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<th>Education Program for Immunization Competencies</th>
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<tr>
<td>Module Name:</td>
<td>Module 2.2: Vaccine-Preventable Diseases</td>
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<tr>
<td>Planning Committee:</td>
<td>Developed in 2010 by: Michael Boivin, BScPhm, Susan Bowles, BScPhm, PharmD, MSc, Ian Gemmill, MD, CCFP, FCFP, FRCPC, Danielle Grenier, MD, FRCPC, Alexandra Henteleff, RN, BN, MEd</td>
</tr>
<tr>
<td>Expert video commentary by:</td>
<td>Maryanne Crockett, MD, MPH, Andrea Derban, RN, BScN, Simon Dobson, MD, MA, MBBS, Joanne Embree, MD, MSc, FRCPC, Ian Gemmill, MD, CCFP, FCFP, FRCPC, Alexandra Henteleff, RN, BN, MEd, Nicole Le Saux, MD, FRCPC, Noni MacDonald, MD, MSc, FRCPC</td>
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<td>Accreditation Information:</td>
<td>This version of the program is unaccredited and intended for informational purposes only. An accredited version is available online at <a href="http://www.AdvancingPractice.com">www.AdvancingPractice.com</a>.</td>
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Competency: Demonstrates an understanding of the rationale and benefit of immunization, as relevant to the practice setting.

Learning Objectives
Upon successful completion of this continuing education lesson, you will be better able to:

1. Describe the key clinical features, including acute and long-term complications of vaccine-preventable diseases.
2. Describe the key epidemiologic features of each vaccine-preventable disease.
3. Describe the historical impact of immunization on the epidemiology of vaccine-preventable disease.
4. For each of the vaccines administered in the practice setting, formulate a response to the question “Why should I be immunized when vaccine-preventable diseases are so rare in Canada?”
5. Explain why accurate diagnosis of vaccine-preventable diseases is important.
6. Discuss the immunization recommendations for common vaccine-preventable diseases

Test Your Current Knowledge
Based on your current knowledge, determine if the following statements are true or false.

1. Antigenic shift are most commonly associated with the influenza B virus.
   a. True
   b. False
2. Morbid obesity is considered a risk factor for influenza-related complications.
   a. True
   b. False
3. The complication risk from measles is very low, but we immunize due to its high transmission rate.
   a. True
   b. False
4. Japanese encephalitis vaccine is recommended for most travellers to Asia.
   a. True
   b. False
5. Approximately 90% of susceptible family members will become infected with mumps following an illness in a child.
   a. True
   b. False
Influenza

Note to reader: this section has been updated for the 2014-2015 season. Clinicians are encouraged to review the annual NACI influenza statement for the most current recommendations.

Causal Agent

Influenza is a single-stranded, helically shaped, RNA virus. The three types are: influenza type A, type B and type C, based on their nuclear material.

Influenza type A has subtypes that are determined by the surface antigens haemagglutinin (H) and neuraminidase (N). Haemagglutinin has a role in virus attachment to cells. Neuraminidase has a role in enabling the release of the influenza virus from the host cell. Influenza A causes moderate to severe illness and affects all age groups. The virus infects humans and other animals. Influenza A viruses are perpetuated in nature by wild birds, predominantly waterfowl. Most of these viruses are not pathogenic to their natural hosts and do not change or evolve.

Influenza type B generally causes less severe disease than type A and primarily affects children. Influenza B outbreaks are also common in long-term care facilities and can cause severe disease in the frail elderly. Influenza B is more stable than influenza A, with less antigenic drift and consequently more immunologic stability. Outbreaks of influenza B are generally more localized and in any one year may be restricted to one region of the country. Data indicates that 15% to 58% of pediatric influenza-related hospitalizations were related to influenza.

Influenza type C is rarely reported as a cause of human illness, probably because most cases are subclinical. It has not been associated with epidemic disease.

Pathogenesis

The respiratory tract is the major target of influenza virus. The virus attaches to and penetrates respiratory epithelial cells in the trachea and bronchi. Viral replication occurs, which results in the destruction of the host cell.

Influenza A vaccine is continually evolving. Haemagglutinin and neuraminidase periodically change, apparently due to sequential evolution within immune or partially immune populations. Antigenic mutants emerge and are selected as the predominant virus to the extent that they differ from the antecedent virus, which is suppressed by specific antibody arising in the population as a result of infection. This cycle repeats continuously. In inter-pandemic periods, mutants arise by serial point mutations in the RNA coding for haemagglutinin. This minor change in surface antigens is referred to antigen drift.

Antigenic shift is a major change in one or both surface antigens (H or N) that occurs at varying intervals. Antigenic shifts are probably due to genetic recombination (an exchange of a gene segment) between influenza A viruses; usually those that affect humans and birds. An antigenic shift may result in a worldwide pandemic if the virus is efficiently transmitted from person to person and the population is largely susceptible to the new variant.
Major epidemics in history include:  
- 1889-90 – (“Russian Flu”) 250,000 deaths in Europe and a death total worldwide of 2 to 3 times that number  
- 1918 – (“Spanish Flu”) 20 million deaths worldwide, 450,000 deaths in the United States, 30,000-50,000 deaths in Canada  
- 1957 – (“Asian Flu”) 2 million deaths worldwide  
- 1968 – (“Hong Kong Flu”) 1 million deaths worldwide  

**Transmission**  
Infected patients will shed the influenza virus in respiratory secretions for 5-10 days. The virus is transmitted to other people by the inhalation of infected droplets or through reaching the tissues of the nasopharynx via contaminated fingers.  

**Signs and Symptoms**  
Influenza infection results in a wide range of illness:  
- Cold-like illness with or without fever  
  - Immunize Canada has a chart comparing a common cold to influenza  
- Common flu symptoms such as sudden onset of fever, headache and myalgia (muscle pain)  
- High fever (> 40°C/104°F) without other symptoms, especially in infants and young children  
- Fever is often absent in the frail elderly but cough, headache and myalgias are often prominent  
- Croup in children < 2 years of age  

The symptoms are the result in damage to the respiratory tract caused by the influenza virus. The generalized symptoms of fever, headache, myalgia, and exhaustion are not the result of spread of the virus through the body, but rather the result of the intense response of body defences to the infection. Influenza is unique in the rapidity of onset of symptoms. Individuals feel well and then are suddenly (over a few hours) overcome by headache, myalgia and intense fatigue.  

Persons over the age of 65 years and both children and adults with chronic conditions are most susceptible to influenza-related complications, such as a secondary bacterial pneumonia.  

**NACI Recommendations for Vaccine Use**  
**Immunization**  
- Immunization programs should focus on:  
  - Those at high risk of influenza-related complications  
    - Adults (including pregnant women) and children with the following chronic health conditions:  
      - Cardiac or pulmonary disorders (including bronchopulmonary dysplasia, cystic fibrosis and asthma)  
      - Diabetes mellitus and other metabolic diseases
Cancer, immune compromising conditions (due to underlying disease and/or therapy)
Renal disease
Anemia or hemoglobinopathy
Conditions that compromise the management of respiratory secretions and are associated with an increased risk of aspiration
Morbid obesity (BMI ≥ 40)
Children and adolescents (age 6 months to 18 years) with conditions treated for long periods with acetylsalicylic acid, because of the potential increase of Reye's syndrome associated with influenza
- People of any age who are residents of nursing homes and other chronic care facilities
- People ≥ 65 years of age
- All children 6 to 59 months of age
- Healthy pregnant women (the risk of influenza-related hospitalization increases with length of gestation, i.e., it is higher in the third than in the second trimester)
- Aboriginal Peoples
  - Those capable of spreading influenza to individuals at high risk of complications
    - Healthcare providers in facilities and community settings
    - Household contacts of high-risk persons including infants < 6 months of age
    - Those providing care to children ≤ 59 months of age
    - Those providing services in closed settings to those at high risk (e.g. crew on a ship)
    - Members of a household expecting a newborn during the influenza season
    - Those who provide essential community services
    - Those who provide services within closed or relatively closed settings to persons at high risk
    - People in direct contact during culling operations with poultry infected with avian influenza
- NACI also encourages influenza vaccine for all Canadians, because significant illness and societal costs also occur in people not considered to be at high risk of complications.
- NACI has a detailed characteristic list for each of the influenza vaccines in Canada. This list can be accessed at:
- The best evidence for superior efficacy of live attenuated influenza vaccine (LAIV) vs trivalent influenza virus (TIV) is in children between the ages of 2 and 6 years with weaker evidence for older children (although it is anticipated that this extends beyond the age of 6). However, the age at which LAIV and TIV become equivalent in efficacy is not known.22
- Please also consider mentioning that LAIV does not demonstrate superiority over TIV in adults and in some studies TIV has demonstrated superiority.22
Key Information Regarding the Vaccine

- Multiple studies show that influenza vaccine is efficacious with higher efficacy demonstrated against laboratory-confirmed influenza than clinically defined outcomes.

- In a systematic review of healthy adults, inactivated influenza vaccine efficacy against laboratory-confirmed influenza was estimated to be 80% (95% CI [56%,91%]) and vaccine effectiveness against influenza-like illness was estimated at 30% (95% CI [17%, 41%]) when the vaccine strain matched the circulating strains and circulation was high.22

- In healthy children (equal to or younger than 16 or 18 years old, depending on the study), a systematic review and meta-analyses showed that the efficacy of influenza vaccine against laboratory confirmed influenza ranged from 59% to 82%. Similarly, a 2013 literature review looking at influenza vaccine effectiveness, immunogenicity, and safety in healthy 5-18 year olds found that vaccine efficacy against laboratory confirmed influenza was variable but most frequently between 65-85%.22

- There are currently eight vaccines indicated for the prevention of seasonal influenza in Canada:
  - The majority are the standard intramuscular TIV:
    - These include Agrifu®, Fluviral®, Fluzone®, Influvac®, Vaxigrip®
  - Another product is also an intramuscular TIV but contains an MF59 adjuvant and is indicated for patients ≥ 65 years of age (Fluad®).
  - One TIV is administered through the intradermal route and has one dose (9 µg strain) 18-59 years and one (15 µg) strain for ≥ 60 years. The higher dose can be considered for younger immunocompromised patients.
  - The last product is a LAIV nasal spray (Flumist®). It is currently preferred for children 2 to 17 years of age.

- Although NACI may recommend specific vaccines for certain populations, programmatic considerations at the provincial/territorial level impact what vaccines are available within publicly funded programs.

- Children who have been previously immunized with seasonal influenza vaccine and adults should receive one dose of influenza vaccine each year.

- Children 6 months to <9 years of age receiving seasonal influenza vaccine for the first time should be given two doses, with a minimum interval of four weeks between doses.

- Immunization with currently available influenza vaccines is not recommended for infants <6 months of age because it does not work well in this population.

- For intramuscular TIV, the dose is now 0.5 ml for all age groups.

- For intradermal TIV, the dose is 0.1 mL (9 µg/strain) for ages 18-59 years and 0.1 mL (15 µg/strain) for ≥ 60 years.

- For LAIV, 0.2 mL (0.1 mL per nostril) is for age groups 2-59 years.

- Vaccination should be deferred in persons with serious acute febrile illness.

- Vaccination can be given in patients with egg allergies. The regimen to be used will vary based on the severity of the allergy.

- The LAIV has specific contraindications:
Children <24 months of age due to increased risk of wheezing.
- Individuals with severe asthma (as defined as currently on oral or high dose inhaled glucocorticosteroids or active wheezing) or those with medically attended wheezing in the 7 days prior to vaccination.
- Children and adolescents (2-17 years of age) currently receiving aspirin or aspirin-containing therapy because of the association of Reye’s syndrome with aspirin and wild-type influenza infection. It is recommended that aspirin-containing products in children <18 years of age be delayed for four weeks after receipt of LAIV.
- Pregnant women, because it is a live attenuated vaccine and there is a lack of safety data at this time. However, it is not contraindicated in nursing mothers.
- Persons with immune compromising conditions, due to underlying disease and/or therapy, as the vaccine contains live attenuated virus.

Based on effectiveness, efficacy and immunogenicity data, NACI recommends LAIV for use in healthy children and adolescents 2-17 years of age. Available data indicates that LAIV would be preferred over TIV in this population. In contrast to children, most comparative studies in persons 18 to 59 years of age have found that LAIV and TIV had similar efficacy or that TIV was more efficacious.

The NACI recommended dosages and route by age for the 2014-2015 season are listed in Table 3.

### Table 3 - Choice of influenza vaccine for selected age and risk groups (for persons without a contraindication to the vaccine)²²

<table>
<thead>
<tr>
<th>Recipient by age group</th>
<th>Vaccine types available for use</th>
<th>Comments</th>
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<tr>
<td>Children 6-23 months of age</td>
<td>TIV QIV</td>
<td>Only TIV and QIV are available for this age group.</td>
</tr>
<tr>
<td>Children 2-17 years of age</td>
<td>TIV QIV LAIV</td>
<td>LAIV is not recommended for children with immune compromising conditions, see below. LAIV or TIV can be used in children with chronic health conditions, including non-severe asthma.</td>
</tr>
<tr>
<td>Adults 18-59 years of age</td>
<td>TIV QIV TIV-ID (9 µg) LAIV</td>
<td>TIV, QIV and TIV-ID are the preferred products for adults with chronic health conditions. For adults with immune compromising conditions: LAIV is not recommended. TIV-ID 15 µg formulation can be considered.</td>
</tr>
<tr>
<td>Adults 60-64 years of age</td>
<td>TIV QIV TIV-ID (15 µg)</td>
<td></td>
</tr>
<tr>
<td>Adults 65+ years of age</td>
<td>TIV QIV</td>
<td></td>
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</tbody>
</table>
**Key Points**

- Influenza is caused by influenza A and B viruses and occurs in Canada every year, generally during late fall and the winter months.
- “Classic” influenza disease is characterized by the abrupt onset of fever, myalgia, sore throat, non-productive cough, and headache. Symptoms may present atypically in young children and frail elderly.
- Each year, influenza infects 10-20% of the population of North America. In Canada there have been 4000-8000 deaths caused by influenza annually.
- There are a large variety of influenza viruses based on the haemagglutinin (H) and neuraminidase (N) surface antigens on the influenza A virus. A patient with antibodies to certain specific types of these antigens, particularly to H antigen, is only protected against a virus carrying the same antigen type. For this reason, immunity to influenza is very specific and requires an annual immunization based on the most common strains circulating throughout the region; annual immunization is also required because the duration of protection often does not exceed a year.
- During inter-pandemic periods, minor H antigen change (referred to as drifts) is common. The greater the change in antigens the less the cross-immunity to the previously circulating virus.
- Pandemic influenza is usually associated with a major antigenic change (referred to as a shift) and the rapid global spread of influenza A virus with a different H and possibly a different N antigen from strains circulating previously.
- All health care professionals should be immunized each year to protect their patients from influenza.
- NACI has concluded that egg-allergic individuals may be vaccinated against influenza using TIV or QIV without prior influenza vaccine skin test and with the full dose, irrespective of a past severe reaction to egg and without any particular consideration including immunization setting. The only stipulation is that immunizers should have the necessary equipment to be prepared to respond to a vaccine emergency at all times.
Japanese Encephalitis

Causal Agent

Japanese encephalitis virus (JEV) is a single-stranded RNA virus that belongs to the genus Flavivirus and is closely related to West Nile and Saint Louis encephalitis viruses. JEV is the most common vaccine-preventable cause of encephalitis in Asia, occurring throughout most of Asia and parts of the western Pacific. (The WHO has a map of countries or areas at risk for Japanese Encephalitis.)

The overall incidence of JEV among people from non-endemic countries traveling to Asia is estimated to be less than 1 case per 1 million travellers. The World Health Organization (WHO) estimates that more than 50,000 JEV cases occur annually, with 10,000 deaths and 15,000 cases of long-term neuropsychiatric sequelae. However, expatriates and travelers who stay for prolonged periods in rural areas with active JEV transmission are likely at similar risk as the susceptible resident population (5–50 cases per 100,000 children per year). Travellers on even brief trips might be at increased risk if they have extensive outdoor or nighttime exposure in rural areas during periods of active transmission. Short-term (<1 month) travelers whose visits are restricted to major urban areas are at minimal risk for JEV. In endemic areas there are few human cases among residents because of vaccination or natural immunity.

Pathogenesis

The virus is primarily maintained through a relationship between Culex mosquito and wild birds. Secondary cycles can lead to infections of humans, often with domestic pigs as amplifying hosts. Humans are incidental hosts, because they usually do not develop a level or duration of viraemia sufficient to infect mosquitoes and propagate the cycle. The incubation period is 5–15 days. Infection with the virus can lead from no symptoms to severe symptoms and complications.

Transmission

JEV is transmitted to humans through the bite of an infected mosquito, primarily Culex species. Transmission principally occurs in rural agricultural areas, often associated with rice cultivation and flooding irrigation. In temperate areas of Asia, transmission is seasonal, and human disease usually peaks in summer and fall. In the subtropics and tropics, seasonal transmission varies with monsoon rains and irrigation practices and may be extended or even occur year-round.

Signs and Symptoms

- Most JEV infections are asymptomatic. Less than 1% of people infected with JEV develop clinical disease. In endemic areas, disease occurs primarily in children.
- Illness usually begins with sudden onset of fever, headache, and vomiting. Mental status changes, focal neurologic deficits, generalized weakness, and movement disorders may develop over the next few days.
- The classical description of JE includes a parkinsonian syndrome with masklike facies, tremor, cogwheel rigidity, and choreoathetoid movements.
- Acute flaccid paralysis.
Seizures are common, especially among children. Clinical laboratory findings might include a moderate leukocytosis, mild anaemia, and hyponatraemia. Cerebrospinal fluid (CSF) typically has a mild to moderate pleocytosis with a lymphocytic predominance, slightly elevated protein, and normal ratio of CSF to plasma glucose. The case-fatality ratio is approximately 20%–30%. Among survivors, 30%–50% have significant neurologic, cognitive, or psychiatric sequelae. There is no specific antiviral treatment for JE; therapy consists of supportive care and management of complications.

NACI Recommendations for Vaccine Use

Immunization

Japanese encephalitis vaccine (JEV) is recommended for travellers to JE endemic/epidemic areas during the transmission season who will:

- Spend more than a cumulative total of 30 days in rural areas during the season of risk (or in urban areas known to be endemic or epidemic for JE); including longer-term travellers or expatriates who, while based in urban areas, anticipate making intermittent short trips to rural areas of risk.
- Spend less than a cumulative total of 30 days in rural areas during the season of risk (or in urban areas known to be endemic or epidemic for JE) if substantial activity outdoors (or indoors if the indoor area does not exclude mosquitoes) is anticipated, especially during the evening/night.

JEV is generally not recommended to travellers to JE endemic/epidemic areas during the transmission season whose:

- Entire itinerary will be in urban areas (unless the urban areas are known to be endemic or epidemic for JE).
- Visits to rural areas (or urban areas known to be endemic or epidemic for JE) will be during the daytime only.

JEV is recommended for laboratory personnel who work with the JE virus.

Key information regarding the vaccine

- No efficacy or effectiveness data exist for the Vero cell culture-derived JEV vaccine.
- Give JEV vaccine as two separate 0.5 mL doses on days 0 and 28.
- The most commonly reported adverse events following JEV vaccination are injection site tenderness, redness and hardening; headache; myalgia; and fatigue.
- The JEV is not authorized for use in persons less than 18 years of age due to little safety and efficacy data in this population. The pediatric traveller, especially the longer-term traveller, to areas endemic for JE may be at risk for JE infection and serious complications. If travel cannot be avoided or deferred, travellers less than 18 years of age should be advised to diligently use protective measures to prevent mosquito bites. The use of the JEV can be considered for off-
label use in the patients at high-risk. Preliminary data suggest the use of a half adult dose in children less than 3 years of age.

**Key Points**

- JEV is a viral cause of encephalitis, occurring only in certain countries in Asia.
- The risk of infection for travellers is very low.
- There are seasonal variances in the rate of JEV infections.
- The majority of cases are asymptomatic.
- If encephalitis develops, the treatment is strictly supportive.
- The JEV vaccine is recommended for adult travellers with a high exposure risk.

**Measles**

**Causal Agent**

The measles virus is a paramyxovirus, genus Morbillivirus. It is 100–200 nm in diameter, with a core of single-stranded RNA. Although there has been some change in the antigen component of the measles, they are not viewed as significant changes as there has been no change in vaccine efficacy.

**Pathogenesis**

Measles is a systemic infection. The primary site of infection is the respiratory epithelium of the nasopharynx. Two to three days after invasion and replication in the respiratory epithelium and regional lymph nodes, the virus enters the blood and is carried throughout the body to other lymph glands, the liver, spleen and bone marrow where it continues to multiply for 3 to 5 days. The virus then reinvades the blood and spreads to the skin, eyes, respiratory tract and other organs. The virus reaches a peak level at 11 to 14 days after exposure then declines rapidly over a few days.

The measles virus is shed from the nasopharynx, beginning with the prodrome until 3-4 days after rash onset.

**Clinical Note**

Measles is so contagious that over 90% of susceptible person exposed at home to a child with measles will develop it.

**Transmission**

Measles transmission is primarily person to person via large respiratory droplets. Airborne transmission via aerosolized droplet nuclei has been documented in closed areas (e.g. office examination room) for up to 2 hours after a person with measles occupied the area. The measles virus is rapidly inactivated by heat, light, acidic pH, ether, and trypsin. It has a short survival time (less than 2 hours) in the air or on objects and surfaces.
Signs and Symptoms
The incubation period for measles from exposure to prodrome averages 10-12 days. The prodrome phase lasts for 2-4 days (range 1-7 days) and is characterized by fever, which increases in a stepwise fashion reaching 39.4-40°C (103-104°F). This is followed by the onset of cough, runny nose and conjunctivitis. During this phase blue-white spots (Koplik spots) can be seen on buccal mucosa. These spots appear 1-2 days before the rash and up to 1-2 days after the rash and are characteristic of measles infection.

Rash from Measles
Koplik Spots
Photo Courtesy: Center of Disease Control and Prevention

The measles rash consists of large red spots that first appear on the face and head and spread down over the body to the arms and legs. The spots can become so large that there may be no unaffected skin in between, especially on the face and upper body. The average rash begins to fade after about a week and the total illness is 7 to 14 days.

Complications from measles are very common due to spread of the virus throughout the body and the extensive damage to the respiratory tract.

Complications include:
- Otitis media: 7-9% of children
- Bacterial pneumonia: 1-6%
- Diarrhoea: 6%
- Encephalitis: 1 in 1000 cases
- Subacute sclerosing panencephalitis (SSPE): 1 in 100,000 cases

Hospitalization occurs in 1% of children with measles. Death occurs in approximately 1 in 1000 cases of measles. The most common causes of death from measles is by pneumonia and encephalitis. Measles during pregnancy results in a higher risk of premature labour, spontaneous abortion and low
birth weight infants. Subacute sclerosing panencephalitis (SSPE) is a rare but fatal complication of measles. It is caused by a chronic infection of brain cells by the measles virus.\textsuperscript{16}

**Clinical Note**

In 2014 a measles outbreak occurred in the Fraser Valley of British Columbia. As of April 8, 2014 there were 375 confirmed cases mostly in unimmunized young people and partially immunized adults.\textsuperscript{27}

**NACI Recommendations for Vaccine Use\textsuperscript{26}**

**Immunization**

**Children (12 months to 17 years)**

- Two doses of measles-containing vaccine should be given for routine immunization of children and for immunization of children and adolescents who have missed measles immunization on the routine schedule. MMRV vaccine may be used in children aged 12 months to 12 years.

**Adults (18 years of age and older)**

- Routine immunization: adults born before 1970 are generally presumed to have acquired natural immunity to measles; however, some of these individuals may be susceptible.
- Adults without contraindications, born in 1970 or later who do not have documented evidence of receiving measles-containing vaccine on or after their first birthday, or laboratory evidence of immunity, or a history of laboratory confirmed measles infection should be immunized with one dose of MMR vaccine.
- **Health care workers**, regardless of their year of birth, who do not have documented evidence of receiving two doses of measles-containing vaccine on or after their first birthday, or laboratory evidence of immunity, or a history of laboratory confirmed measles disease should receive two doses of MMR vaccine. Refer to Workers.
- Students in post-secondary educational settings, born in 1970 or later, who do not have documented evidence of receiving two doses of measles-containing vaccine on or after their first birthday, or laboratory evidence of immunity, or a history of laboratory confirmed measles disease should receive two doses of MMR vaccine. In students born before 1970, administration of one dose of MMR vaccine should be considered.
- **Military personnel**, regardless of their year of birth, who do not have documented evidence of receiving two doses of measles-containing vaccine on or after their first birthday, or laboratory evidence of immunity, or a history of laboratory confirmed measles disease should receive two doses of MMR vaccine.
- **Travellers** to destinations outside of North America, born in 1970 or later, who do not have documented evidence of receiving two doses of measles-containing vaccine on or after their first birthday, or laboratory evidence of immunity, or a history of laboratory confirmed measles
disease should receive two doses of measles-containing vaccine. Travellers born before 1970 who do not have documented evidence of receiving a measles-containing vaccine on or after their first birthday, or laboratory evidence of immunity, or a history of laboratory confirmed measles disease should receive one dose of MMR vaccine.

<table>
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<tr>
<th>Summary of NACI Recommendations for measles immunization²⁶</th>
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<tbody>
<tr>
<td><strong>Routine</strong></td>
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<tr>
<td>Documentation of vaccination:</td>
</tr>
<tr>
<td>- Children 12 months to 17 years of age: 2 doses†</td>
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<td>OR</td>
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</table>

† - Measles-containing vaccine
Key information regarding the vaccine

- Measles vaccine is available as measles-mumps-rubella (MMR) or measles-mumps-rubella-varicella (MMRV) vaccine.
- 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%.
- MMR and MMRV vaccines are safe and effective.
- Adverse events following MMR immunization occur less frequently and are less severe than those associated with natural disease. Adverse reactions are less frequent after the second dose of vaccine and tend to occur only in those not protected by the first dose. Six to 23 days after MMR immunization, approximately 5% of immunized children experience malaise and fever (with or without rash) lasting up to 3 days. Parotitis, rash, lymphadenopathy, and joint symptoms also occur occasionally after MMR immunization.
- Pain and redness at the injection site or low-grade fever occur in 10% or more of vaccines receiving MMRV. Rash, including measles-like, rubella-like and varicella-like rash, as well as swelling at the injection site and moderate fever (greater than 39°C) occur in 1% to less than 10% of vaccinees. As varicella-like rashes that occur within the first two weeks after immunization may be caused by wild-type virus, health care providers should obtain specimens using viral transport media from a lesion to ensure varicella disease is not confused with a reaction to vaccination.
- Acute transient arthritis or arthralgia may occur 1 to 3 weeks after immunization with rubella-containing vaccine, lasts for about 1 to 3 weeks, and rarely recurs. This is more common in post-pubertal females, among whom arthralgia develops in 25% and arthritis in 10% after immunization with rubella-containing vaccine. There is no evidence of increased risk of new onset, chronic arthropathies or neurologic conditions.

Key Points

- The measles virus is a paramyxovirus, genus Morbillivirus, with a core of single-stranded RNA.
- Measles transmission is primarily person to person via large respiratory droplets.
- Vaccine was introduced in 1954.
- Peak incidence: Before the vaccine, measles epidemics were common occurring every 2 to 3 years and an estimated 300,000 to 400,000 cases occurred annually; down to a yearly average of 14 between 2001 and 2005; outbreaks continue to occur in under-immunized populations.
- First symptoms of a measles infection are fever, aches and pains, runny nose, cough and red and inflamed eyes. A rash will develop starting on the face and head and spreading down over the body to arms and legs. The total illness is 7-14 days.
- Approximately 30% of reported measles cases have one or more complications.
- Complications include measles encephalitis (1 in 1000 cases), which may result in permanent brain damage. Measles during pregnancy results in a higher risk of premature labour, spontaneous abortion and low birth weight infants. Otitis media, pneumonia are common complications. Deaths occur in about 1 in every 1000 measles cases.
• Measles vaccine should be given at an earlier age than usual for children travelling to countries outside of North America. MMR vaccine may be given as early as 6 months of age; however, two additional doses of measles-containing vaccine must be administered after the child is 12 months old to ensure long lasting immunity to measles.  

• MMR vaccine may be recommended for children between 6 months to less than 12 months of age for post-exposure management if it is given within 72 hours of exposure; however, two additional doses of measles-containing vaccine must be administered after the child is 12 months old (and at least 28 days from the previous dose) to ensure long lasting immunity to measles.  

• The CDC has some useful information to use in patient consultations on the consequences of if the measles vaccination was discontinued.

Meningococcal Disease

Causal Agent

N. meningitidis, or meningococcus, is an aerobic, gram-negative diplococcus, closely related to N. gonorrhoeae. The outer membrane contains several protein structures that enable the bacteria to interact with the host cells as well as perform other functions. The outer membrane is surrounded by a polysaccharide capsule that is necessary for pathogenicity because it helps the bacteria to resist phagocytosis and complement-mediated lysis. The outer membrane proteins and the capsular polysaccharide make up the main surface antigens of the organism.

Meningococci are classified by using serologic methods based on the structure of the polysaccharide capsule. Although many serogroups exist, almost all invasive disease is caused by one of five serogroups: A, B, C, Y, and W-135. The relative importance of each serogroup depends on geographic location, as well as other factors, such as age.

A review of IMPACT data provided some insight to the common forms of invasive meningococcal disease in Canada. Between 2002 and 2011, there were a total of 769 invasive meningococcal cases; 54% (n=413) in children with a peak incidence of 6.16 per 100,000 in children aged < 1 year in 2009. Serogroup B accounted for the largest proportion of cases, with the highest fatality rate (4.3% of children) and 21% of paediatric survivors had long-term sequelae.

Clinical Note from the Canadian Immunization Guide

An average of 298 cases of meningococcal disease has been reported annually. Disease occurs year round, but there is seasonal variation with the majority of cases occurring in the winter months.
Pathogenesis
Meningococci are transmitted by droplet aerosol or secretions from the nasopharynx of colonized persons. The bacteria attach to and multiply on the mucosal cells of the nasopharynx. In a small portion (less than 1%) of colonized persons, the organism penetrates the mucosal cells and enters the bloodstream. The bacteria spread by way of the blood to many organs. In about 50% of bacteraemic persons, the organism crosses the blood–brain barrier into the cerebrospinal fluid and causes purulent meningitis. An antecedent upper respiratory infection may be a contributing factor.

A majority of individuals with meningococcal disease are asymptomatic carriers. The bacteria resides and multiplies in the nasopharynx but causes no symptoms or illness. The frequency of carrier state is very low in infants and young children and is highest (10-30%) in adolescents and young adults.

Transmission
The bacteria are extremely fragile outside the body and are not highly contagious. Meningococci are transmitted by droplet aerosol or secretions from the nasopharynx of colonized persons. The bacteria attach to and multiply on the mucosal cells of the nasopharynx. In a small proportion (less than 1%) of colonized persons, the organism penetrates the mucosal cells and enters the bloodstream.

Signs and Symptoms
The incubation period of meningococcal disease is 3 to 4 days, with a range of 2 to 10 days. Approximately 40% of patients with clinical manifestations of meningococcal disease have meningitis alone, 40% have both meningitis and septicemia, 10-15% have septicemia alone and 5% have other forms (pneumonia, arthritis or otitis media).

Meningitis is the most common presentation of invasive meningococcal disease and results from the spread of the organism through the blood to the central nervous system. Patients will present with a sudden onset of fever, headache, and stiff neck, often accompanied by other symptoms, such as nausea, vomiting, photophobia (eye sensitivity to light), and altered mental status. Meningococci can be isolated from the blood in up to 75% of persons with meningitis. The case-fatality rate of invasive meningococcal disease is approximately 10% and is highest for type C and lowest for type B.

Septicaemia is the most severe form of meningococcal disease. While in the blood, the bacteria release endotoxin that causes an intense reaction of the body's defence system. This condition is characterized by abrupt onset of fever and a petechial or purpuric, non-blanching rash, often associated with hypotension, shock, acute adrenal hemorrhage and multi-organ failure. The fatality rate of meningococcemia is up to 40%. As many as 20% of survivors have permanent sequelae, such as hearing loss, neurologic damage, or loss of a limb. Septicemia can kill very rapidly, with the total of first symptoms to death being as short as 6 to 12 hours.

Dermnet has some images of the rash commonly seen with meningococcal infection.
NACI Recommendations for Vaccine Use

Immunization

Healthy infants and children (2 months to 11 years)

- Infants may receive Meningococcal conjugated type C (Men C-C) vaccine beginning at 2 months of age depending on the provincial/territorial schedule and the incidence of meningococcal serogroup C disease in their jurisdiction. Men-C-C vaccine is recommended for all children at 12 to 23 months of age regardless of any doses given at less than 12 months of age. It is routinely given at 12 months and is recommended in unimmunized children less than 5 years of age. Men-C-C vaccine may be considered for children 5 to 11 years of age if not previously immunized as infants or toddlers.

- Infants born prematurely: Premature infants in stable clinical condition should be immunized with conjugate meningococcal vaccine at the same chronological age and according to the same schedule as full-term infants. Infants born prematurely (especially those weighing less than 1,500 grams at birth) are at higher risk of apnea and bradycardia following vaccination. Hospitalized premature infants should have continuous cardiac and respiratory monitoring for 48 hours after their first immunization.

Healthy adolescents and young adults (12 to 24 years of age)

- Either Men-C-C or meningococcal conjugated type ACYW-135 (Men-C-ACYW-135) vaccine (depending on local epidemiology and programmatic considerations) is recommended for adolescents (routinely at 12 years of age) and young adults, even if previously vaccinated as an infant or toddler.

High risk groups

- Individuals with increased risk of meningococcal disease because of underlying medical conditions are as follows:
  - Persons with functional or anatomic asplenia (including sickle cell disease)
  - Persons with congenital complement, properdin, factor D or primary antibody deficiencies
  - Persons with acquired complement deficiency due to receipt of the terminal complement inhibitor eculizumab (Soliris™)
  - Men-C-ACYW-135 vaccine should be considered for individuals with HIV, especially if congenitally acquired.
Outbreaks of Meningococcal Disease

<table>
<thead>
<tr>
<th>NACI Recommended vaccination of close contacts for post-exposure management and for outbreak control[^30]</th>
<th>Group</th>
<th>Recommended vaccine(s)</th>
<th>Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Close contacts and outbreak control of <strong>serogroup C</strong> invasive meningococcal disease</td>
<td>2 months to less than 12 months of age</td>
<td>Men-C-C†</td>
<td><strong>Unvaccinated</strong>: 1 dose immediately after exposure then complete the routine series of Men-C-C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Previously vaccinated</strong>: If previously vaccinated then re-vaccinate with Men-C-C if at least 4 weeks since last dose, then complete the routine series of Men-C-C if necessary</td>
</tr>
<tr>
<td></td>
<td>12 months – 10 years of age</td>
<td>Men-C-C†</td>
<td><strong>Unvaccinated</strong>: 1 dose immediately after exposure</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Previously vaccinated</strong>: If previously vaccinated at less than 1 year of age OR person is at high risk for IMD due to underlying medical conditions‡, then re-vaccinate with one dose of Men-C-C if at least 4 weeks since last dose; otherwise re-vaccinate if at least 1 year since last dose</td>
</tr>
<tr>
<td></td>
<td>11 years of age and older</td>
<td>Men-C-C† OR Men-C-ACYW-135§</td>
<td><strong>Unvaccinated</strong>: 1 dose immediately after exposure</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Previously vaccinated</strong>: If previously vaccinated at less than 1 year of age OR person is at high risk for IMD due to underlying medical conditions‡, then re-vaccinate with one dose of vaccine of choice if at least 4 weeks since last dose; otherwise re-vaccinate if at least 1 year since last dose</td>
</tr>
<tr>
<td>Close contacts and outbreak control of <strong>serogroup A, Y, or W-135</strong> invasive meningococcal disease</td>
<td>2 months to less than 12 months of age</td>
<td>Menveo™α</td>
<td><strong>Unvaccinated</strong>: 2 or 3 doses given 8 weeks apart with another dose between 12 and 23 months and at least 8 weeks from the previous dose</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Previously vaccinated</strong>: If previously vaccinated with only Men C-C, give Menveo™ as for unvaccinated persons, regardless of when Men-C-C was previously</td>
</tr>
</tbody>
</table>
### Education Program for Immunization Competencies

**Module 2.2: Vaccine-Preventable Diseases**

<table>
<thead>
<tr>
<th>Age Range</th>
<th>Vaccine/Doses</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 to 23 months of age</td>
<td>Menveo™α</td>
</tr>
<tr>
<td>Unvaccinated:</td>
<td>2 doses at least 8 weeks apart</td>
</tr>
<tr>
<td>Previously vaccinated:</td>
<td>If previously vaccinated with only Men C-C, give Menveo™ as for unvaccinated persons, regardless of when Men C-C was previously given.</td>
</tr>
<tr>
<td></td>
<td>If previously vaccinated with Men-C-ACYW-135 at less than 1 year of age OR if person is at high risk for IMD due to underlying medical conditions, then re-vaccinate with one dose of Menveo™ if at least 4 weeks since last dose of Men-C-ACYW-135; otherwise re-vaccinate with one dose of Menveo™ if at least 1 year since last dose of Men-C-ACYW-135</td>
</tr>
<tr>
<td>2 years and older</td>
<td>Men-C-ACYW-135§</td>
</tr>
<tr>
<td>Unvaccinated:</td>
<td>1 dose immediately after exposure≠</td>
</tr>
<tr>
<td>Previously vaccinated:</td>
<td>If previously vaccinated with only Men C-C, give Men-C-ACYW-135 as for unvaccinated persons, regardless of when Men-C-C was previously given≠</td>
</tr>
<tr>
<td></td>
<td>If previously vaccinated with Men-C-ACYW-135 at less than 1 year of age OR if person is at high risk for IMD due to underlying medical conditions, then re-vaccinate with one dose of Men-C-ACYW-135 if at least 4 weeks since last dose of Men-C-ACYW-135 if at least 1 year since last dose of Men-C-ACYW-135</td>
</tr>
</tbody>
</table>

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† - Men-C: Meningitec® or Menjugate® or NeisVac-C®

‡ - At high risk due to underlying medical conditions

§ - Men-C-ACYW-135: Menactra® or Menveo™

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An online version is available at www.AdvancingPractice.com.
α - Menveo™ is not authorized for use in children less than 2 years of age; there are no authorized schedules for these children. The schedules in this table are based on those used in published clinical trials and the recommendation that a dose of meningococcal conjugate vaccine be given in the second year of life (12 to 23 months) for children vaccinated at less than 1 year of age.

¥ - In general, a minimum four week interval is recommended between doses of conjugate meningococcal vaccines; however, in an outbreak or to manage a close contact of a case of IMD, the second dose of conjugate meningococcal vaccine may be given as soon as indicated to provide protection to a close contact who is unvaccinated for the implicated serogroup.

≠ - Individuals at high risk due to underlying medical conditions routinely need two doses of Men-C-ACYW-135.

### Meningococcal Type B Vaccine (4CMenB)

- Individuals greater than or equal to two months of age:
  - Who are at high risk of meningococcal disease caused by serogroup B Neisseria meningitidis
  - That have been in close contact with a case of IMD caused by serogroup B N. meningitidis
  - Who may be at risk during IMD outbreaks caused by serogroup B N. meningitidis or the emergence of hyperendemic and/or hypervirulent N. meningitidis strains that are predicted to be susceptible to the vaccine based on Meningococcal Antigen Typing System (MATS) testing

### Key Information Regarding the Vaccine

- Meningococcal vaccines in Canada include polysaccharide A, C, Y, W-135 (Menomune®), meningococcal serogroup C conjugate vaccine (Meningitec®, Menjugate®, Neis Vac-c®), quadrivalent meningococcal conjugate A, C, Y, W-135 (Menactra®, Menveo®, Nimenrix®) and Meningococcal serogroup B (Bexsero®).
- Meningococcal vaccines are initially highly effective; effectiveness wanes over time.
- Monovalent conjugate meningococcal vaccine (Men-C) effectiveness in infants is 97% within one year of vaccination. Vaccine effectiveness of the quadrivalent conjugate meningococcal vaccine Menactra® in adolescents is 80% to 85% within 3 to 4 years of vaccination.
- Men-C-C vaccine may be administered concomitantly with routine childhood vaccines and Men-C-ACYW-135 vaccine may be administered concomitantly with adolescent and adult age-appropriate vaccines at different injection sites using separate needles and syringes.
- Menveo™ can be administered with routine paediatric vaccines; however, further studies are needed with regard to concomitant administration with pneumococcal 13-valent conjugate vaccine.
- There may be redness, swelling and soreness at the injection site.
The Canadian Paediatric Society recommendations for meningococcal vaccines in Canada are listed in Table 4.

Table 4 – Meningococcal Vaccines in Canada

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Brand Name</th>
<th>Suggested Use</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Men-C-ACYW-135</strong>&lt;br&gt;Quadrivalent meningococcal conjugate (A, C, Y, W-135)</td>
<td>Menactra&lt;br&gt;Menveo</td>
<td>Adolescent booster&lt;br&gt;After age two in groups at increased risk&lt;br&gt;In children 2-23 months of age Menveo™ should be used because it has been found to be safe and immunogenic</td>
</tr>
<tr>
<td><strong>Men-C-C</strong>&lt;br&gt;Meningococcal serogroup C conjugate vaccine</td>
<td>Meningitec&lt;br&gt;Menjugate&lt;br&gt;Neis Vac-C</td>
<td>One dose in second year of life (12 months)&lt;br&gt;For infants at increased risk, a dose at two, four and 12 months of age&lt;br&gt;Adolescent booster</td>
</tr>
<tr>
<td><strong>Polysaccharide A, C, Y, W-135</strong>&lt;br&gt;</td>
<td>Menomune</td>
<td>No longer useful in paediatrics</td>
</tr>
<tr>
<td><strong>4CMenB</strong>&lt;br&gt;</td>
<td>Bexsero</td>
<td>≥ 2 months of age who are at higher risk of meningococcal disease caused by serogroup B Neisseria meningitidis</td>
</tr>
</tbody>
</table>

Key Points

- Meningococcal disease is the result of a systemic bacterial infection by the gram-negative diplococcic *Neisseria meningitides*.  
- Invasive meningococcal disease (IMD) is endemic in Canada, showing periods of increased activity roughly every 10 to 15 years with no consistent pattern.  
- Meningococcal disease is primarily transmitted by respiratory droplet spread or by direct contact. Approximately 10-20% of adults and adolescents are healthy carriers of meningococcal disease and act as reservoirs for the disease.  
- Vaccine was introduced: in 1960’s and 1970’s against groups A and C meningococci. This vaccine was not effective in children less than 2 years of age. In 2006, a new conjugate vaccine against strains A, C, Y and W-135 became available.
• Peak incidence: Large epidemics occurred every 7-10 years. Between 1940 and 1943 there were more than 2600 cases per year. Since 1985, the overall incidence of IMD has remained at or below 2 per 100,000 per year.
• Meningitis is the most common presentation of invasive meningococcal disease. Septicaemia, pneumonia, arthritis, otitis media and epiglottis can also occur.
• Overall mortality is approximately 10%, and 10%-20% of survivors have long term sequelae which include hearing loss, neurologic disabilities, and digit or limb amputations.

Mumps

Causal Agent
Mumps virus is a paramyxovirus in the same group as parainfluenza and Newcastle disease virus. The virus has a single-stranded RNA genome. It has been recovered from the saliva, cerebrospinal fluid, urine, blood, milk, and infected tissues of patients with mumps.

Pathogenesis
The virus enters the body and starts to replicate in the nasopharynx and regional lymph nodes. After 12 to 25 days a viraemia occurs, which lasts from 3 to 5 days. During the viraemia, the virus spreads to multiple tissues, including the meninges, and glands such as the salivary, pancreas, testes, and ovaries. Inflammation in infected tissues leads to characteristic symptoms of parotitis and aseptic meningitis.

Clinical Note from the Canadian Immunization Guide
A single dose of mumps vaccine produces an antibody response in over 95% of susceptible individuals. However, field studies have demonstrated lower estimates of vaccine efficacy, usually around 80% with single-dose regimens. For this reason each province has implemented a 2 dose regimen.

Transmission
The virus is acquired by respiratory droplets. The spread of the mumps virus requires close and direct contact with an infected patient. Mumps is less contagious than measles or chicken pox, with only 1/3 of susceptible family members getting mumps following an illness in a child.

Signs and Symptoms
Approximately 20% of mumps infections are asymptomatic. An additional 40% to 50% may have only nonspecific or primarily respiratory symptoms.

Mumps has an incubation period of 14-18 days (range 14 to 25 days). This is followed by a prodromal stage in which patients will have nonspecific symptoms such as myalgia, malaise, headache and low-grade fever.

Inflammation of the parotid salivary gland is common in patients with mumps. The parotid gland is the largest salivary gland and is located in front of the ear behind the angle of the jaw. Parotitis may be unilateral or bilateral, and any combination of single or multiple salivary glands may be affected.
Parotitis tends to occur within the first 2 days and may first be noted as earache and tenderness.\(^7\) Symptoms tend to decrease after 1 week and usually resolve after 10 days.\(^7\)

Meningitis commonly occurs with mumps.\(^{16}\) Symptomatic meningitis (headache, stiff neck) occurs in up to 15% of patients.\(^7\) Most cases are very mild and symptoms such as headache, neck stiffness and drowsiness last only a few days.\(^{16}\) It resolves without sequelae in 3 to 10 days.\(^{16}\)

Orchitis (testicular inflammation) is the most common complication in post-pubertal males.\(^7\) It occurs in as many as 20-40% of post-pubertal males, usually after parotitis.\(^7\) It is bilateral in approximately 30% of affected males. There is usually abrupt onset of testicular swelling, tenderness, nausea, vomiting, and fever.\(^7\) Pain and swelling may subside in 1 week, but tenderness may last for weeks. Approximately 50% of patients with orchitis have some degree of testicular atrophy, but sterility is rare even when both testicles are infected.\(^7\)

Oophoritis (ovarian inflammation) occurs in 5% of post-pubertal females. It may mimic appendicitis. Patients may have painful swelling of the breasts and abdominal or pelvic pain.\(^{16}\) There is no relationship to impaired fertility.

Pancreatitis is infrequent, but occasionally occurs without parotitis; the hyperglycaemia is transient and is reversible.\(^7\) A causal relationship with mumps virus infection and has yet to be conclusively demonstrated.\(^7\)

Deafness caused by mumps virus occurs in approximately 1 per 20,000 reported cases. Hearing loss is unilateral in approximately 80% of cases. Onset is usually sudden and results in permanent hearing impairment.\(^7\)

**NACI Recommendations for Vaccine Use**\(^{32}\)

**Immunization**

**Children (12 months to 12 years of age)**

- For routine immunization of children aged 12 months to 12 years, two doses of mumps-containing vaccine (MMR or MMRV) should be administered. The first dose of mumps-containing vaccine should be administered at 12 to 15 months of age and the second dose at 18 months of age or any time thereafter, typically before school entry.
- The recommended minimum interval between doses of MMR vaccine is 4 weeks. Children who previously received a single dose of MMR vaccine should receive a second dose at least 4 weeks after the first dose. The recommended interval between 2 doses of MMRV vaccine is at least 3 months; a minimum interval of 6 weeks between doses may be used if rapid, complete protection is required.

**Adolescents (13 to 17 years of age)**

- Mumps-susceptible adolescents should receive two doses of MMR vaccine given at least 4 weeks apart.
Adults (18 years of age and older)

- Mumps-susceptible adults should receive one or two doses of MMR vaccine as appropriate for age and risk factors
- If two doses are needed, MMR vaccine is administered with a minimum interval of 4 weeks between doses.

### NACI Recommended Criteria for Immunity to Mumps

<table>
<thead>
<tr>
<th>Routine</th>
<th>Health care workers</th>
<th>Travellers to destinations outside North America</th>
<th>Students in secondary or post-secondary educational settings</th>
<th>Military personnel</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Documentation of vaccination:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Children 12 months to 17 years of age: 2 doses†</td>
<td>Documentation of vaccination with 2 doses† (regardless of year of birth)</td>
<td>Documentation of vaccination:</td>
<td>Documentation of vaccination:</td>
<td>Documentation of vaccination with 2 doses† (regardless of year of birth)</td>
</tr>
<tr>
<td>• Adults born in 1970 or later: 1 dose‡</td>
<td>OR History of laboratory confirmed infection</td>
<td>• If born in 1970 or later: 2 doses†</td>
<td>• If born in 1970 or later: 2 doses†</td>
<td>OR History of laboratory confirmed infection</td>
</tr>
<tr>
<td>• History of laboratory confirmed infection</td>
<td>OR Laboratory evidence of immunity</td>
<td>• If born before 1970: 1 dose†</td>
<td>• If born before 1970: 1 dose†</td>
<td>OR Laboratory evidence of immunity</td>
</tr>
<tr>
<td>• Laboratory evidence of immunity</td>
<td>OR Laboratory evidence of immunity</td>
<td>OR Laboratory evidence of immunity</td>
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<td>OR Laboratory evidence of immunity</td>
</tr>
<tr>
<td>• Born before 1970</td>
<td>OR Laboratory evidence of immunity</td>
<td>OR Laboratory evidence of immunity</td>
<td>OR Laboratory evidence of immunity</td>
<td>OR Laboratory evidence of immunity</td>
</tr>
</tbody>
</table>

† - Mumps-containing vaccine
Key Information Regarding the Vaccine

- Mumps vaccine effectiveness has been estimated at 62% to 91% for one dose and 76% to 95% for two doses.
- MMR and MMRV vaccines are safe and effective.
- Reactions to MMR and MMRV vaccine are generally mild and transient and include pain and redness at the injection site, low-grade fever and rash.

Key Points

- The mumps is a paramyxovirus in the same group as parainfluenza and Newcastle disease virus.
- The spread of the mumps virus requires close and direct contact with saliva of an infected patient.
- Vaccine was introduced in 1969.
- The number of mumps cases has dropped from 34,000 per year in the early 1950’s to an average of 87 cases reported annually between 2000 and 2004.
- Mumps will normally start with a prodromal phase. The prodromal symptoms are nonspecific, and include myalgia, anorexia, malaise, headache, and low-grade fever. After 1 or more days, the salivary glands become swollen and painful. The parotid gland (the largest salivary gland, located in front of the ear behind the angle of the jaw) is commonly affected. Parotitis is the most common manifestation and occurs in 30% to 40% of infected persons.
- Symptomatic meningitis occurs in up to 15% of patients and resolves without long-term sequelae in 3 to 10 days. Orchitis (testicular inflammation) is the most common complication in post-pubertal males. Deafness caused by mumps virus occurs in approximately 1 per 20,000 reported cases.
- The CDC has some useful information to use in patient consultations on the consequences if we discontinued the mumps vaccination.

Pertussis
Causal Agent

Pertussis or whooping cough is caused by acute infection with Bordetella pertussis. It is a small aerobic gram-negative bacteria. B. pertussis produces multiple antigenic and biologically active products, including pertussis toxin, filamentous haemagglutinin, agglutinogens, adenylate cyclase, pertactin, and tracheal cytotoxin. These products are responsible for the clinical features of pertussis disease and an immune response to one or more produces immunity following infection.

Pathogenesis

The bacteria attaches to the cells of the respiratory tract that have cilia. Pertussis toxin and adenylate cyclase and other toxins damage the cilia, cause inflammation of the respiratory tract and interfere with their normal function of transferring mucus from the airways to the mouth. Pertussis antigens appear to allow the organism to evade host defences and interfere with the normal function of white blood cells.
Transmission
Transmission most commonly occurs by the respiratory route through contact with respiratory droplets, or by contact with airborne droplets of respiratory secretions. Pertussis is highly contagious with an estimated 9 out of 10 susceptible close contacts developing pertussis if in contact with an infected person in the home. Transmission occurs less frequently by contact with fomites (freshly contaminated articles of an infected person).

Pertussis is most contagious during the first 2 weeks, when the patient is presenting with mild “cold-like” symptoms. Infectiousness declines rapidly but may last for up to 3 weeks. Five days after antibiotics are initiated, the patient is no longer contagious.

Signs and Symptoms
The incubation period of pertussis is commonly 7–10 days, with a range of 4–21 days. The first stage of a pertussis infection is characterized by the insidious onset of runny nose, sneezing, low-grade fever, and a mild, occasional cough, similar to the common cold. The cough gradually becomes more severe, and after 1–2 weeks, the second or paroxysmal stage begins. Fever is generally minimal throughout the course of the illness.

The next stage involves the patient’s developing bursts, or paroxysms, of numerous, rapid coughs, apparently due to difficulty expelling thick mucus from the tracheobronchial tree. At the end of the paroxysm, a long inspiratory effort causes a characteristic high-pitched whoop. During such an attack, the patient may become cyanotic (turn blue) and vomiting and exhaustion commonly follow the episode. This stage will usually last for 1 to 6 weeks but can persist for 10 weeks. The recovery is gradual with the cough becoming less common and disappearing in 2 to 3 weeks. However, paroxysms often recur with subsequent respiratory infections for many months after the onset of pertussis.

The most common complication, and the cause of most pertussis-related deaths, is secondary bacterial pneumonia. Neurologic complications such as seizures and encephalopathy may occur as a result of hypoxia (reduction of oxygen supply) from coughing, or possibly from toxin. Young infants are at highest risk for acquiring pertussis-associated complications. Other less serious complications of pertussis include otitis media, anorexia, and dehydration.

Approximately 20-30% of infants with pertussis require hospitalization and 1 in 400 hospitalized infants with pertussis die.

Practice Tool
There is a great sound clip, available online, that can be used when counselling patients.
NACI Recommendations for Vaccine Use

Infants and children (2 months to 6 years of age)

- DTaP-IPV-Hib vaccine should be given at 2, 4, 6 and 12 to 23 months of age (generally given at 18 months of age).
- If infant immunization for hepatitis B is undertaken, DTaP-HB-IPV-Hib vaccine may be used as an alternative to separately administered hepatitis B and DTaP-IPV-Hib vaccines. DTaP-HB-IPV-Hib vaccine is authorized for use in children 6 weeks to 23 months of age and may be given to children aged 24 months to less than 7 years, if necessary. DTaP-HB-IPV-Hib vaccine may be given at 2, 4, 6 and 12 to 23 months of age but the fourth dose is unlikely to provide significant additional hepatitis B protection and will increase cost; DTap-IPV-Hib vaccine provided at 12 to 23 months of age may be used to complete the primary series of DTaP-HB-IPV-Hib vaccine administered at 2, 4 and 6 months of age.
- If rapid protection is required for an infant, the first dose of DTaP-IPV-Hib or DTaP-HB-IPV-Hib vaccine can be given at 6 weeks of age. The first three doses may be administered at intervals of 4 weeks and, optimally, the fourth dose given 12 months after the third dose. The fourth dose may be given at a minimum interval of 6 months after the third dose in certain situations (e.g., travel) but must be administered on or after 12 months of age for sustained immunity.

Children < 7 years of age not immunized in infancy

- 3 doses of DTaP-IPV (with or without Hib) vaccine with an interval of 8 weeks between doses, followed by a dose of DTaP-IPV vaccine 6 to 12 months after the third dose. A booster dose of either DTaP-IPV or Tdap-IPV vaccine should be administered at 4 to 6 years of age (school entry). The booster dose at 4 to 6 years of age is not required if the fourth dose of tetanus-toxoid containing vaccine was administered after the fourth birthday.
- If rapid protection is required for a child less than 7 years of age not immunized in infancy, the first three doses of vaccine may be administered at intervals of 4 weeks and, optimally the fourth dose given 12 months after the third dose. The fourth dose may be given at a minimum interval of 6 months after the third dose in certain situations (e.g., travel).

Children who received a primary series of acellular pertussis-containing vaccine and a booster dose 6-12 months later

- A booster dose of either DTaP-IPV or Tdap-IPV vaccine at 4 to 6 years of age (school entry); and, 10 years later, a booster dose of Tdap vaccine at 14 to 16 years of age. The booster dose at 4 to 6 years of age is not required if the fourth dose of acellular pertussis-containing vaccine was administered after the fourth birthday.

Children and adolescents (7 years to 17 years of age)

- Children 7 years of age and older not previously immunized should receive three doses of Tdap-IPV vaccine with an interval of 8 weeks between the first two doses followed by a third dose.
administered 6 to 12 months after the second dose. A booster dose of Tdap vaccine should be administered 10 years after the last dose.

**Adults** (18 years of age and older)

- Adults who have not previously received Tdap vaccine in adulthood should receive one dose of Tdap vaccine, which can be administered regardless of the interval since the last dose of tetanus and diphtheria toxoid-containing vaccine.

**Booster doses and re-immunization**

- The preschool booster dose of either DTaP-IPV or Tdap-IPV vaccine should be administered at 4 to 6 years of age. Adolescents should routinely receive a booster dose of Tdap vaccine at 14 to 16 years of age. Adults who have not previously received Tdap vaccine in adulthood, should receive one dose of Tdap vaccine regardless of the interval since the last dose of tetanus or diphtheria toxoid-containing vaccine.

**Key Information Regarding the Vaccine**

- Acellular pertussis vaccine is only available as a combination vaccine.
- Acellular pertussis vaccines have an estimated effectiveness of 80% to 85% following 3 doses.
- Acellular pertussis-containing vaccines may be administered concomitantly with routine vaccines at different injection sites using separate needles and syringes.
- Adolescents and adults who have not received a booster vaccination are at risk of infection and are often the source of infection for infants.
- NACI states that immunization with Tdap to date has been shown to be safe in pregnant women and allows high levels of antibody to be transferred to newborns during the first two months of life when the morbidity and mortality from pertussis infection is the highest. All pregnant women following 26 weeks of pregnancy who have not received a dose of pertussis-containing vaccine in adulthood should be encouraged to receive Tdap vaccination. In special circumstances, such as an outbreak situation, all pregnant women who are 26 weeks gestation or greater may be offered Tdap vaccination irrespective of their immunization history.

**Key Points**

- Pertussis, or whooping cough, is an acute infectious disease caused by the bacterium *Bordetella pertussis*.
- Transmission most commonly occurs by the respiratory route through contact with respiratory droplets, or by contact with airborne droplets of respiratory secretions.
- Vaccine with whole cell pertussis began in the 1940’s and has been replaced by an acellular vaccine in 1997-98.
- Prior to immunization, between 30,000 and 50,000 cases of pertussis occurred every year in Canada with 50-100 deaths. Most deaths occurred in infants less than 12 months of age.
Symptoms of pertussis infection will normally start with a runny nose, sneezing, low-grade fever and a mild and occasional cough similar to a common cold. The next phase is the paroxysmal stage where the patient has bursts, or paroxysms, of numerous, rapid coughs, apparently due to difficulty expelling thick mucus from the tracheobronchial tree. At the end of the paroxysm, a long inspiratory effort is usually accompanied by a characteristic high-pitched whoop.

The most common complication, and the cause of most pertussis-related deaths, is secondary bacterial pneumonia. Approximately 20-30% of infants with pertussis require hospitalization and 1 in 400 hospitalized infants with pertussis die.

The CDC has some useful information to use in patient consultations on the consequences of if we discontinued the pertussis vaccination.

Post-Test

When Taylor W. (23 yo) is in to see you today you mention that he should consider the influenza vaccine. Taylor doesn’t bother as he is young and is trying to minimize the amount of foreign chemicals in his body. You feel there are some education gaps regarding influenza and the vaccine and start to discuss it.

1. You start by providing him some general information on the vaccine. Which of the following statements is TRUE?
   a. The virus is transmitted to other people by the inhalation of infected droplets
   b. High fever is uncommon in most patients with the flu
   c. The myalgia, headache and exhaustion are due to a direct effect of the virus
   d. Only trivalent influenza vaccine (TIV) is recommended in children 6-23 months

2. You assess Taylor to see if he is a patient that is a high risk of influenza complications. Which of the following groups is at high risk of influenza complications?
   a. Children 60-84 months
   b. Overweight patients
   c. Those providing care to children ≤ 59 months of age
   d. Healthy pregnant women

Betty (33 yo) is travelling to rural China. She was advised to receive the Japanese encephalitis vaccine and would like to know more about it.

3. You start by providing some basic education regarding the Japanese encephalitis. Which of the following statements is TRUE?
   a. Betty’s risk of being infected by the Japanese encephalitis virus is approximately 2 in 100 travellers
   b. The length of Betty’s trip will have a major impact on her risk of coming into contact with the Japanese encephalitis virus
   c. Transmission will normally occur year round
   d. Most patients develop a severe clinical symptomatic disease
4. You discuss the Japanese encephalitis vaccine with Betty. Which of the following statements is TRUE?
   a. It is highly effective at reducing the risk of Japanese encephalitis
   b. It requires one dose prior to travel and a booster at 1 year
   c. The vaccine is recommended for most travellers to Asia
   d. The most common adverse effects from the vaccine are injection site tenderness, redness and hardening, headache, myalgia and fatigue.

   **Joan W. is in with her 1 year old son to receive his Measles-Mumps and Rubella (MMR) injection. She is a bit nervous about giving this vaccine to her son. You decide it would be a good time to review Measles and Mumps.**

5. You start by discussing Measles. Which of the following statements is TRUE?
   a. Measles is a highly infective bacteria
   b. Transmission primarily occurs through the fecal-oral route
   c. Bacterial pneumonia occurs in 1-6% of cases
   d. Approximately 5 in 1000 cases require hospitalization

6. You move the discussion to mumps. Which of the following statements is TRUE?
   a. Mumps is just as contagious as measles
   b. Approximately 20% of cases are asymptomatic
   c. Sterility is common in males that develop orchitis (testicular inflammation)
   d. Pancreatitis is a common complication of mumps

7. You start discussing the MMR vaccine. Which of the following is the standard immunization regimen for a child?
   a. One dose at 6 months and another dose at 1 year
   b. One dose at 12 months
   c. One dose at 1 year and another before the 17th year
   d. Three doses at 1 year, 2 years and 5 years

   **Nathan A. is in to discuss a recent meningococcal disease outbreak in a community in Canada. He is concerned and wants to protect his daughter from this horrific disease.**

8. You start by providing him some background on meningococcal disease. Which of the following statements is TRUE?
   a. The polysaccharide capsule is used for the classification of meningococci
   b. There are only 5 serogroups of meningococcus
   c. The most common serogroup of meningococcus that causes invasive meningococcal disease is type D
   d. The prevalence of each serogroup is approximately the same in all regions of the world
9. Nathan was reading online that his daughter should receive a meningococcal conjugated quadrivalent vaccine. Antigens for which one of the following serogroups is NOT included in this vaccine?
   a. A  
   b. B  
   c. C  
   d. Y

10. While discussing the meningococcal vaccine with Nathan, you check on his tetanus-diphtheria and acellular pertussis vaccine status. Which of the following statements is TRUE?
   a. Pertussis is not overly infectious  
   b. Complications of pertussis are most common in the elderly  
   c. Adults should receive one dose of acellular pertussis vaccine in adulthood  
   d. Ideally a patient should receive only acellular pertussis vaccine without any other antigens

Discussion Forum
- Have you seen any vaccine preventable diseases in your practice? If you have, can you share the details with your colleagues (i.e. presenting symptoms, immunization status, and outcomes)?
References


