Ontario Laboratories.

Case Management

Case Investigation

All suspected cases of measles should be investigated as soon as possible.

In addition to the requirements set out in the Requirement #2 of the "Management of Infectious Diseases – Sporadic Cases" and "Investigation and Management of Infectious Diseases Outbreaks" sections of the *Infectious Diseases Protocol, 2023* (or

as current), the board of health shall investigate cases to determine the source of infection. Refer to Provincial Reporting Requirements above for relevant data to be collected during case investigation.

The following disease-specific information should also be obtained during case management:

- Immunization history (i.e., number of doses, date(s) of administration);
- Exposure history to identify source of infection (e.g., travel history, ill contacts);
- Contact during their period of communicability with susceptible contacts, especially those at highest risk of measles and its complications (high risk individuals include immunocompromised persons, pregnant individuals and infants under 12 months of age); and
- Attendance or work during their period of communicability within a high-risk setting (a high-risk setting is a setting where individuals vulnerable to measles and measles complications are likely to be found, (i.e., child care settings, health care environments such as doctors waiting rooms or hospital emergency rooms)).
- Travel history both within and outside of Canada (e.g., dates of travel, mode of transportation, departure and arrival locations, flight or ship carrier, flight # and seat #) if the case traveled during their period of communicability. The public health unit that identifies a potentially infectious traveler should notify PHO during business hours at ivpd@oahpp.ca and after hours using the standard on-call process for further consultation.

Lab Testing

Laboratory confirmation should be sought in all suspected cases. Ensure that appropriate specimens have been collected, including specimens for viral detection (e.g., nasopharyngeal swab and urine sample), as viral identification should be prioritized and attempted for all cases of suspect measles. Refer to PHO's laboratory test information sheet for more information.[12]

Isolation & Exclusion:

Confirmed and probable cases of measles should be advised to self-isolate for four days after the onset of the rash. Immunocompromised individuals may be infectious

for longer and should be advised to isolate for the duration of illness. Self-isolation will help to prevent further transmission of the virus.[5]

The medical officer of health should exclude cases from all public places for four days after the appearance of the rash. Public places include but are not limited to: child care settings, schools, post-secondary educational institutions, work places, places of worship, sporting events, health care and other group settings.[6,5]

Persons under investigation may also be asked to self-isolate from all public places during the period of communicability if there is a high degree of suspicion for measles. Initiation of control measures do not need to await laboratory confirmation of the case.

Treatment

There is no specific treatment for persons with measles infection; however severe complications can be avoided through supportive care that ensures good nutrition and adequate fluid intake.[5]

Effect of recent vaccination

Vaccine-associated measles may occur 5-12 days after measles vaccination.[13] PHO's laboratory will perform Measles Vaccine Genotype PCR on all PCR positive specimens which distinguishes between vaccine-associated (Genotype A) and wild-type measles strains. Individuals with a positive measles PCR result should be excluded until vaccine genotyping results are available.

Vaccine-associated measles should not be classified as a confirmed measles case once vaccine-strain is confirmed by genotyping. There is no current evidence of human-to-human transmission of measles vaccine virus in individuals with vaccine-associated measles.[13]

In contacts who are given Measles, Mumps, Rubella (MMR) vaccine post-exposure, a fever/rash illness could represent a real wild-type measles infection or vaccine-associated measles. Measles contacts with a fever/rash illness who have received PEP should be managed as suspected measles until vaccine genotype PCR results are available.

Contact Management

Contact Identification

Within 24 hours of reporting a confirmed or probable case of measles, all possible efforts should be made to:

- Identify all potential contacts.
- Assess their susceptibility to infection and classify them as susceptible* or non-susceptible.
- Determine whether they are high-risk** and implement post-exposure prophylaxis, where appropriate.

A measles contact is any susceptible (see Host Susceptibility and Resistance under Disease Characteristics section) person who shared the same room or air space for any length of time during the case's period of communicability, including two hours after the case left the room or air space (e.g., home, school, child care, school bus, doctor's office, emergency room, etc.).[5]

Contact Prioritization

To help inform the prioritization of contact follow-up, the following information should be collected as part of the case and contact investigation:

- Contact history during period of communicability;
- Assessment of type of contact and probability of transmission (i.e., intensity and duration of exposure);
- Immunization status of contacts;
- Occupation of contact; and
- Residency/attendance at a facility or institution (e.g., congregate care setting, childcare facility, school, post-secondary educational institution).

***Susceptibility Assessment** (Refer to Host Susceptibility and Resistance to determine susceptibility). The immunization status of all contacts should be ascertained to determine susceptibly to measles.

****High Risk:** The following groups should receive priority for contact identification and management, which may include post-exposure prophylaxis (PEP).[5]

- Infants less than 12 months of age
- Immunocompromised individuals
- Susceptible pregnant individuals
- Household contacts and other contacts with similar intensity/duration of exposure as household contacts

Where practical, all contacts should be provided with information on the signs and symptoms of measles and advised to self-monitor and exclude themselves from schools or other settings if they develop symptoms. Contacts should be made aware to contact public health immediately if they develop symptoms.

Where individual contacts cannot be readily identified (e.g., mass gatherings and community locations), strong consideration should be given to the issuance of media releases to inform persons who have been potentially exposed to seek health care if they develop signs and symptoms and to contact their health care provider or local public health unit to discuss vaccination if they are not up to date. A CNPHI alert to communicate possible exposure locations to public health stakeholders in Ontario and/or Canada, as appropriate, is also strongly encouraged.

Post-exposure prophylaxis (PEP)

The timely administration of Measles, Mumps, and Rubella (MMR) vaccine or immunoglobulin (Ig) through the intramuscular route (IMIg) or the intravenous route (IVIg) can reduce the risk of infection in susceptible individuals exposed to measles or in the case of IMIg/IVIg can reduce clinical severity if measles infection occurs.

PEP is not 100% effective and all susceptible contacts who receive PEP should be counseled on the signs and symptoms of measles; to avoid contact with high risk individuals, infants < 12 months of age, immunocompromised individuals, and susceptible pregnant individuals); and to avoid settings or gatherings where high risk individuals are likely to frequent.

MMR Vaccine

Susceptible immunocompetent contacts six months of age and older who have no contraindications should be given MMR vaccine within 72 hours of the exposure.[8,14,15] If MMR vaccine is given prior to 12 months of age as PEP, two additional doses of measles-containing vaccine must be administered after the child is 12 months of

age to ensure long lasting immunity to measles.[8,14] The effectiveness of Measles, Mumps, Rubella, Varicella (MMRV) vaccine for PEP has not been established.[5] A summary of the evidence for the effectiveness of vaccine as PEP can be found elsewhere.[9]

When MMR vaccine is offered 72 hours after exposure, it is no longer considered PEP but represents an opportunity to update immunizations and offers protection from any subsequent measles exposures.

Immunoglobulin (IMIg and IVIg)

Recommendations for post-exposure prophylaxis for susceptible contacts are based on the updated 2018 National Advisory Committee on Immunization (NACI) recommendations.[14]

IMIg/IVIg, if administered within 6 days of exposure, may provide some protection or modify the clinical course of disease among susceptible contacts.[7] As the efficacy of Ig prophylaxis decreases with time from exposure, prompt administration of Ig is encouraged, if needed. Ig should be reserved for susceptible contacts at higher risk of disease severity.

NACI recommends intramuscular immunoglobulin (IMIg) or intravenous immunoglobulin (IVIg) for measles PEP among susceptible, high-risk groups, which include:[14]

- Immunocompromised individuals;
- Susceptible pregnant individuals;
- Susceptible infants less than 6 months of age; and
- Susceptible immunocompetent infants six to 12 months of age who are identified after 72 hours and within six days of a measles exposure.

NACI does not recommend that susceptible immunocompetent individuals older than 12 months of age, who are not pregnant, receive Ig for PEP due to the low risk of disease complications and the practical challenges of administering Ig products.[14]

The maximum recommended volume for administration of IMIg is 15 ml. NACI concluded that anyone weighing 30 kg or more will not receive an optimal dose of IMIg at the recommended dosage of 0.5 ml/kg. For individuals who weigh 30 kg or more, or if injection volume is a concern, IVIg is recommended as an alternative to

IMIg.[14]

See Table 1 for a summary of recommended measles PEP strategies.

Table 1: Summary of updated measles post-exposure prophylaxis recommendations for susceptible contacts

Population	Time since exposure to measles	
	≤ 72 hours	**73 hours-6 days**
Susceptible infants 0-6 months of age	IMIg (0.5 ml/kg)[a,b]	
Susceptible immunocompetent infants 6-12 months of age	MMR vaccine[a]	IMIg (0.5 ml/kg)[b]
Susceptible immunocompromised[c] individuals 6 months of age and older	IVIg (400 mg/kg) or IMIg (0.5 ml/kg), limited protection if body weight ≥ 30 kg[d]	
Susceptible immunocompetent individuals 12 months of age and older	MMR vaccine	MMR vaccine[e]
Susceptible pregnant individuals[f]	IVIg (400 mg/kg) or IMIg (0.5 ml/kg), limited protection if body weight ≥ 30 kg[d]	

Notes:

a) Two doses of measles-containing vaccine are still required after the first birthday for long-term protection

b) If injection volume is a major concern, IVIg (400 mg/kg) may be considered

c) Please refer to the additional considerations outlined in the 'Host Susceptibility and Resistance' Section for further information regarding assessing the susceptibility of immunocompromised individuals.

d) For individuals weighing 30 kg or more, IMIg will not provide complete protection but may provide partial protection.

e) MMR vaccine will not be effective for PEP if given > 72 hours after exposure, however starting and completing a two dose series should not be delayed and will provide long-term protection.

f) The 2018 NACI guidance on IVIg as PEP used the Canadian Immunization Guide (CIG) definition of immunity of at least 1 dose of measles-containing vaccine for adults born on or after 1970. Therefore, recommendations for PEP using IVIg for adults, should consider the intensity and duration of the measles exposure, and the immunization status (0 versus 1 dose) of the contact. Serology may also play a role in supporting decisions for IVIg if it can be obtained in a timely fashion. MMR vaccine should be provided postpartum as needed to provide long term protection.

Adapted from the 2018 NACI recommendations[14] with permission available from: https://creativecommons.org/licenses/by/4.0/

Individuals receiving replacement IVIg as part of the management of an underlying condition (400 mg/kg of body weight or higher) are considered protected against measles and do not require PEP if the last dose of IVIg was received within three weeks prior to the measles exposure.[8,14]

GamaSTAN is the only Ig product for administration via the intramuscular route (IMIg).[16] It is advisable to review the NACI recommendations and Canadian Immunization Guide (CIG) prior to administration, as the dosage differs from the drug product monograph.[8,14]

Canadian Blood Services carries multiple manufacturers brands of Ig available for IMIg and intravenous infusion (IVIg). Both products are available through local hospitals' Transfusions Medicine Laboratories. IVIg can only be ordered by hospital-based providers using the appropriate (non-Neurology) Ministry of Health (MOH) Ig Request form, as it requires in-hospital administration and active patient monitoring over several hours of infusion. ORBCoN and the MOH are aware of NACI's recommendation for the use of IVIg for measles PEP and plans to add measles PEP to Ontario's IG Utilization Management Guidelines in a future update.[17]

If IMIg or IVIg is received as PEP (or any indication), future doses of live virus vaccines (i.e., MMR vaccine and varicella-containing vaccines) must be delayed.[18] For additional information on measles PEP and the timing of immunization following

the receipt of an Ig product, refer to the CIG[8,18]and the NACI measles PEP recommendations.[14]

Exclusion and other guidance for susceptible contacts

At the discretion of the medical officer of health, susceptible contacts may be excluded from licensed child care settings, schools, and post-secondary educational institutions and may be required to exclude themselves from work places, or other group settings, including travel.

The following factors should be considered to inform the decision to exclude a susceptible contact, including contacts with unknown vaccination status: the vaccination status of the contact (unknown, zero or 1 doses); the intensity and duration of contact with the case (e.g., household contact); the number of susceptible individuals in the setting; the presence of high risk individuals (i.e., infants under 12 months of age, immunocompromised individuals, and/or pregnant individuals) in the setting; and the reliability of the individual to comply with early symptom recognition and self-isolation should symptoms develop.[5] Please note: additional details to guide the management of contacts who are health care workers are outlined in a specific section below.

If exclusions occur, the period of exclusion should extend from the 5th day after the first exposure to the 21st day after the last exposure. Measles guidance from the Centers for Disease Control and Prevention (CDC) notes that immunoglobulin may prolong the incubation period of measles and that contacts who receive an immunoglobulin as PEP should continue to monitor for signs and symptoms of measles for 28 days after the last exposure.

Contacts who are not health care workers

Contacts attending high risk settings such as school and child care (and other settings at the discretion of the medical officer of health) who are, unimmunized (zero doses of vaccine) and those with unknown vaccine history (who have serology results indicating they are IgG negative and where serology results are not available) should be excluded if vaccine as PEP is not received within the 72 hour timeframe from exposure. Contacts who are determined to be susceptible and who receive IMIg/IVIg as PEP should also be considered for exclusion from high-risk

settings (e.g., health care settings, childcare and school settings) at the discretion of the medical officer of health.

Individuals born after 1970 who have received 1 dose of vaccine should be considered susceptible as part of contact management. This includes children who are between the ages of 12 months to under 4 years who are not yet eligible for their second dose of measles-containing vaccine as per the routine immunization schedule. In general, contacts with 1 dose of vaccine should be excluded from school or licensed childcare settings (and in the case of adults, occupational settings at the discretion of the medical officer of health) until they receive a second dose of measles-containing vaccine. Children can return to school/childcare setting immediately following the receipt of their second dose, even if it is more than 72 hours after exposure. The effectiveness of a single dose of measles-containing vaccine given at 12 or 15 months of age is estimated to be between 85-95%.[8] The immediate release from exclusion following receipt of the second dose, regardless of its timing may be applied to most other contacts, including older children and adults (with the exception of health care workers) who have received only the first dose of measles-containing vaccine. Contacts who would otherwise be excluded are eligible for a second dose of measles-containing vaccine as part of outbreak response, regardless of their routine schedule eligibility.

For close (e.g., household) contacts who have had a significant intensity and duration of exposure to the case, and who have previously received only one dose of vaccine, serology may be helpful in informing decisions regarding the return to school or day-care if the second dose of measles-containing vaccine is received more than 72 hours after exposure. If used to guide exclusion decisions, serology should be taken prior to the second dose of vaccine and the contact should be excluded until the results are available (similar to the approach taken for health care workers, described below).

Contacts who are health care workers

Health care workers that have been exposed to a confirmed case of measles should have their immune status reviewed. If they have had two documented doses of measles-containing vaccine or serological confirmation of immunity, they can be considered immune and can continue to work. If they have received only one

documented dose of measles-containing vaccine, without laboratory evidence of immunity or history of laboratory confirmed measles, they should be tested for measles IgG antibody and one dose of MMR vaccine be administered immediately. While waiting for the serology results, health care workers should be excluded from work. The health care worker can return immediately to work if the serology results indicate measles immunity; if the serology results indicate measles susceptibility, the health care worker should be excluded from the 5th day after the first exposure to the 21st day after the last exposure.[5,20]

Susceptible immunocompromised health care workers should be excluded regardless of whether PEP (vaccine or IVIg) was administered given the very high risk nature of the setting. As the goal of immunoglobulin in susceptible contacts is attenuation of clinical severity should measles develop, susceptible health care workers who receive IVIg should be excluded and consideration should be given to using a period of exclusion of 28 days following the last exposure, in particular for health care workers who work with very high risk patient populations (e.g., neonates, transplant recipients) as immunoglobulin may prolong the incubation period of measles.[9]

Interrupting Chains of Transmission

Assessing the immunization status of the contacts of an individual exposed to measles can assist in reducing the possibility of subsequent transmission, especially in settings with children who have received only 1 dose of MMR vaccine, as well as in family members of exposed contacts where the contact has been excluded from school, child care or other settings. The following should be considered:

- Assessing the immunization status of persons in high-risk settings if a susceptible contact of measles attends the setting while potentially incubating (e.g., in childcare settings); and
- Vaccinating susceptible contacts of the exposed individual, by providing the 2nd dose of measles-containing vaccine in children who have only received 1 dose of measles-containing vaccine (at least 4 weeks apart for measles-containing vaccine) and offering MMR vaccine for children who are unvaccinated.
- Vaccinating susceptible household members of contacts who have been

excluded from child care, school or work.

Outbreak Management

Please see the *Infectious Diseases Protocol, 2023* (or as current) for the public health management of outbreaks or clusters in order to identify the source of illness, manage the outbreak and limit secondary spread.

Outbreaks provide the opportunity to assess the immunization status and update immunization records of contacts if required and to recommend immunization to all those who are not up to date in their measles immunizations.

Prevention and Control Measures

In the event that publicly funded vaccine doses are needed for contact management, the board of health should contact the Ministry of Health's immunization program at vaccine.program@ontario.ca as soon as possible.

Personal Prevention Measures

Immunize as per the current *Publicly Funded Immunization Schedules for Ontario*.[21]

In Ontario, the *Immunization of School Pupils Act* (ISPA) is the legislation that governs the immunization of school pupils for the designated diseases that are included in the Act.[22] All students without a valid exemption (i.e., medical exemption or statement of conscience or religious belief) under the ISPA must have documented receipt of two doses of measles-containing vaccine according to age and the specified schedule.[22]

In Ontario, the *Child Care and Early Years Act, 2014* (CCEYA) is the legislation that governs licensed childcare settings.[23] Pursuant to O. Reg. 137/15 under the CCEYA, children who are not in school and who are attending licensed child care settings must be immunized as recommended by the local medical officer of health prior to being admitted.[24] Under the CCEYA parents can provide a medical reason as to why the child should not be immunized or object to immunization on religious/conscience grounds.[23]

Infection Prevention and Control Strategies

- For hospitalized cases, in addition to Routine Practices, Airborne Precautions in an airborne infection isolation room (AIIR) with the door closed are indicated for the period of communicability including the 4 days after onset of rash in otherwise healthy persons and for the duration of illness in immunocompromised persons.[19] The conservative approach is to maintain patients on precautions in an AIIR until all their measles-related symptoms have resolved.[5,25]

- If an AIIR is not available, the patient should wear a well fitted medical mask (surgical/procedure) and be immediately placed in a single room with the door closed. Patient movement should be curtailed unless absolutely necessary and then only conducted with the patient wearing a well fitted medical mask. Following patient discharge, the room door must remain closed, airborne precautions signage remaining on the door, until all air in the room has been replaced; and no further patients should be placed within the room for a two hour period.[25]

- All health care workers should ensure they are immune to measles. Only health care workers with presumptive immunity to measles should provide care to patients with suspect/confirmed measles due to increased risk of transmission of measles to susceptible individuals.[20,5,26,27]

- Non-immune, susceptible health care workers may only enter the room in exceptional circumstances (i.e., no immune health care workers are available and patient safety would be compromised otherwise).[28,26,27,29]

- **All health care workers regardless of presumptive immunity to measles should wear a fit-tested, seal-checked N95 respirator.**

- Additional personal protective equipment such as gloves, gown and eye protection may be added as required based on a point of care risk assessment (PCRA) per Routine Practices and would be recommended as part of Additional Precautions for acute respiratory illnesses to provide respiratory particle protection (previously referred to as Droplet and Contact Precautions) when caring for individuals presenting with respiratory symptoms and/or undifferentiated viral symptoms.

- Public health advice to all suspected cases of measles cases includes the following: to self-isolate, practice good hand hygiene and respiratory etiquette, and avoid sharing drinking glasses or utensils with others.[5]

Refer to PublicHealthOntario.ca to search for the most up-to-date information on Infection Prevention and Control.

Disease Characteristics

Aetiologic Agent - Measles is caused by the measles virus, a member of the genus *Morbillivirus* of the family *Paramyxoviridae*.[6]

Modes of Transmission - The measles virus is highly contagious and is spread by airborne droplet nuclei, close personal contact or direct contact with the respiratory secretions of a case.[6] Measles virus can persist in the air and on environmental surfaces for at least two hours.[5] There is no current evidence of human-to-human transmission of measles vaccine virus (vaccine-associated measles).[13,6]

Measles is one of the most highly communicable infectious diseases with greater than 90% secondary attack rates among susceptible persons.[6,5]

Incubation Period - The incubation period of measles from exposure to prodrome averages 10 to 12 days.[7,19] The time from exposure to rash onset averages 14 days (the range is 7-21 days).[7,19,6] Individuals who receive immunoglobulin (Ig) for post-exposure prophylaxis (PEP) may have a prolonged incubation period if they develop disease despite the PEP.[7]

Period of Communicability - Cases are considered infectious one day before the start of prodromal period, which is usually about 4 days before rash onset, to 4 days after the onset of rash.[6,8] The onset of the rash is day 0 and is used to establish the period of communicability.

Immunocompromised patients may have prolonged excretion of the virus from their respiratory tract and be contagious for the duration of their illness.[5]

Reservoir - Humans.[6]

Host Susceptibility and Resistance

After infection, immunity is generally lifelong.[6,8]

Any contact born on or after January 1, 1970 (excluding health care workers and military personnel*) should be considered susceptible: if they meet one or more of the following criteria:[8,5]

- Lack of documented evidence of vaccination with two valid doses of measles-containing vaccine

OR

- Lack of laboratory evidence of prior measles infection or documentation of prior confirmed measles disease in iPHIS.

OR

- Lack of laboratory evidence of immunity (i.e., "reactive" or "positive" anti-measles IgG antibody or a previous measles antibody level of > 200 mIU per ml).

*Health care workers and military personnel require documented evidence of vaccination with two valid doses of measles-containing vaccine **regardless of year of birth.**

Additional Considerations:

All infants under 12 months of age are considered susceptible.

Adults born between 1970 and 1976 were only eligible for 1 dose of measles-containing vaccine and were not eligible for the measles catch-up campaigns that offered second doses of measles-containing vaccine in 1995/1996 across Canada. In the context of contact management, these individuals should be considered susceptible and offered a second dose of measles-containing vaccine.

Adults **born before 1970** are generally presumed to have acquired natural immunity to measles; however, some of these individuals may be susceptible. The CIG recommends immunization for select individuals born before 1970: health care workers, military personnel, travelers to destinations outside of Canada and students in post-secondary educational settings.[8]

Some immunocompromising conditions make it unlikely for an individual to have developed or maintained protective levels of anti-measles antibodies, despite previous vaccination. The CIG cites hematopoietic stem cell transplantation (HSCT)

unless the individual is vaccinated post-HSCT and known to have adequate measles antibody titre, and HIV-infection with severe immunosuppression[8] as examples. This is not a comprehensive list and clinical consultation may be required to evaluate the susceptibility of immunocompromised individuals. Measles guidance from the United Kingdom's Health Security Agency provides additional background on considerations for immunocompromised contacts.[9]

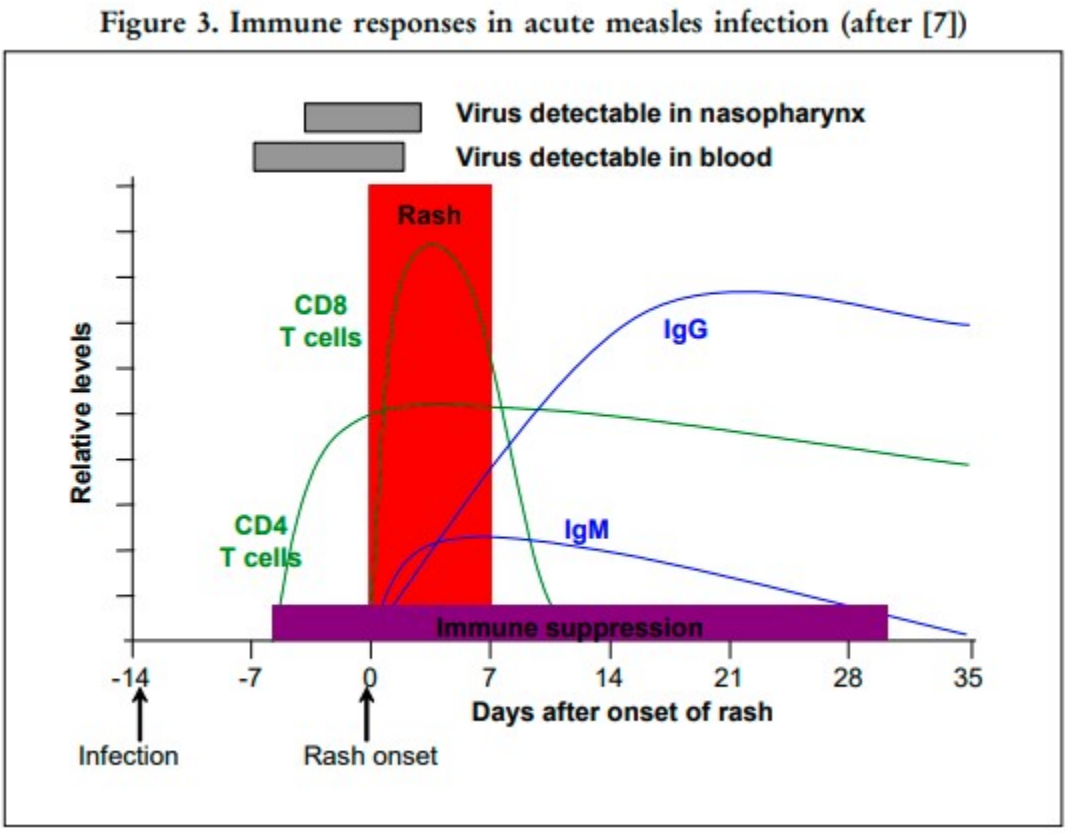
Finally, it is important to note that the susceptibility criteria outlined above apply on a population basis and it is possible that small numbers of individuals within these groups may not be immune to measles. For this reason, contacts should be advised of any relevant exposure and counselled to monitor for signs and symptoms, even if they are not recommended to receive PEP (please see section on contact management for further details) or other public-health management (self-isolation or exclusion).

Please refer to PHO's Infectious Disease Data and other reports for the most up-to-date information on infectious disease trends in Ontario.[30]

For additional national and international epidemiological information, please refer to the Public Health Agency of Canada and the World Health Organization.

Figure 1:

Figure 1. Immune responses in acute measles infection.



Source: World Health Organization, Expanded Programme on Immunization and Vaccine Assessment and Monitoring Team of the Department of Vaccines and Biologicals. Manual for the laboratory diagnosis of measles virus infection. Geneva: World Health Organization; 2007. Figure 3: Immune Responses in acute measles infection (after [7]).

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Document History

Revision Date	Document Section	Description of Revisions

March 2024	Entire Document	• Clarifications and updates to Case Definitions based on available laboratory testing at PHOL
		• Clinical presentation: Updated wording
		• Laboratory evidence: Addition of subheadings to group laboratory indications and limitations by tests (e.g., PCR, Serology). Added new Measles Vaccine Genotype PCR test at PHOL.
		• Case Management:
		  ○ Travel history added as priority information to collect.
		  ○ Subheadings added to case management section to improve readability.
		  ○ Section added 'Effect of Recent Vaccination'.
		• Contact Management:
		  ○ Subheadings added to improve readability.
		  ○ Outlined priority follow-up, including susceptibility assessment and determining high-risk contacts.
		  ○ Susceptibility Assessment (Under Host Susceptibility & Resistance section): 2 doses of measles-containing vaccine for contacts born after 1970.

Revision Date	Document Section	Description of Revisions
March 2024	Entire Document	• Contact Management: (Continued) ○ Post-exposure prophylaxis (PEP): ○ Separate sections provided for MMR vaccine and Immunoglobulin (Ig) ○ Immunoglobulin section updated to reflect NACI 2018 Guidance on PEP (eligibility, timing, dosing, how to access) ○ Exclusion of susceptible contacts: ○ Exclusion of individuals with zero doses of measles-containing if MMR vaccine as PEP is not received in 72 hour timeframe from exposure. ○ Exclusion of individuals who receive immunoglobulin as PEP, as Ig may attenuate but not prevent disease. ○ Provided clarity around exclusion criteria for those with zero-doses vs. 1 dose of measles-containing vaccine at time of exposure.

Revision Date	Document Section	Description of Revisions
March 2024	Entire Document	• Contact Management: (Continued) ○ IPAC: ○ Addition of language around isolation in hospital (Airborne precautions) and health care worker immunity. ○ Changing in masking requirement (fit-tested, seal-checked N95 respirator) for all health care workers regardless of presumptive immunity. ○ Host Susceptibility and Resistance: 2 doses of measles-containing vaccine for contacts born after 1970.
April 2022	Entire Document	New template. Appendix A and B merged. No material content changes.
April 2022	Epidemiology: Occurrence section	Removed.
April 2022	ICD Codes	Removed.