

Episode 130 – Measles April 11, 2025

Introduction

Measles is a highly infectious disease caused by the measles (rubeola) virus. Measles, also known as rubeola or red measles, should not be confused with rubella (German measles). Measles infection causes various cold-like symptoms and a characteristic rash. Complications, mainly pneumonia or encephalitis, may be fatal. Despite the availability of a safe and effective vaccine, the disease remains one of the leading causes of death among young children globally. [1] [2]

The efficacy of a single dose of measles vaccine given at 12 or 15 months of age is estimated to be 85% to 95%. With a second dose, efficacy is almost 100%. [3]

Measles is a nationally notifiable disease in Canada and measles surveillance is conducted by public health professionals in provinces and territories. [1]

In Ontario, under the authority of the *Health Protection and Promotion Act* (HPPA), Ontario Regulations 559/91, measles or suspected measles, must be reported immediately to the local public health unit by healthcare providers (e.g., physicians, nurse practitioners, pharmacists, dentists, etc.), laboratories, and administrators of hospitals, schools and institutions.[1] [4] [5]

Herd immunity

Measles is highly transmissible, requiring more than 95% of the population to be immune to stop sustained disease transmission and achieve herd immunity, also known as community or population immunity. Herd immunity occurs when a significant portion of a population becomes immune to an infectious disease either through infection and recovery, or by vaccination, which limits disease spread. Vaccination creates immunity without the associated risks of contracting the disease. [6] [7]

Herd immunity also protects those who are unable to be vaccinated, such as newborns and people who are immunocompromised, because the disease spread within the population is very limited. Communities with lower vaccine coverage may have outbreaks of vaccine-preventable diseases because the proportion of people who are

[1] If measles is suspected, contact the local public health unit immediately to report the suspected case. To locate a local public health unit, click here: Public Health Unit Locator (gov.on.ca)

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vaccinated is below the necessary herd immunity threshold. Declines in measles vaccination rates globally have increased the risk of measles outbreaks. [6] [7] Individuals who do not have immunity to an infectious disease may still contract the disease even when herd immunity is very high. Herd immunity reduces the risk of acquiring the disease but does not prevent it for nonimmune people. [7]

Public health impact of vaccination

The Expanded Programme on Immunization (EPI) was established by the World Health Assembly in May, 1974, marking a proactive commitment to extend the protective benefits of vaccination to the global population.

A modelling study by Shattock et al. (2024) estimated the global and regional public health impact of 50 years of vaccination (June 1, 1974 to May 31, 2024) in the EPI against 14 pathogens (diphtheria, *Haemophilus influenzae* type B, hepatitis B, Japanese encephalitis, measles, meningitis A, pertussis, invasive pneumococcal disease, poliomyelitis, rotavirus, rubella, tetanus, tuberculosis, yellow fever) in 194 World Health Organization (WHO) member states.

Measles vaccination accounted for 93.7 million (60%) lives saved of the 154 million total lives saved over the 50-year period. Overall, measles vaccination was the single greatest driver of lives saved by vaccination, across all years in every region and all World Bank income strata.

Large gains have been achieved within the 50 years. The next 50 years will require improved targeting and reach, especially for measles vaccines due to the multifaceted complexities of unvaccinated and undervaccinated children and communities. Continuous community engagement in vaccine uptake is critical since these gains can easily be lost. [8]

History of measles in Canada

Before vaccinations, about 10,000 to 90,000 people living in Canada were infected with measles every year. In 1963, a live-attenuated vaccine[2] was approved for use in Canada, followed by the approval of an inactivated vaccine in 1964. The inactivated vaccine had limited availability, and its use was discontinued by the end of 1970.

In the early 1970s, a single-dose schedule using a live-attenuated vaccine was introduced into routine immunization programs across all provinces and territories. The one-dose measles-mumps-rubella (MMR) combination vaccine was implemented between 1974 and 1983, followed by a routine two-dose MMR vaccine that was adopted nationally from 1996 to 1997.

[2] Live-attenuated vaccines contain a version of the living microbe that has been weakened in the laboratory. These vaccines elicit strong immune responses that can confer life-long immunity after only one or two doses. Live-attenuated vaccines include rotavirus, smallpox, chickenpox, yellow fever and the MMR vaccine. Two doses of the measles vaccine are required for life-long immunity. [98] [99]
Refer to Episode 15 for additional information on the various types of vaccines.

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From 1996 to 1997, catch-up campaigns offered school-aged children a second dose of the measles vaccine. Since measles vaccine introduction in Canada, measles cases decreased by over 99%.

In 1998, Canada achieved elimination status for measles when endemic transmission ceased. Most measles cases now arise from outside Canada, with only minimal transmission occurring within the country. Measles elimination was a direct result of successful routine vaccination programs. [1]

Measles outbreaks in Canada

Even though measles is no longer considered endemic in Canada, outbreaks can occur when an unvaccinated or nonimmune individual travels to a country where measles is circulating, acquires the infection, and returns while still infectious. The risk of measles spreading is highest in regions or communities where many unvaccinated or nonimmune individuals are clustered. Despite overall high vaccination rates in Canada, some areas have rates below the necessary threshold for community immunity, which allows for potential outbreaks. Both importation and local transmission have led to measles outbreaks in Canada. [1]

Declines in measles global vaccination rates have increased the risk of measles outbreaks worldwide, including in Canada. A Canadian study by Jeevakanthan et al. (2024) found a decrease in measles vaccination coverage in children in 2023 during the COVID-19 pandemic compared to 2019. Even before the pandemic, Canada had not achieved its 95% coverage goal for most childhood vaccinations. High vaccination coverage is essential for the prevention and control of vaccine-preventable diseases. [9] [10]

Declines in vaccination coverage are concerning. Health professionals, including oral health professionals, who administer care to children should provide parents with accurate information on vaccines and encourage them to have their children vaccinated.

Cost of measles outbreaks

Increases in global measles cases and outbreaks translate to rising costs to society in terms of both disease and economic burden. The potential rippling effects to the local economy when a large number of individuals are away from work or missing school because of outbreaks can be significant.

Ortega-Sanchez et al. (2014) estimated the economic burden on U.S. public health institutions to respond to 16 measles outbreaks in 2011 to be between $2.7 million and $5.3 million USD. [11]

Lo and Hotez (2017) modelled the potential consequences of a 5% decline in MMR vaccine coverage among U.S. children aged 2-11, which translated to 150 additional measles cases and $2.1 million USD in public sector costs. [12]

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A literature review by Pike et al. (2020) estimated costs from 11 measles outbreaks. The median total cost per measles outbreak was $152,308 (range, $9,862-$1,063,936), the median cost per case was $32,805 (range, $7,396-$76,154), and the median cost per contact was $223 (range, $81-$746). [13]

Pike et al. (2021) estimated costs related to an outbreak occurring between December 31, 2018, and April 26, 2019, in Clark County, Washington that included 72 confirmed cases of measles. The overall societal cost of this measles outbreak was $3.4 million USD ($47,479 per case, $814 per contact). Most of the costs, ~$2.3 million, were incurred by the public health response to the outbreak, followed by ~$1.0 million in productivity losses, and ~$76,000 in direct medical costs. [14]

Outbreaks of measles and other vaccine-preventable diseases will likely continue to occur, particularly in areas with insufficient vaccination coverage. Undervaccination (i.e., missing one or both doses of the measles vaccine) can carry a substantial cost for individuals, communities, and public health institutions underscoring the value of vaccination. [14]

Canada

In 2024, there was a significant increase in measles cases worldwide compared to 2023. This trend has continued in Canada, with more cases reported in the first two months of 2025 than in all of 2024. The notable increase was associated with outbreaks in New Brunswick, Ontario, Québec, and Manitoba. [15]

As of March 15, 2025, a total of 496 measles cases (410 confirmed, 86 probable) were reported by five jurisdictions (Alberta, British Columbia, Ontario, Québec, Saskatchewan) for 2025, many requiring hospitalization. Most cases were unvaccinated or undervaccinated children who were exposed in their communities (e.g., social events, daycares, schools, healthcare settings). [15] [16]

Ontario[3]

In recent months, measles cases in Ontario have occurred because travellers were exposed to measles in another country. [15]

Ontario is experiencing a multijurisdictional measles outbreak, including cases from New Brunswick and Manitoba. As of March 27, 2025, a total of 557 measles cases (464 confirmed, 93 probable) were reported in Ontario for 2025. In comparison, between 2013 and 2023 there were 101 confirmed cases, while in 2024 there were 64. [17]

[3] Public Health Ontario (PHO) developed a new measles exposure webpage to provide information on all Ontario measles exposures published by public health units, including exposure locations, dates, and times, and how long individuals should monitor for symptoms. The information is updated on Tuesdays and Fridays. Anyone who has visited the locations listed during the specified dates and times should contact their local public health unit if they are not protected against measles.

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United States of America
As of March 27, 2025, 483 confirmed measles cases were reported by 20 jurisdictions in the U.S. (Alaska, California, Florida, Georgia, Kansas, Kentucky, Maryland, Michigan, Minnesota, New Jersey, New Mexico, New York City, New York State, Ohio, Pennsylvania, Rhode Island, Tennessee, Texas, Vermont, Washington). This number already surpasses the total number of cases of 285 in 2024.

Ninety-seven percent of the cases were unvaccinated or unknown vaccination status. The majority (75%) of cases were in children and youth:

- 33% were <5 years
- 42% were 5-19 years
- 14% of all cases were hospitalized (25% <5 years)
- 2 deaths were reported [18]

On March 27, 2025, the WHO stated the U.S. outbreak is an "unusual event with potential significant public health impact, with the number of cases and deaths in 2025 exceeding the numbers in previous years." In addition, cases linked to the outbreak in Texas were reported in Mexico. [19]

In 2000, measles was declared eliminated in the U.S., meaning the disease was no longer endemic (i.e., constantly present). Since then, imported cases of measles have been detected in the country since the disease remains endemic in many parts of the world. [19] [20]

In 2019, the U.S. nearly lost its elimination status with almost 1,300 measles cases from a large outbreak in New York and cases in 30 additional states. After a decrease in global measles incidence during the COVID-19 pandemic, measles activity globally and in the U.S. continue to rise. [21]

In the 2023-2024 school year, the vaccination coverage rate for two doses of the MMR vaccine among children in kindergarten in the U.S. was 92.7%. As recently as the 2019-20 school year, coverage was 95%, the recommended vaccine rate to produce herd immunity. This declining vaccination coverage, along with the increase in vaccination exemptions, increases the risk for outbreaks in clusters of undervaccinated children.

These results may indicate changes in parental attitudes toward routine vaccination transferred from COVID-19 vaccination hesitancy or any vaccine requirements arising from objections to COVID-19 vaccine mandates, increasing the potential for larger decreases in coverage or increases in vaccine exemptions. [6] [19] [20]

Data for MMR vaccination coverage for the above study was drawn from older children who are already in kindergarten. Younger children under the age of 5 were not captured in the data because they have not reached kindergarten age.

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The Centers for Disease Control and Prevention (CDC) estimated vaccine coverage of at least one dose of MMR vaccine by age 24 months was 90.6% in a subset of children in 2021. [22]

Zhou et al. (2025) surveyed 19,892 parents of children under age 5 from July 2023 through April 2024, finding only 71.8% reported their children received at least one dose of MMR vaccine. These vaccination rates are well below the 95% threshold for herd immunity. The authors acknowledged results should be interpreted cautiously because MMR vaccination is not indicated for most children until aged 12 months and self-reported responses are prone to recall or social desirability bias. [23]

European region

On March 13, 2025, the WHO announced measles cases in the European region were at the highest they have been for the past 25 years and accounted for one third of all measles cases globally in 2024. According to an analysis by the WHO and the United Nations Children's Fund (UNICEF), the total number reported for 2024 was 127,350, double that reported in 2023 and the highest since 1997. [24]

Children under 5 years accounted for more than 40% of cases in the region, comprising 53 countries in Europe and Central Asia. More than half of the cases required hospitalization, and 38 deaths were reported. [24]

Measles in the region had generally declined since 1997, with around 216,000 cases reported, reaching a low of 4,440 cases in 2016. However, in 2018 and 2019, there was a resurgence, with around 89,000 and 106,000 cases, respectively. After a drop in immunization coverage during the COVID-19 pandemic, measles cases surged in 2023 and 2024, with vaccination rates in numerous countries still lower than before the pandemic. [24]

WHO and UNICEF noted less than 80% of eligible children in Bosnia and Herzegovina, Montenegro, North Macedonia, and Romania were vaccinated with the first dose of measles in 2023, far below the 95% coverage rate required to retain herd immunity. [24]

Measles remains a significant global threat. In 2024, 359,521 cases of measles were reported worldwide. Transmission of the virus across borders and continents occurs regularly, and outbreaks of this highly infectious disease will occur wherever the virus finds pockets of unvaccinated or undervaccinated individuals, particularly children. [24]

Vaccination is the most effective way to prevent measles infection. Anyone without immunity against measles (i.e., fully vaccinated or had a lab-confirmed measles infection) is at risk of infection, especially when travelling abroad. People who become infected while travelling may spread to those who are unvaccinated upon their return home. They could also infect vulnerable people who are unable to be vaccinated (e.g., young infants, pregnant people, and those with weakened immune systems). [25]

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Travel precautions[4]
Vaccination is essential for individuals planning travel. Travellers should consult a healthcare provider or visit a travel health clinic at least six weeks before travelling for advice and recommendations.

Recommendations before travelling include:

- Infants (6 to 12 months) travelling to high-risk areas should receive an early measles vaccine dose. Afterwards, the routine two-dose series start on or after the first birthday (equalling three doses in total). The measles vaccine is not recommended for infants under six months. Parents should consult a healthcare provider for guidance on how best to protect very young infants.
- Children and adolescents should receive both doses of a measles-containing vaccine.
- Adults born in 1970 or after should receive two doses of a measles-containing vaccine if there is no evidence of immunity (e.g. through blood testing or a history of lab-confirmed measles).
- Individuals born before 1970 should receive one dose of the measles vaccine if there is no evidence of immunity (e.g. through blood testing or a history of lab-confirmed measles disease), particularly if travelling to an area with active transmission. [15]

Clinical manifestations of measles
Prodromal (i.e., early or initial) measles symptoms begin 7 to 21 days after becoming infected.

Symptoms include:

- Fever (≥38.3˚C - oral)
- Malaise
- Cough (dry)
- Coryza (runny, stuffy nose)
- Conjunctivitis (non-purulent, red watery eyes).

These symptoms can make people think they have a cold. As a result, people with measles might not isolate when they are highly contagious.

A pathognomonic enanthema (white spots on the buccal mucosa) known as Koplik spots, may appear two to three days after symptoms begin. Followed by a generalized maculopapular rash, which usually appears about 14 days after a person is exposed or about three to seven days after prodromal symptoms begin. It typically starts on the

[4] The Public Health Agency of Canada's (PHAC) posts travel health notices outlining potential health risks to Canadian travellers. Since March 13, 2024, a level one travel health notice for measles has been in place for all countries. A level one travel health notice reminds Canadian travellers to follow travel health precautions for their destination, including practising proper hand hygiene and being up-to-date on all recommended vaccinations. Any PHAC advisory remains in effect until removed from the website. [15] [25] [100]

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face at the hairline and then spreads downward to the neck, trunk, arms, legs, and feet. The rash is not itchy and looks like small, flat red spots that coalesce as they spread to form blotchy patches. In darker skin colours, the redness may be challenging to see, or it may appear purple or darker than the surrounding skin. The rash can last four to seven days and can be accompanied by a spike in fever. Most people recover from measles within two to three weeks. However, some people can develop severe complications. [1] [25] [26] [27]

Koplik spots

Koplik spots were named after Dr. Henry Koplik of New York, who first described them in relation to measles in 1896. Koplik spots usually show in the buccal mucosa one day before the onset of the skin rash. The spots appear as bluish-white spots, slightly raised with a diameter of approximately 2 to 3 mm on an erythematous base (red halo), usually opposite the molars. This characteristic appearance of Koplik spots is sometimes described as “grains of salt on a red background.” The bluish appearance is due to the collar of dilated veins around the submucosal gland duct, and the white portion is likely due to the destruction of glandular epithelium cells. The spots may also appear on the soft palate. [28] [29]

Koplik spots appear in more than 70% of individuals with measles. The height of the eruption occurs when the skin rash appears and starts spreading. As the skin rash progresses, the spots on the mucosal membrane lose their discrete spotting and become a diffuse red background with innumerable bluish-white specks scattered on its surface. Eventually, the mucous membrane reverts to normal appearance before the skin rash resolves. [28] [29]

Early recognition of Koplik spots can help control measles outbreaks since measures can be taken to limit the spread, including prompt measles diagnosis, management, isolation, contact tracing, and post-exposure prophylaxis of close contacts.[5] [28] [30]

Differential diagnosis for Koplik spots may include Fordyce granules (which lack a bright red background) and aphthous ulcers (which are painful and less numerous). [28] [29]

Measles complications

Common complications from measles can include:

- Otitis media/ear infection (1 of every 10 cases)
- Bronchopneumonia (1 of every 10 cases)
- Diarrhea (less than 1 of every 10 cases), which can lead to dehydration.

Measles infection can result in hospitalization. Severe complications can also result from measles infection, such as:

[5] Images of measles and Koplik spots can be found at the following websites:
https://www.canada.ca/en/public-health/services/diseases/measles/health-professionals-measles.html
https://www.cdc.gov/measles/signs-symptoms/photos.html
https://www.aad.org/member/clinical-quality/clinical-care/emerging-diseases/measles/clinical-information

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- Pneumonia due to measles virus infection of the lungs occurs in approximately 5% of individuals, even during apparently uncomplicated infection.
- Respiratory failure
- Acute thrombocytopenic purpura may occur after infection resolves and cause skin bruising and mild, self-limited bleeding tendency, but occasionally, bleeding is severe.
- Encephalitis (inflammation and swelling of the brain), which can cause headache, seizures, and coma about 2 to 14 days after the rash appears and can cause permanent brain damage or death. Occurs in approximately 1 of every 1,000 reported cases.
- Death, estimated to occur in 1 to 10 of every 10,000 cases in higher-income countries like Canada, mainly due to a respiratory or neurologic complication. Undernutrition and vitamin A deficiency may increase the risk of death in people infected with measles. [1] [25] [31] [32] [33] [34]

In 2023 alone, the WHO estimated measles were responsible for approximately 107,500 deaths worldwide, mostly among unvaccinated or undervaccinated children less than 5 years old. [35]

Measles during pregnancy results in a higher risk of:
- Low birth weight
- Premature labour
- Spontaneous abortion [1] [36] [37]

Long-term sequelae of measles can include:
- Enamel hypoplasia, characterized by enamel pitting, can result from measles (and other febrile illnesses) occurring during tooth formation
- Blindness
- Deafness
- Permanent neurological sequelae
- Subacute sclerosing panencephalitis [1] [36] [37] [38] [39]

Subacute sclerosing panencephalitis (SSPE) is a rare and fatal degenerative central nervous system disease, characterized by behavioural changes, intellectual deterioration (memory loss), gradual inability to control body movement, and seizures. SSPE can develop 7 to 10 years after a child has recovered from measles. SSPE occurs at a rate of 4 to 11 in every 100,000 measles cases, with the highest rates in children infected before two years of age. [1]

Measles complications are more likely in:
- People who are pregnant
- Young children, especial those under 5 years
- People who are immunocompromised (e.g., from leukemia, HIV infection)
- Adults older than 20 years [1] [25] [37] [38]

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Immune amnesia
Measles can also damage the immune system by “erasing" its memory of how to fight infections, leaving those who recover from measles vulnerable to other diseases. During the acute phase of infection, measles induces immune suppression through a process called immune amnesia where the measles virus infection diminishes preexisting antibodies that offer protection from other pathogens.

Studies in nonhuman primates revealed measles virus replaces the old memory cells of its host with new, measles virus-specific lymphocytes. As a result, the person emerges with both a strong measles virus-specific immunity and an increased vulnerability to all other pathogens. The increased susceptibility to other infections may continue for years after apparent recovery. Analysis of mortality data suggests it disables immune memory for two to three years.

Corresponding evidence indicates it may take up to five years for children to develop healthy immune systems even without the immune suppressing effects of measles infection. Long-term measles-induced immune suppression also increases overall childhood infectious disease mortality. Furthermore, if measles infection essentially resets a child’s developing immunity to that of a newborn, revaccination or exposure to all previously encountered microbes will be required to rebuild proper immune function. Vaccination not only safeguards children against measles, but it also prevents other infections from taking advantage of measles-induced immune damage. [24] [40] [41] [42] [43] [44]

Transmission
Measles is one of the most highly communicable infectious diseases. Measles has a greater than 90% secondary attack rate, meaning 9 out of 10 susceptible people in a room will acquire measles in an exposure. The virus is transmitted via airborne route and respiratory droplets (e.g., when the person breathes, coughs, sneezes, talks) or direct contact with fomites or nasal or throat secretions of an infected person. The measles virus can remain infectious in the air or on surfaces for up to two hours after a person who is infected has left the area. [1] [3] [45]

Incubation period
The incubation period is approximately 10 days (range 7-18 days) from exposure to the onset of prodromal symptoms. The interval from exposure to appearance of the rash averages 14 days, but the rash can appear as late as 19 to 21 days from infection. People with measles are infectious from four days prior to rash onset to four days after the rash appears. Sometimes individuals who are immunocompromised do not develop the rash. Humans are the only reservoir for measles. People who recover from measles usually have permanent immunity to the disease. [1] [3] [45]

Risk factors
People who have not had measles or who have not received two doses of a measles vaccine are at risk of measles infection. Some protection can be provided to young

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infants due to antibody transfer during pregnancy from the mother who has had measles or has been vaccinated. This immunity lasts for most of the infant's first year of life. Thereafter, however, susceptibility to measles is high unless vaccination is given.

In Canada, adults born before 1970 are generally presumed to have acquired natural immunity to measles from measles infection when they were younger. This is due to high levels of measles circulation before 1970. However, vaccination for measles is still recommended for some population groups, even if born before 1970 (e.g., healthcare providers). [1] [3] [33]

Individuals at greatest risk of exposure to measles

Adolescents and adults at greatest risk of exposure to measles include:

- Travellers to destinations outside of Canada
- Healthcare workers
- Military personnel
- Students in post-secondary educational settings [3]

Diagnosis

Early measles diagnosis is critical to help prevent transmission to other people. Clinicians should consider measles in individuals presenting with signs and symptoms of measles (e.g., febrile illness, Koplik spots, and rash), especially if they are unvaccinated, partially vaccinated, or immunocompromised and if there is a potential exposure risk, including:

- Recent travel
- Known contact with someone with measles
- Living or working in an area where measles has been identified. [1] [27] [36]

Measles diagnosis is usually confirmed with a lab test, which may include:

- Nasopharyngeal or throat swab for viral detection
- Blood test for serology
- Urine test for viral detection [1] [36]

Differential diagnosis for measles

Differential diagnosis may include:

- Rubella (German measles or 3-day measles): Typical symptoms include mild fever, enlarged postauricular (behind ears) and suboccipital (base of skull) lymph nodes, rose-coloured spots on the palate, and a fine, pink rash that begins on the face, spreading to the trunk, then the arms and legs. [46]
- Scarlet fever: A red rash usually begins on the face, spreads to the trunk, arms and legs. The rash feels like coarse sandpaper. "Strawberry tongue" begins with a white coated tongue with hyperplastic papillae. As the white coating resolves, papules remain, giving the tongue the strawberry appearance. Other symptoms include high fever, very sore red throat, sometimes with white or yellowish patches. [47] [48]

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- Drug rash: A rash caused by drug hypersensitivity often resembles the measles rash, but the rash does not spread from the face downwards, there are no cold-like symptoms and there is usually a history of recent drug exposure.
- Roseola infantum: A high fever is followed by a rash that resembles measles. The disease seldom occurs in children >3 years of age. [49]
- Infectious mononucleosis: Symptoms may include extreme fatigue, sore throat, fever, enlarged lymph nodes in the neck and armpits, swollen tonsils, headache, and skin rash. [50] [51]
- Erythema infectiosum (parvovirus B19 infection, fifth disease, slapped-cheek disease): Symptoms include mild fever, bright (slapped-cheek) red rash on the face, and a lacy rash on the trunk, legs, which may be itchy. [52] [53]
- Kawasaki disease: Causes inflammation of blood vessels throughout the body in children <5 years. Symptoms include fever, rash, and a red strawberry tongue. [54]
- Hand-foot-mouth disease: Symptoms include fever, painful mouth sores, and a rash on the palms and soles, most often in young children. [34] [55] [56]

Treatment

There is no treatment to cure measles or specific antiviral treatment for measles infection. Medical management is supportive aimed at symptom relief and managing complications. This can include rehydration, rest, medication to reduce fever (e.g., ibuprofen or acetaminophen), and treating complications (e.g., antibiotics for bacterial pneumonia). Most people with measles recover at home within 2 to 3 weeks if complications do not develop. Some people with severe infection may require hospitalization.

Vitamin A supplements are recommended for children with measles who are at an increased risk of vitamin A deficiency. Research suggests supplementation might reduce serious disease and death due to measles. [1] [33] [36] [57] [58]

Vitamin A toxicity

Vitamin A will not prevent measles and should not be used as a preventative strategy. While vitamin A is important for vision, growth, cell division, reproduction, and immunity, high doses of vitamin A can be harmful. The only effective way to prevent measles is through vaccination.

A healthy and varied diet will provide most individuals with enough vitamin A. Vitamin A is a fat-soluble vitamin. Fat-soluble vitamins are stored in the liver and in fatty tissues. Excess amounts of vitamin A can lead to vitamin A toxicity (also called hypervitaminosis A). Excess vitamin A during pregnancy is associated with birth defects.

Vitamin A toxicity can be acute or chronic. Acute toxicity occurs after consuming large amounts of vitamin A over a short period of time, typically within a few hours or days. Chronic toxicity occurs when large amounts of vitamin A are taken over a long period of time.

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Symptoms of vitamin A toxicity
Both acute and chronic toxicity usually cause headache and rash.

Acute toxicity can cause:
- Increased intracranial pressure, particularly in children
- Drowsiness
- Irritability
- Abdominal pain
- Nausea and vomiting
- Coma and death may occur unless vitamin A consumption is stopped.

Early symptoms of chronic toxicity can include:
- Sparsely distributed, coarse hair
- Alopecia of the eyebrows
- Dry, rough skin and cracked lips
- Dry eyes
- Liver damage

Later symptoms of chronic toxicity can include:
- Severe headache
- Idiopathic intracranial hypertension, which is characterized by increased pressure within the skull (intracranial pressure). Symptoms include daily or near daily headaches, sometimes with nausea, blurred or double vision, and tinnitus.
- Generalized weakness.
- Bone and joint pain, especially in children.
- Fractures may occur easily, especially in older people.
- Pruritus (itchy skin), loss of appetite, and failure to thrive in children.
- Enlargement of the liver (hepatomegaly) and spleen (splenomegaly), children are most affected. [57] [59] [60] [61] [62]

Treatment of vitamin A toxicity involves stopping vitamin A supplements. Complete recovery usually occurs if vitamin A ingestion stops. Symptoms and signs of chronic toxicity usually disappear within one to four weeks. However, birth defects in the fetus from megadoses of vitamin A are not reversible. [59] [60]

Vitamin A recommendations by the U.S. Center for Disease Control and Infection (CDC) state:

> *Under the supervision of a healthcare provider, vitamin A may be administered to infants and children in the United States with measles as part of supportive management. Under a physician's supervision, children with severe measles, such as those who are hospitalized, should be managed with vitamin A.*

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Also under physician supervision, if vitamin A is recommended, it should be administered immediately on diagnosis and repeated the next day for a total of 2 doses. Inappropriate dosing may lead to hypervitaminosis A. [45]

On March 26, 2025, the media reported several children hospitalized for measles complications in West Texas had abnormal liver function on routine lab tests, a probable sign they had taken too much of the vitamin, raising concerns about misinformation. The hospitalized children were all unvaccinated. The hospital is near the outbreak epicenter in West Texas. The only way to prevent measles infection is through vaccination, not through vitamin A supplementation. [63]

Cod liver oil

Cod liver oil for the treatment of measles has received recent attention in the media. Cod liver oil does not prevent or treat measles. It has high amounts of vitamin A, much higher than the recommended daily amounts. Cod liver oil is also high in vitamin D, a fat-soluble vitamin that can be harmful if children take more than the recommended daily amount.

Side effects of cod liver oil include heartburn, stomach upset, and nausea. High doses of cod liver oil are possibly unsafe. Taking high doses of fish oil supplements may increase the risk of bleeding and possibly increase the risk of stroke.

Cod liver oil supplementation may interact with various medications. For example, taking cod liver oil with:

- Diabetes medications might cause blood sugar to drop too low.
- Antihypertensive drugs might cause blood pressure to drop too low.
- Anticoagulant or antiplatelet drugs, ginkgo biloba, or ginseng might increase the risk of bruising and bleeding.

Vitamin A and D levels might also become too high with high doses of cod liver oil. The main concern of vitamin D toxicity is hypercalcemia, a buildup of calcium in the blood. Hypercalcemia results from resorption of bone and intestinal absorption of calcium due to high levels of vitamin D. Hypercalcemia can cause loss of appetite, nausea, vomiting, weakness, frequent urination, nervousness, and hypertension. It also can lead to bone pain and kidney troubles (e.g., kidney stones).

Because the calcium level is high, calcium may be deposited throughout the body, particularly in the kidneys, blood vessels, lungs, and heart. The kidneys may be permanently damaged and malfunction, resulting in kidney failure.

Treatment for vitamin D toxicity includes stopping use of vitamin D supplements, restricting dietary calcium, intravenous hydration, and corticosteroids or bisphosphonates (which inhibit bone resorption) to reduce blood calcium levels. Kidney damage, if present, may be irreversible. [64] [65] [66] [67] [68] [69] [70] [71]

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Measles parties
In March 2025, the media reported parents were holding “measles parties” in the U.S. to intentionally expose their children to someone infected with measles to build natural immunity. The idea is similar to “chickenpox parties” that were common before the chickenpox vaccine. [72] [73]

U.S. health officials have warned the public not to hold measles parties due to:
- Measles can cause severe complications and death, even in otherwise healthy individuals.
- Symptom severity cannot be predicted.
- Exposing children on purpose puts others at risk, especially those who are unvaccinated or immunocompromised.
- Vaccination is the safest way to protect children against measles. [74]

Measles prevention
Measles can be prevented through vaccination. The MMR vaccine or the measles-mumps-rubella-varicella (MMRV) vaccine is recommended for routine immunization of children. The MMR vaccine was authorized for use in Canada in 1963, and the MMRV vaccine was authorized in 2007. [1] [75]

The first dose is recommended after the first birthday at 12 to 15 months of age. A second dose is given at 18 months of age or after, but no later than around school entry. Two doses provide lifelong immunity in most people. [1]

One dose of a measles-containing vaccine given after 12 months of age is up to 95% effective at preventing measles and two doses is about 99% effective. [76]
Measles vaccination recommendations from the Canadian Immunization Guide include:
- Measles vaccine is recommended for children and adolescents who missed the routine immunization. Children and adolescents who are not immunized should receive two doses of a measles vaccine.
- Measles vaccine is recommended for susceptible adults born in or after 1970 and should receive one dose of MMR vaccine.
- Adults born before 1970 can be presumed to have acquired natural immunity to measles. However, susceptible individuals (e.g., healthcare workers, travellers to destinations outside of Canada, military personnel) should receive MMR vaccine, regardless of year of birth.
- Susceptible adults born in or after 1970 should receive one dose of MMR vaccine. Those at great risk of measles exposure (e.g., travellers to destinations outside of Canada, healthcare workers, students in post-secondary school settings, and military personnel) should receive two doses of MMR vaccine.
- Susceptible healthcare workers and military personnel born before 1970 should receive two doses of MMR vaccine.
- Susceptible travellers to destinations outside of Canada born before 1970 should receive one dose of MMR vaccine.

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- Susceptible students in post-secondary educational settings born before 1970, 1 dose of MMR vaccine should be considered. [3]

The MMR vaccine can be given throughout the lifespan in individuals who have not received all their scheduled vaccinations. The MMRV vaccine is only authorized for individuals 12 months to less than 13 years of age. [1]

Criteria for measles immunity [3]

Routine immunization	Healthcare workers	Travellers to areas outside of Canada	Students in post-secondary educational settings	Military personnel
Documentation of vaccination: -Children 12 months to <18 years of age: two doses* -Adults ≥18 years of age born in or after 1970: one dose*	-Documentation of vaccination with two doses* (regardless of year of birth)	Documentation of vaccination: -If born in or after 1970: two doses* If born before 1970: one dose*	Documentation of vaccination: -If born in or after 1970: two doses* -If born before 1970: consider one dose* if no documentation of receipt of measles vaccine	Documentation of vaccination with two doses* (regardless of year of birth)
OR -History of laboratory confirmed infection	**OR** -History of laboratory confirmed infection	**OR** -History of laboratory confirmed infection	**OR** -History of laboratory confirmed infection	**OR** -History of laboratory confirmed infection
OR -Laboratory evidence of immunity	**OR** -Laboratory evidence of immunity	**OR** -Laboratory evidence of immunity	**OR** -Laboratory evidence of immunity	**OR** -Laboratory evidence of immunity
OR -Born before 1970				

*Measles-containing vaccine

Uncertainty of immune status

Those who are unsure whether they are immune to measles, should first try to find their vaccination records or documentation of measles immunity. If an individual's immunization records are unavailable, immunization with measles-containing vaccine is generally preferable to ordering serology (blood tests) to determine immune status. This avoids the potential for false positive and/or false negative results and reduces the risk of missed opportunities for immunization. It is safe to give additional doses of MMR vaccine to those who are already immune. [27]

Vaccine side effects

After vaccination, it is common to have mild side effects at the injection site, including swelling, soreness, and redness, which resolve on their own. Children may also be

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more fussy than usual after vaccination. Some side effects may develop one to three weeks after vaccination, including fever and mild rash, but people are not contagious. Occasionally, the rubella component of the MMR vaccine causes temporary stiff and painful joint swelling in adults, usually in females. These reactions are normal and usually resolve within a few days. Individuals can take medication if needed for pain or fever. It is important to note that the vaccine **does not** cause autism.

Very rarely, someone may have a serious reaction to a vaccine, including an allergic reaction. Symptoms of a serious allergic reaction (anaphylaxis) typically occur soon after vaccination and is treatable with epinephrine.

Signs and symptoms of anaphylaxis may include:
- Itchy rash
- Swelling of the lips, face, airway, tongue
- Increased heart rate
- Loss of consciousness
- Sudden low blood pressure
- Abdominal pain, vomiting, and diarrhea
- Sneezing, coughing, and difficulty breathing

Signs of anaphylaxis in children may include:
- Hives
- Flushing and swelling of the face
- Drooling
- Lack of control over bladder and bowels
- Behavioural changes (e.g., irritability and unconsolable crying)
- Sudden quietness or sleepiness
- Vomiting

Those receiving vaccinations will be asked to remain at the clinic for at least 15 minutes after vaccination to be monitored for abnormal or very rare reactions to receive prompt treatment. [1] [33] [76] [77] [78] [79]

Stress-related reactions
Stress-related reactions are potential side effects of vaccination. They can make people uncomfortable or afraid of vaccinations, which can be a barrier to future vaccination.

A small number of people who are very anxious about vaccines may:
- Turn pale and start to sweat
- Feel lightheaded or dizzy
- Feel numbness or tingling
- Hyperventilate
- Feel loss of sensation in the face, hands or feet

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These symptoms can lead to fainting during or shortly after receiving a vaccine. Individuals may remain pale and sweaty and have low blood pressure for several minutes afterwards. Fainting can cause head injuries if there is a fall. [79]

Vaccine contraindications and precautions

Measles vaccines have a well-established history of safety. However, there are some contraindications and situations that warrant extra precautions, such as:

- Individuals who have previously experienced an anaphylactic reaction to the vaccine or have a proven history of immediate or anaphylactic hypersensitivity to any vaccine component, except for egg allergy, should not be given the vaccine. Measles and mumps components of MMR and MMRV vaccines are produced in chicken embryo cell culture and may contain traces of residual egg and chicken protein. However, this trace amount in the vaccine appears to be insufficient to cause an allergic reaction in people with egg allergy. Skin testing is not recommended prior to vaccination as it does not predict a reaction to the vaccine. MMR or MMRV vaccine can be administered in the routine manner to individuals with a history of anaphylactic hypersensitivity to hens' eggs.
- Children with a known or suspected family history of congenital or hereditary immunodeficiency contraindicating vaccination with live vaccine should not receive live the MMR or MMRV vaccine unless their immune competence has been established.
- MMRV vaccine may be contraindicated in persons with impaired immune function, including primary or acquired immunodeficiency (e.g., due to leukemia, lymphomas, solid tumours, tumours affecting bone marrow or the lymphatic system, AIDS, severe HIV infection, treatment with chemotherapy, or long-term use of immunosuppressants).
- MMR and MMRV vaccines are generally contraindicated during pregnancy because of the theoretical risk to the fetus. Vaccination is usually postponed until after pregnancy. However, there is no evidence of a teratogenic risk from the vaccines. In some situations, potential benefits of vaccination with MMR vaccine may outweigh risks (e.g., during measles or rubella outbreaks), in which case vaccination may be considered based on medical recommendation.
- MMR and MMRV vaccines are contraindicated in individuals with active, untreated tuberculosis (TB) as a precautionary measure.
- Immunization should be postponed for individuals with moderate or severe acute illness. Individuals with a minor illness, with or without fever, may be vaccinated.
- A history of febrile seizures or a family history of seizures is not a contraindication for the MMRV vaccine.
- It is recommended to avoid the use of salicylates (e.g., acetylsalicylic acid [ASA]) for six weeks after immunization with MMRV vaccine because of an association between wild-type varicella, salicylate therapy, and Reye's syndrome. [3] [77] [80]

Measles after full vaccination

It is uncommon for someone who is fully vaccinated to develop measles. However, no vaccine is 100% effective. Breakthrough infections can occur, especially in communities

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experiencing an outbreak where high levels of measles virus are circulating. Fully vaccinated individuals who get measles tend to have a milder illness and fewer complications. Also, they are less likely to spread the disease to others, including individuals who cannot get vaccinated because they are too young or are immunocompromised. The low rate of transmission from breakthrough infections may be associated with the elevated and rapid production of neutralizing antibodies that quickly reduce the viral load, but also the development of milder symptoms (e.g., mild, unproductive cough) reduces the likelihood of effective viral transmission. [18] [81] [82] [83]

Vaccine hesitancy

The WHO recognizes vaccine hesitancy as one of the ten major global public health threats. Vaccine hesitancy, the reluctance or refusal to vaccinate despite the availability of vaccines, threatens to reverse progress made in reducing vaccine-preventable diseases. Vaccination is one of the most cost-effective ways of avoiding disease. Vaccination currently prevents 2-3 million deaths a year, and a further 1.5 million could be avoided if global coverage of vaccinations improved. [84]

Reasons why individuals choose not to vaccinate are complex. Complacency, inconvenience in accessing vaccines, and lack of confidence are key reasons underlying hesitancy. Healthcare providers remain the most trusted advisor and influencer of vaccination decisions. [84]

Concerns about the safety of the measles vaccine have persisted for decades after British physician Dr. Andrew Wakefield and colleagues published a brief report involving 12 children in *The Lancet* in 1998, which has long since been retracted, linking the MMR vaccine to autism. The paper received significant global media attention, and many parents began to doubt MMR vaccine safety. Since then, no other studies have found the MMR vaccine causes autism. [85] [86] [87]

The largest of these studies looked at 537,303 Danish children who were born between 1991 and 1998. Most (82%) of these children had been given the MMR vaccine. The study found the children who had been vaccinated were no more likely to develop autism than those who were not vaccinated. [88]

A follow-up study of all children born in Denmark between 1999 and 2010, a total of 657,461 children, concluded the MMR vaccine does not cause autism, nor does it increase the risk in children who are at high-risk of autism because of their family history. [89]

Other similar studies from across the world have reached similar conclusions. In addition, the research in the original widely publicized study linking autism and the MMR vaccine has been found to have serious scientific flaws and has been discredited by the medical and scientific communities. [85] [86] [87]

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In 2010, *The Lancet* fully retracted the 1998 report based on the findings of the British General Medical Council. Three months after *The Lancet*'s retraction, Wakefield had his medical license revoked for using falsified data as evidence. Despite the overwhelming evidence to support the safety of the MMR vaccines, and the discrediting of Wakefield's research, many parents remain unconvinced. [85] [86] [87]

Role of healthcare providers

Healthcare providers play a crucial role in fostering vaccine acceptance among those who are vaccine-hesitant. They are also expected to be knowledgeable about the risks and benefits of vaccination, the risks of vaccine-preventable diseases, and to be able to communicate this information well to their clients.

Key messages for healthcare providers to communicate about immunization include:

- Immunization also protects others: The idea that vaccines protect not just the individual but also protect others who cannot be vaccinated (e.g. individuals with immune deficiencies, those with allergies to vaccine components, newborns) may improve willingness to vaccinate.
- Approved vaccines are safe and are thoroughly evaluated: Important to inform the individual about vaccine development and approval, about the vaccine's influence on the frequency of outbreaks and the probability of complications during an infection compared to side effects of the vaccine.
- Herd immunity can eliminate diseases: Familiarize the individual with the concept of herd immunity, which occurs when a high percentage of the community is immune to a disease (e.g. through vaccination), making the spread of this disease from person to person unlikely. [90]

Research has demonstrated most healthcare providers are confident in their ability to explain vaccine use and safety to their clients. Furthermore, healthcare providers with more knowledge about vaccines were also more likely to recommend vaccination. However, many healthcare providers hold negative beliefs about vaccination and are vaccine-hesitant. Consequently, they are unlikely to dispel their clients' concerns, fears, and doubts about vaccination. Therefore, vaccine hesitancy among healthcare providers must be addressed considering most people look to their healthcare provider for information and advice on vaccines and vaccine-preventable diseases. [91] [92] [93]

Outbreak control

If a person has been exposed to measles while travelling abroad, they should follow the advice of local public health officials as they can:

- Determine if the person is at risk of getting measles and if further action is needed (e.g., post-exposure prophylaxis)
- Provide advice on how to reduce the risk of spreading measles to others.
- Monitor for measles symptoms until 21 days after the date of exposure.

People with symptoms of measles, should **not** travel. Those who experience any symptoms of measles while travelling in or returning to Canada should:

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- Wear a well-fitting respirator or mask.
- Minimize contact with others.
- Inform the flight attendant, cruise staff and/or border services officer as soon as possible. The traveller may be referred to a Quarantine Officer for a health assessment and further direction. [25]

If symptoms develop after returning to Canada, travellers should:
- Minimize contact with others.
- Call a healthcare provider immediately before seeking care (e.g., a doctor's office, emergency room, pharmacy, local public health unit) so they can provide advice while also minimizing the risk of exposure to others.
- Those who attend or work at a school, childcare, or healthcare setting, must stay home and contact their local public health unit for further direction.
- Wear a well-fitting respirator or medical mask when seeking medical care.
- Tell the healthcare provider where they travelled and if they received measles vaccination.
- Individuals with suspected measles should isolate while laboratory results are pending. [15] [17] [27] [94]

Individuals with measles

Individuals with measles are considered infectious from 4 days prior to rash onset until 4 days after rash onset (9 days total). Individuals who are immunocompromised may be infectious for longer and should isolate for the duration of illness.

Individuals with measles should adhere to the following precautions until the end of the infectious period:
- Self-isolate from all public places (e.g., childcare settings, schools, post-secondary educational institutions, workplaces, places of worship, sporting events, healthcare, other group settings).
- Avoid contact with non-household contacts.
- Avoid contact with individuals at high-risk (e.g., pregnant individuals, infants <12 months, individuals who are immunocompromised, etc.).
- Contact healthcare providers, hospitals, or other healthcare facilities prior to arrival so appropriate IPAC precautions can be implemented to avoid exposures (i.e., mask upon arrival, placed immediately in an appropriate isolation room). [27]

In healthcare settings, routine practices and airborne precautions should be followed, including the use of an airborne isolation room. [26]

All contacts of a person who may be infected should be identified and classified as susceptible or non-susceptible. Susceptible contacts should be managed as per the guidelines for the prevention and control of measles outbreaks in Canada. [1]

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Post-exposure prophylaxis
The MMR vaccine or human immunoglobulin (Ig) may be used for measles post-exposure management in susceptible individuals depending on the time since exposure and their individual risk factors. Ig provides only short-term protection and requires postponing the administration of MMR vaccine. Long-term protection against measles only follows immunization with MMR or MMRV vaccine, or measles infection.

Post-exposure vaccination with the MMR vaccine may protect people without immunity to measles (e.g., individuals 6 months and older) if given within 72 hours of measles exposure. If measles still develops, it usually has milder symptoms and lasts for a shorter time.

Human immunoglobulin can help prevent disease or lessen the severity of symptoms if given within 6 days after measles exposure. However, Ig should be given as soon as possible after exposure. Individuals that should be considered for Ig therapy include susceptible pregnant people, infants, and people who are immunocompromised. [3] [58]

Despite the use of MMR vaccine or Ig for post-exposure prophylaxis, measles infection may occur. Individuals who have been exposed should be counselled on:
- Signs and symptoms of measles.
- Isolation precautions.
- When to seek medical care, including calling ahead so appropriate infection control precautions can be taken. [1]

Measles in oral healthcare
Measles cases and outbreaks are rising. Oral health professionals should remain vigilant for signs and symptoms of measles (e.g., high fever, cough, runny nose, conjunctivitis, Koplik spots, red maculopapular rash), especially in individuals who have recently travelled, have had contact with travellers, or contact with a known case of measles.

Screening for measles in oral healthcare includes:
- Pre-screen clients for illness when scheduling or confirming appointments, reschedule those who are ill as measles is highly contagious.
- Signage should be posted at the entrance of the oral healthcare facility prompting all staff, clients, and visitors to self-assess and identify themselves to the reception if they have signs and symptoms of infectious disease. The reception area must have 70-90% alcohol-based hand rub and masks available with signage for their use.
- Clients and visitors should be actively screened by asking screening questions at the entrance into the facility or arriving at the point of care destination. Symptomatic clients should be rescheduled.
- Oral health professionals should remain aware of advisories from their local public health unit for any diseases requiring pre-screening, such as measles. If there is a local measles outbreak, ask all clients when confirming appointments or on arrival at the office whether they have had any contact with a person infected with measles.

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- Dental hygiene procedures are contraindicated during the period of measles communicability. Infectiousness begins from one day before the beginning of the prodromal period (usually about four days before rash onset) to four days after appearance of the rash. Immunocompromised individuals may be infectious for longer. [39] [95] [96] [97]

Reporting

Suspected measles cases must be reported immediately to local public health units.[6] Public health professionals will provide guidance on next steps for the client, the oral health professional, and the potentially exposed staff, clients, and visitors in the oral healthcare facility. A client with suspected measles should be advised to isolate until they can be further evaluated by a medical practitioner. The receiving medical facility should be contacted in advance before the client arrives to allow IPAC measures to be implemented to prevent exposures.

Immunization

Immunizations are an essential part of infection prevention and control as they substantially reduce the risk of oral health providers contracting an infectious as well as potentially transmitting an infectious disease to clients and other staff. [95] [96]

Both the CDHO Infection Prevention and Control (IPAC) Guidelines and the RCDSO Infection Prevention and Control in the Dental Office Standard of Practice provide information on immunization. [95] [96]

The CDHO IPAC guideline states:

> *All RDHs should be aware of their personal immunization status and ensure their vaccines are up to date.* [95]

Contact a CDHO practice advisor for additional guidance on measles and IPAC procedures.

Take home messages

- Measles is a highly contagious respiratory infection, with cases and outbreaks rising in Canada and globally.
- Measles is a vaccine preventable disease. People who have not had measles or who have not been vaccinated are at risk of infection. Measles complications occur in about 10% of measles cases.
- Getting vaccinated is the best way to protect against measles.
- Oral health professionals can play an essential role in educating individuals on measles prevention and fostering vaccine acceptance among those who are vaccine-hesitant.

[6] To find your local public health unit, click here: Public Health Unit Locator (gov.on.ca)

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- Oral health professionals must remain vigilant for signs and symptoms of measles. Koplik spots are early oral indicators of the measles virus and may appear two to three days after initial symptoms begin. Suspected cases of measles must be immediately reported to local public health units.

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