Public Health Agency of Canada | Agence de la santé publique du Canada

Canada

Themed Edition – Back to school vaccination

Vaccine Confidence InfoBulletin

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Providing credible and timely information on vaccines to health care providers and public health decision makers to support vaccine confidence. Thank you for being a trusted source of vaccine information for individuals and communities across Canada.

In this issue

Trending topics

Meningococcal outbreaks in Florida

The state of Florida is experiencing one of the worst outbreaks of meningococcal disease in US history. The outbreak of meningococcal serogroup C appears to be concentrated amongst men who have sex with men. As of June 2022, the Centers for Disease Control and Prevention (CDC) reported 24 cases and 6 deaths associated with the outbreak [1].

Meningococcal disease is a bacterial infection caused by *Neisseria meningitidis* that can cause meningitis or sepsis. It progresses rapidly and is extremely serious with a high fatality rate [2]. Meningococcal serogroup C infection can be prevented with a monovalent conjugate C meningococcal (Men-C-C) vaccine and a quadrivalent conjugate meningococcal (Men-C-ACYW) vaccine [3].

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...Trending topics continued

Florida is also reporting a cluster of cases of meningococcal serogroup B among college and university students in Leon County [1]. Meningococcal serogroup B infection can be prevented with a MenB vaccine [4]. There are two serogroup B meningococcal vaccines currently authorized for use in Canada (MenB-fHBP and 4CMenB) [5].

For more information visit the Canada.ca webpage Invasive meningococcal disease.

Case of polio confirmed in New York State

On July 21st, 2022, the New York State Department of Health and the Rockland County Department of Health announced that a case of polio had been confirmed in an adult male in New York State. The person is a member of a religious group that discourages vaccination. The viral strain was vaccine-derived poliovirus type 2 (VDPV2), which is a strain of the Sabin type 2 virus (the polio virus found in live attenuated oral polio vaccines (OPVs)) which has mutated to behave more like wild poliovirus. This mutation includes being capable of causing poliomyelitis. Approximately 1% of polio infections result in some degree of poliomyelitis which appears clinically as acute flaccid paralysis [6].

Individuals who receive OPVs can shed the virus in their stool, and it can be transmitted between unvaccinated persons and vaccinated persons. The vaccinated persons can become infected and shed the virus but are protected against poliomyelitis. To prevent the risk of vaccine-derived poliovirus and vaccine-associated poliomyelitis, the OPV was replaced with an inactivated poliomyelitis vaccine (IPV) in Canada in 1995/1996 and continues to be used to date [7], [8]. Many other countries, including the United States (US), have also discontinued the use of OPV in favour of IPV. However, the individual in the New York State case is unvaccinated and reported no history of international travel, suggesting that the virus may have been transmitted amongst this community in the US. The case experienced respiratory symptoms followed by acute flaccid weakness in his lower limbs. He was admitted to hospital for treatment on June 21st.

Public health officials are conducting a case investigation and surveillance for possible other cases, as well as conducting vaccination campaigns to target unvaccinated or under vaccinated individuals and potentially exposed individuals.

While the general risk to the Canadian public from polio remains low, this example underscores the importance of continued vaccination, even for rare vaccine preventable diseases [2], [4]. PHAC is working closely with the US CDC and provinces and territories to closely examine and monitor the situation to inform risk assessment and any public health actions in Canada.

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Featured article

Impact of COVID-19 on routine childhood vaccinations

The COVID-19 pandemic has had a negative effect on access to routine vaccinations globally. The World Health Organization (WHO) estimates that 23 million children missed their routine vaccines in 2020, an additional 3.7 million compared to 2019 [9]. Disruption of routine vaccinations is of concern because of the increased risk of vaccine-preventable disease outbreaks. For example, the 2013-2014 Ebola outbreak in Liberia lead to a decrease in measles vaccinations which resulted in a six-fold increase in measles cases across the country [10].

"COVID-19 pandemic fuels largest continued backslide in vaccinations in three decades"
Read the WHO's July 15th news release on the status of global routine childhood vaccinations.

While both the WHO and the National Advisory Committee on Immunization (NACI) have provided guidance on the continuity of immunization programs during the COVID-19 pandemic [11], various factors have resulted in a reduction in global childhood immunization coverage. This includes the diversion of health care resources from routine immunization to mitigating COVID-19 outbreaks, personal protective measures (e.g., social distancing practices, school closures), the cancellation of immunization appointments by health care providers, and parental vaccine hesitancy [12], [13].

As the new school year approaches, catch-up of routine vaccinations for school-aged children needs to be a priority. Measles is of particular concern because a reduction of even 2-5% in vaccine uptake can have a significant impact on potential measles outbreaks, for which a substantial uptick has already been noted around the world recently [14]. Furthermore, while achieving community immunity for measles requires a vaccination rate of 95% [13], Canada had a national measles vaccination rate of 90% prior to the COVID-19 pandemic [11]. It is important to maintain vaccination status to reduce the spread of vaccine preventable diseases.

Catch-up efforts in Canada

Catch-up efforts for missed routine vaccinations have been ongoing across Canada for infants and young children. For example, combined efforts from the Quebec Immunization Committee and public health units across Quebec have resulted in the successful increase of children under the age of 2 receiving routine vaccinations, reaching only 2% difference in the cumulative proportion of immunized children compared to 2019 [12].

It is equally important to continue these efforts by prioritizing catch-up clinics for youth and adolescents who have also experienced gaps in vaccination during the COVID-19 pandemic. In Ontario, the city of Toronto estimates that 73,000 grade 7 to 12 students are behind at least one dose of Hepatitis B, Human Papillomavirus and Meningococcal vaccines [15]. Another 13,710 students in the Windsor-Essex County Health Unit are in similar position [16]. Consequently, this gap in routine vaccinations has

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put students at both an increased risk of vaccine-preventable diseases and of being suspended for the upcoming school year [15].

Priority strategies for vaccine catch-up include the use of clear messaging on the importance of routine vaccinations to address vaccine hesitancy and misinformation, utilizing evidence-informed approaches to make the vaccination experience positive [17], and prioritizing equitable access to healthcare for low-income and marginalized communities [18].

Health care providers can facilitate vaccine catch-up by:

- **proactively engaging in thoughtful discussions about the vaccination status of** clients of all ages at each appointment, including for routine vaccines, COVID-19 vaccines, and influenza;
- **encouraging clients to maintain their immunization records** via the CANImmunize application;
- **regularly reviewing:**
  - the provincial and territorial routine and catch-up vaccination schedule for infants and children in Canada; and
  - provincial and territorial routine vaccination programs for healthy, previously immunized adults;
- **using and referring to** CARD™ (C - Comfort, A - Ask, R - Relax, D - Distract), an evidence-based system that teaches how to prepare and improve the vaccination experience; and
- **sharing with clients where to find information on routine and catch-up immunization clinics** put on by the local public health authority [19].

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Vaccine confidence corner

Providing evidence-informed tips, strategies and information in support of vaccine confidence.

Evidence-informed strategies for building vaccine confidence among caregivers of children

The COVID-19 pandemic has brought a great deal of attention to the public health concern of vaccine hesitancy amongst families and caregivers of children [20]. Varying trust in the effectiveness of vaccines, increasing complacency for the risk of vaccine-preventable diseases to children, ongoing experiences of systemic racism, and negative interactions with the healthcare system are only a handful of the many factors contributing to vaccine hesitancy across Canada [21].

While 42% of children between the ages of 5 and 11 in Canada have completed their COVID-19 primary series [22], vaccine hesitancy continues to be a barrier in parental intentions to vaccinate their children [23], [24], [25], with 80% of parents of unvaccinated children aged 5 to 11 indicating their intention not to vaccinate them [26]. Although the impact of both COVID-19 and high vaccine hesitancy on routine childhood immunization is not yet known, health care providers should be prepared to have effective, compassionate conversations with their patients and caregivers.

Evidence continues to demonstrate that health care providers are trusted sources of vaccine information [27] and as such, they are in a unique position to discuss vaccination and build vaccine confidence during each patient-provider interaction. Thus, health care providers should be ready to come back to the conversation, over the course of multiple visits, with patience and empathy [21], [26].

Below are some evidence-informed strategies for building vaccine confidence among caregivers of children during one-to-one conversations [21], [28].

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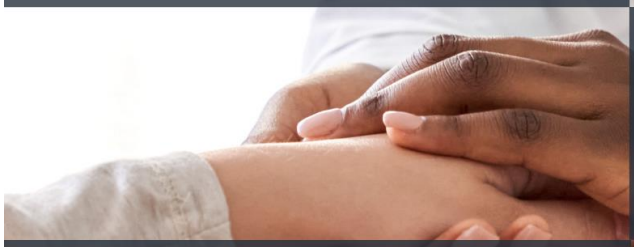
Conversations about COVID-19 pediatric vaccines

Evidence-informed strategies for building vaccine confidence among caregivers of children [21].

1. Presume

Use presumptive statements that convey the social norm of vaccination and the expectation that patients will vaccinate. For example, " I will set some time aside for [child's name] COVID-19 vaccination during your appointment next week" [21].

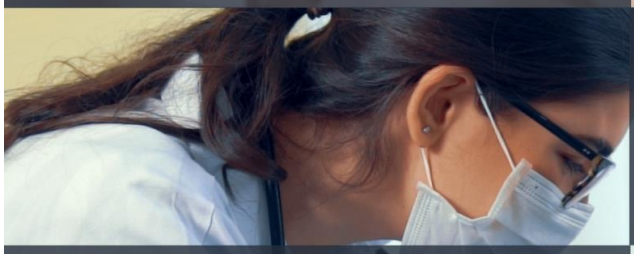


2. Cultivate Safety

Cultivating a "safe space" for vaccination discussions accounts for individuals' distinct worldviews and helps built trust. Strategies include engaging in active listening, learning about patients' experiences with vaccination, and using accessible language [21].

3. Open Up

As a trusted source of health information, your expressions of vaccine confidence can build vaccine confidence in your patients. Leverage the power of storytelling by sharing your own experiences in getting vaccinated [21].



4. Managing Pain

Improve the vaccination experience by preparing for vaccination, managing needle fear and anxiety, and reducing stress-related reactions with the CARD™ evidence-based framework (Comfort, Ask, Relax, Distract) [28].

5. Be Transparent

Transparency is key in building trust, particularly in the current era of widespread mis/disinformation. Discussing vaccination using a positive frame is more likely to inspire vaccine confidence as research shows that fear can disempower and immobilize us [21].

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For more evidence-informed strategies for building vaccine confidence among caregivers of children:

- Visit the Strategies for building vaccine confidence section of the Canada.ca webpage Addressing vaccine hesitancy in the context of COVID-19: A primer for health care providers.
- Watch the National Collaborating Centre for Infectious Diseases (NCCID) webinar Conversations about pediatric vaccines in the context of COVID-19.
    - In this 60 minute webinar, Dr. Cora Constantinescu and Dr. Olivier Drouin discuss the challenges to vaccine confidence for caregivers of children (17 years and younger), identify strategies for building vaccine confidence among caregivers of children, and discuss the ways in which behavioral science can inform conversations on pediatric vaccines with caregivers of children.

Mis/disinformation monitor alert

Presenting credible sources to debunk mis and disinformation.

Human papillomavirus (HPV) vaccination misinformation

Misinformation is information that is false or misleading, but presented as fact, regardless of intention.

Disinformation is information which is intentionally created and circulated to deceive or mislead.

As HPV is estimated to be one of the most common sexually transmitted infections (STIs) in Canada and worldwide, and often presents without any noticeable symptoms [29]. Immunization against HPV has been an instrumental approach across the world to protect individuals against the most common high-risk HPV types that cause 70% of all cervical cancers and 90% of anogenital warts [30]. Despite the high efficacy and safety profile of current HPV vaccines [31], [32], misinformation and disinformation have adversely impacted HPV immunization coverage across the world by increasing hesitancy, delay, refusal of individuals to accept the HPV vaccine and reluctance on behalf of some governments to recommend it [33], [34], [35].

The HPV vaccine controversy in Japan is a notable example of the detrimental impacts of misinformation on public health. In April 2013, the Ministry of Health, Labor and Welfare of Japan integrated HPV vaccination into the country's national immunization program and began to recommend HPV vaccines to the public with an initial vaccination coverage success rate reaching over 70% of the eligible population. However, reports of a small amount of alleged adverse events claimed to be caused by HPV vaccination emerged and circulated widely across media outlets in Japan [36]. Reported adverse events included complex regional pain syndrome (CRPS) (i.e., a post-traumatic neuropathic syndrome characterized by regional pain, sensory changes, abnormal skin colour and temperature, and

edema) [37] and motor dysfunction. This led to the formation of the Nationwide Cervical Cancer Vaccine Victim Liaison Committee made up of individuals who claimed suffering from serious damage as a result of HPV vaccines [36]. Consequently, the intensity in media coverage of these alleged events resulted in the Ministry of Health, Labour, and Welfare's Vaccine Adverse Reactions Review Committee to suspend the recommendation for HPV vaccination just two months after its implementation, leading to a dramatic drop in the vaccination coverage rate to less than 1% [38].

Recent modeling has estimated that the suspension resulted in an additional 27,300 HPV cases and up to 5,700 deaths since 2013 [39]. The Ministry of Health, Labour, and Welfare's Vaccine Adverse Reactions Review Committee reinstated the recommendation for HPV vaccination for girls aged 12 to 16 on April 1, 2022 [40]. This was years after the WHO Global Advisory Committee on Vaccine Safety conducted a comprehensive systematic review of serious adverse events following HPV vaccines in 2017 and concluded that there was no epidemiologic evidence to suggest a causal association between the HPV vaccine and reported adverse events following immunization (AEFI) [39].

It is important to note that an AEFI can be the result of reactions to vaccine ingredients, but they may also be the result of concurrent illnesses or conditions, medications taken, anxiety-related reactions, or coincidence [41]. The WHO defines an AEFI as "any untoward medical occurrence which follows immunization, and which **does not necessarily have a causal relationship** with the usage of the vaccine. The adverse event may be an unfavorable or unintended sign, abnormal laboratory finding, symptom or disease" [41, pp. 39-41]. Because AEFI reporting is generally poorly understood by the public [42], anti-vaccination groups frequently leverage this to control the vaccine narrative and deter vaccination [43]. Mis/disinformation regarding HPV vaccination in the media has played a leading role contributing to HPV vaccine hesitancy across the world [44].

Science spotlight

Providing explanations of the science underpinning vaccine guidance and public health response.

Measles infection and the immune system

Prior to widespread vaccination, which began in the 1960s, there were an average of 300,000 to 400,000 cases of measles per year in Canada [45]. Over the past eight years, that number has ranged from 196 cases in 2015 to 0 cases in 2021 [46]. It is therefore unlikely for most in Canada to know someone who has contracted measles in recent memory, and as such, many people may not have a tangible grasp on the consequences of measles infection. With ongoing measles outbreaks around the world [13], it is important for health care providers and public health professionals to understand the sequelae of measles infection and keep vaccination rates high. Furthermore, as measles is considered one of the most highly communicable infectious diseases, with greater than 90% secondary attack rates among susceptible persons, any unvaccinated individual is at risk when measles circulates [47].

Immunosuppression due to measles is a well-established phenomenon. It was first noted in the 19th century when it was discovered that tuberculin responses were supressed during and following measles infections in tuberculosis-positive patients [48]. It is now understood that most deaths related to measles are actually caused by the opportunistic infections that take hold due to measles-induced immune suppression [49] . While immune suppression during active infection has been a known phenomenon for some time, recent research has demonstrated that the impacts of measles infection on the immune system extend far beyond the acute infection [50].

The unique interaction between the measles virus and the immune system, paradoxically, provides excellent lifelong protection against measles infection while impairing overall immune function in both the short and long term. Dendritic cells are important immune cells that act as messengers between the innate and adaptive immune systems. When pathogens come into contact with the body, dendritic cells present antigens on their cell surface and migrate to the lymph nodes where they interact with T and B lymphocytes, which initiate the adaptive immune response [48]. Measles virus infects dendritic cells and impairs their ability to present non-measles antigens to stimulate lymphocyte activity and create an immune response. Additionally, when the infected dendritic cells migrate to the lymph nodes, lymphocytes become infected with the measles virus as well. Measles-infected dendritic cells do, however, present measles virus antigens, so while the immune response to other pathogens is blunted during infection, the immune system establishes strong and durable protection against measles as a result of infection [48].

Measles-induced immune amnesia

Not only does measles infection impair immune function during infection, but recent research demonstrates that the virus preferentially infects memory T and B cells [50], [51]. The only way to clear the infection is by destroying infected cells, potentially wiping out an individual's immune memory [51]. Lymphocyte levels drop dramatically during infection and then recover, however the new lymphocytes carry only the memory of the measles virus [51]. This leaves individuals with a naïve immune system and the need to restore previously established immunity. This is referred to as measles-induced immune amnesia.

Measles vaccination is a highly effective way to prevent measles infection, also protecting individuals against the serious consequences of measles on their immune system [52]. As measles is less and less familiar to the general population in Canada due to widespread vaccination, it is important to provide reminders of the salience of measles as an ongoing public health threat and encourage measles vaccination.

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In the clinic

Providing current recommendations, resources and vaccination best practices for immunizers.

Updated guidance on concurrent administration of COVID-19 vaccines and other vaccines for children 5 to 11 years of age

On June 21, 2022, PHAC released updated guidance on concurrent administration of COVID-19 vaccines with other vaccines in the COVID-19 vaccine chapter of the Canadian Immunization Guide (CIG). This guidance is based on the current evidence and NACI's expert opinion.

Previously, during early COVID-19 vaccine rollout in children 5 to 11 years of age, NACI advised that it was beneficial to refrain from concurrent administration of COVID-19 vaccines with non-COVID-19 vaccines in order to be able to more accurately monitor potential rare and very rare adverse events of COVID-19 vaccines in this age group. After reviewing the published literature and Canadian surveillance data, NACI now recommends that for most individuals 5 years of age and older, COVID-19 vaccines may be given concurrently with (i.e., same day), or at any time before or after, non-COVID-19 vaccines (including live and non-live vaccines). However, NACI recommends that the newly authorized Moderna Spikevax™ COVID-19 vaccine (25 mcg) for those 6 months to 5 years of age, should not routinely be given concurrently with other vaccines, to allow for surveillance of potential rare and very rare adverse events in this population.

If more than one type of vaccine is administered at a single visit, they should be administered at different injection sites using separate injection equipment.

Informed consent should include a discussion of the benefits and risks given the limited data available on administration of COVID-19 vaccines at the same time as, or shortly before or after, other vaccines.

There is currently limited data available on whether the reactogenicity of COVID-19 vaccines is increased with concurrent administration of other vaccines. No specific safety concerns have been identified to date. Studies to assess the safety and immunogenicity of concurrent administration of COVID-19 vaccines with other vaccines are ongoing.

For more information, consult the COVID-19 vaccine chapter of the CIG. Refer to Timing of vaccine administration in Part 1 of the CIG for additional general information on concurrent administration of other vaccines.

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PHAC COVID-19 Vaccination Tool Kit for Health Care Providers

Download the 3rd edition of the PHAC COVID-19 Vaccination Tool Kit for Health Care Providers.

This tool kit is designed to provide a simple, one-stop destination to locate evidence-informed resources to support constructive dialogue about COVID-19 vaccines authorized for use in Canada.

Within the updated tool kit you will find:

- ✓ Links to the latest guidance on vaccines and boosters
- ✓ Resources to address vaccine hesitancy
- ✓ Information on authorized COVID-19 vaccines and vaccine safety
- ✓ Information sheets, consent forms and aftercare sheets
- ✓ Guidance on vaccination pain and fear of needles
- ✓ Webinars for health care providers on COVID-19 vaccines and vaccine hesitancy
- ✓ Videos, digital tools, social media “shareables” and more!

Community spotlight

Putting the spotlight on innovative projects and best practices from communities across Canada.

Ontario Physical Health Education Association (Ophea) - Vaccination Talks Toolkit

Developed by Ophea, with support from the PHAC Immunization Partnership Fund (IPF), the Vaccination Talks Toolkit is a free online resource for educators that integrates health literacy and media literacy to support children and youth in developing critical inquiry related to vaccination.

Parents and caregivers identify educators as one of the most trusted sources of health information for their children, yet schools are often overlooked as impactful spaces to influence population-level health interventions. With this in mind, Ophea has developed the Vaccination Talks Toolkit. The toolkit contains evidence-informed, curriculum-connected activity plans for students in grades 1-8, tools to support educators with connecting activity plans to curriculum, practical strategies for consideration when talking about vaccines with students and a database of health literacy resources.

Do you know an educator? Encourage them to visit the Vaccination Talks Toolkit to learn more.

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PHAC webinars and webcasts for health care providers

PHAC, in collaboration with the Canadian Vaccination Evidence Resource and Exchange Centre (CANVax) and the National Collaborating Centre for Infectious Diseases (NCCID), offers expert-led webinars and webcasts focused on providing health care providers with clinical guidance and information related to key vaccine topics.

Webcasts are video resources.

Webinars are live events, with an audience and question & answer period. These live events are recorded and later posted for viewing.

Webcast - Needle fear, pain and vaccines: Introduction to the CARD™ system as a framework for vaccination delivery (18 mins)

Experts Dr. Anna Taddio and Dr. Meghan McMurtry discuss contributors to stress-related reactions during vaccination and evidence-based strategies to improve the vaccine experience for people receiving vaccines and those who support them.

Contact Vaccine Confidence

Subscribe to receive the PHAC Vaccine Confidence InfoBulletin directly in your inbox. To explore past issues, see archived issues on the CANVax website.

Have questions or feedback to share? Email us: vaccination@phac-aspc.gc.ca

Please note that any medical questions should be directed to your local health care provider and any urgent medical questions should be directed to 911 or your local emergency department.

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Annex

What's new from NACI?

Recommendations on the use of Moderna Spikevax™ COVID-19 vaccine in children 6 months to 5 years of age

On July 14, 2022, NACI made recommendations on the use of Moderna's 6 months to 5 years of age COVID-19 vaccine. Summary of recommendations include:

- A primary series of two doses of Moderna Spikevax™ (25 mcg) COVID-19 vaccine may be offered to children 6 months to 5 years of age, 8 weeks apart.
- A primary series of three doses of Moderna Spikevax™ (25 mcg) COVID-19 vaccine may be offered to children 6 months to 5 years of age who are moderately to severely immunocompromised, 4 to 8 weeks apart.
- At this time, Moderna Spikevax™ (25 mcg) COVID-19 vaccine should not routinely be given concurrently (i.e., same day) with other vaccines.

Consult the NACI statement to read the full guidance and the NACI summary statement for a short overview.

Interim guidance on planning considerations for a Fall 2022 COVID-19 vaccine booster program in Canada

On June 29, 2022, PHAC released interim guidance from NACI on planning considerations for a Fall 2022 COVID-19 vaccine booster program in Canada. This guidance is based on current evidence and NACI's expert opinion. It will help provinces and territories plan Fall booster dose programs in their jurisdictions to help increase protection against COVID-19 in advance of a possible future wave.

Consult the NACI statement to read the full guidance and the NACI summary statement for a short overview.

Guidance on the use of Evusheld™ (AstraZeneca) in the context of COVID-19 vaccination

On June 21, 2022, guidance on the use of Evusheld™ (AstraZeneca) in the context of COVID-19 vaccination was added to the COVID-19 vaccine chapter in the CIG. Evusheld™ (AstraZeneca) is currently the only anti-SARS-CoV-2 monoclonal antibody authorized in Canada for prophylaxis against COVID-19.

NACI was asked to provide guidance on a recommended interval between the use of Evusheld™ and COVID-19 vaccination. NACI reviewed the limited literature available on the use of Evusheld™ in the context of COVID-19 vaccination and sought information from the manufacturer on this issue.

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To read the guidance, consult the Blood products, human immunoglobulin and timing of immunization section of the COVID-19 vaccine chapter of the CIG. Additionally, a summary of the updates in the CIG from June 21, 2022 can be found here.

Statement on the seasonal influenza vaccine for 2022–2023

On June 8, 2022, the CIG chapter on influenza and statement on seasonal influenza vaccine for 2022-2023 was published and is now available online.

New and/or updated information from the 2022–2023 statement includes:

- guidance on the use of seasonal influenza vaccine in the presence COVID-19;
- guidance on concomitant administration of influenza and COVID-19 vaccines;
- inclusion of recombinant quadrivalent seasonal influenza vaccine; and
- updated recommendations on mammalian cell culture-based quadrivalent influenza vaccine.

To read the guidance, consult the CIG chapter on influenza and statement on seasonal influenza vaccine for 2022-2023.

Recommended use of palivizumab to reduce complications of RSV infection in infants

On June 1, 2022, NACI made recommendations for public health program level decision-making on the recommended use of monoclonal antibody preparation palivizumab (PVZ) to reduce complications of respiratory syncytial virus (RSV) in infants.

The purpose of this guidance is to update previous NACI recommendations for the use of PVZ, taking into consideration recent data on:

- the burden of illness due to RSV disease;
- the efficacy and effectiveness of PVZ in infants at risk of more severe RSV disease; and
- the economic implications of PVZ use.

Consult the NACI statement to read the full guidance.

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References

[1] Centers for Disease Control and Prevention (CDC), "CDC Assists with Meningococcal Disease Outbreak Investigation in Florida," U.S. Department of Health & Human Services, 22 6 2022. [Online]. Available: https://www.cdc.gov/media/releases/2022/p0622-Meningococcal-Outbreak.html. [Accessed 28 6 2022].

[2] Centers for Disease Control and Prevention (CDC), "Menongococcal Disease: Clinical Information," U.S. Department of Health & Human Services, 7 2 2022. [Online]. Available: https://www.cdc.gov/meningococcal/clinical-info.html. [Accessed 28 6 2022].

[3] Public Health Agency of Canada (PHAC), "Meningococcal vaccine: Canadian Immunization Guide," Government of Canada, 23 9 2021. [Online]. Available: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-13-meningococcal-vaccine.html. [Accessed 30 6 2022].

[4] Centers for Disease Control and Prevention, "About Meningococcal Vaccines," U.S. Department of Health & Human Services, 12 10 2021. [Online]. Available: https://www.cdc.gov/vaccines/vpd/mening/hcp/about-vaccine.html. [Accessed 28 6 2022].

[5] National Advisory Committee on Immunization (NACI), "The Use of Bivalent Factor H Binding Protein Meningococcal Serogroup B (MenB-fHBP) Vaccine for the Prevention of Meningococcal B Disease," Public Health Agency of Canada (PHAC), 24 12 2019. [Online]. Available: https://www.canada.ca/en/public-health/services/publications/vaccines-immunization/bivalent-factor-h-binding-protein-meningococcal-serogroup-b-prevention-meningococcal-b-disease.html. [Accessed 30 6 2022].

[6] Centers for Disease Control and Prevention (CDC), "Epidemiology and Prevention of Vaccine Preventable Diseases: Poliomyelitis," 18 August 2021. [Online]. Available: https://www.cdc.gov/vaccines/pubs/pinkbook/polio.html. [Accessed 28 July 2022].

[7] Public Health Agency of Canada (PHAC), "Poliomyelitis vaccine: Canadian Immunization Guide:," Government of Canada, 23 September 2021. [Online]. Available: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-17-poliomyelitis-vaccine.html. [Accessed 28 June 2022].

[8] Polio Eradication , "OPV Cessation," [Online]. Available: https://polioeradication.org/polio-today/preparing-for-a-polio-free-world/opv-cessation/.

[9] A. Shet, K. Carr, M. C. Danovaro-Holliday, S. V. Sodha, C. Prosperi, J. Wunderlick, C. Wonodi, H. W. Reynolds, I. Mirza, M. Gacic-Dobo, K. L. O'Brien and A. Lindstrand, "Impact of the SARS-CoV-2 pandemic on routine immunisation services: evidence of disruption and recovery from 170 countries and territories," *The Lancet,* vol. 10, no. 2, pp. 1-9, 2022.

[10] C. S. Wesseh, R. Najjemba, J. K. Edwards, P. Owiti, H. Tweya and P. Bhat, "Did the Ebola outbreak disrupt immunisation services? A case study from Liberia," *Public Health Action,* vol. 7, no. 1, pp. 82-87, 2017.

[11] N. MacDonald, E. Dubé and L. M. Bucci, "COVID-19: Potential Impact on Vaccine-Preventable Diseases in Canada," CANVAx, 19 5 2020. [Online]. Available: https://canvax.ca/brief/covid-19-potential-impact-vaccine-preventable-diseases-canada. [Accessed 21 6 2022].

[12] M. Kiely, T. Mansour, N. Brousseau, E. Rafferty, Y. R. Paudel, M. Sadarangani, L. W. Svenson, J. L. Robinson, A. Gagneur, S. M. Driedger and S. E. MacDonald, "COVID-19 pandemic impact on childhood vaccination coverage in Quebec, Canada," *Human Vaccines & Immunotherapeutics,* vol. 18, no. 1, pp. 1-9, 2021.

[13] The World Health Organization, "UNICEF and WHO warn of perfect storm of conditions for measles outbreaks, affecting children," 27 4 2022. [Online]. Available: https://www.who.int/news/item/27-04-2022-unicef-and-who-warn-of--perfect-storm--of-conditions-for-measles-outbreaks--affecting-children. [Accessed 21 6 2022].

[14] V. K. Phadke, R. A. Bednarczyk and S. B. Omer, "Vaccine Refusal and Measles Outbreaks in the US," *JAMA,* vol. 324, no. 13, pp. 1344-1345, 2020.

[15] P. Loriggio, "Thousands of Ontario students behind on vaccines usually administered in schools," CBC, 5 4 2022. [Online]. Available: https://www.cbc.ca/news/canada/toronto/ont-students-vaccines-1.6409216. [Accessed 21 6 2022].

[16] D. Chen, "Half of local high school students need updated shots, says health unit," Windsor Star, 2 6 2022. [Online]. Available: https://windsorstar.com/news/local-news/thousands-of-windsor-essex-high-school-students-need-to-update-immunizations-says-health-unit. [Accessed 21 6 2022].

[17] N. E. MacDonald, J. L. Comeau and L. M. Bucci, "COVID-19 and missed routine immunizations: designing for effective catch-up in Canada," *Canadian Journal of Public Health,* vol. 111, pp. 469-472, 2020.

[18] C. Ji, P. Piché-Renaud, J. Apajee, E. Stephenson, M. Forte, J. N. Friedman, M. Science, S. Zlotkin, S. Morris and K. Tu, "Impact of the COVID-19 pandemic on routine immunization coverage in children under 2 years old in Ontario, Canada: A retrospective cohort study," *Vaccine,* vol. 40, no. 12, pp. 1790-1798, 2022.

[19] "Leave no one behind : guidance for planning and implementing catch-up vaccination," The World Health Organization, 1 April 2021. [Online]. Available: https://www.who.int/publications/i/item/leave-no-one-behind-guidance-for-planning-and-implementing-catch-up-vaccination. [Accessed 6 July 2022].

[20] E. Dubé, D. Gagnon, M. Ouakki, J. A. Bettinger, H. O. Witteman, S. MacDonald, W. Fisher, V. Saini and D. Greyson, "Measuring vaccine acceptance among Canadian parents: A survey of the Canadian Immunization Research Network," *Vaccine,* vol. 36, no. 4, pp. 545-552, 2018.

[21] Public Health Agency of Canada, "Addressing vaccine hesitancy in the context of COVID-19: A primer for health care providers," Government of Canada, 7 5 2021. [Online]. Available: https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/health-professionals/vaccines/vaccine-hesitancy-primer.html. [Accessed 24 6 2022].

[22] Public Health Agency of Canada, "Canadian COVID-19 vaccination coverage report," Government of Canada, 13 5 2022. [Online]. Available: https://health-infobase.canada.ca/covid-19/vaccination-coverage/archive/2022-06-17/. [Accessed 24 6 2022].

[23] B. McKinnon, C. Quach, È. Dubé, C. T. Nguyen and K. Zinszer, "Social inequalities in COVID-19 vaccine acceptance and uptake for children and adolescents in Montreal, Canada," *Vaccine,* vol. 39, no. 49, pp. 7140-7145, 2021.

[24] R. M. Humble, H. Sell, E. Dubé, N. E. MacDonald, J. Robinson, S. M. Driedger, M. Sadarangani, S. B. Meyer, S. Wilson, K. M. Benzies, Lemaire-Paquette, Samuel and S. E. MacDonald, "Canadian parents' perceptions of COVID-19 vaccination and intention to vaccinate their children: Results from a cross-sectional national survey," *Vaccine,* vol. 39, no. 52, pp. 7669-7676, 2021.

[25] Public Health Agency of Canada, "COVID-19 vaccine uptake and intent: Canadian Community Health Survey (CCHS) insight," Government of Canada, 7 6 2022. [Online]. Available: https://www.canada.ca/en/public-health/services/publications/vaccines-immunization/covid-19-vaccine-uptake-intent-canadian-community-health-survey.html. [Accessed 24 6 2022].

[26] Impact Canada, "Wave 2.1: COSMO Canada," Government of Canada, 2022. [Online]. Available: https://impact.canada.ca/en/cosmo-canada/Wave-2_1. [Accessed 24 6 2022].

[27] J. Greenberg, E. Dubé and M. Driedger, "Vaccine Hesitancy: In Search of the Risk Communication Comfort Zone," *PLOS Currents,* vol. 9, pp. 1-11, 2017.

[28] AboutSickKids, "The CARD system for health-care providers," The Hospital for Sick Children, 9 3 2022. [Online]. Available: https://www.aboutkidshealth.ca/Article?contentid=4024&language=English&hub=cardhcpedu#card.. [Accessed 24 6 2022].

[29] Public Health Agency of Canada, "What Everyone Should Know About Human Papillomavirus (HPV): Questions and Answers," Government of Canada, 9 11 2012. [Online]. Available: https://www.canada.ca/en/public-health/services/infectious-diseases/sexual-health-sexually-transmitted-infections/should-know-hpv-questions-answers.html. [Accessed 29 6 2022].

[30] Public Health Agency of Canada, "Human Papillomavirus (HPV)," Government of Canada, 14 2 2020. [Online]. Available: https://www.canada.ca/en/public-health/services/diseases/human-papillomavirus-hpv.html. [Accessed 29 6 2022].

[31] Public Health Agency of Canada, "Updated Recommendations on Human Papillomavirus (HPV) Vaccines: 9-valent HPV vaccine 2-dose immunization schedule and the use of HPV vaccines in immunocompromised populations," 5 2017. [Online]. Available: https://www.canada.ca/en/public-health/services/publications/healthy-living/updated-recommendations-human-papillomavirus-immunization-schedule-immunocompromised-populations.html. [Accessed 29 6 2022].

[32] World Health Organization, "Safety of HPV vaccines," World Health Organization, 14 7 2017. [Online]. Available: https://www.who.int/groups/global-advisory-committee-on-vaccine-safety/topics/human-papillomavirus-vaccines/safety. [Accessed 29 6 2022].

[33] A. G. Dunn, D. Surian, J. Leask, A. Dey, K. D. Mandl and E. Coiera, "Mapping information exposure on social media to explain differences in HPV vaccine coverage in the United States," *Vaccine,* vol. 35, no. 23, pp. 3033-3040, 2017.

[34] G. D. Zimet, Z. Rosberger, W. A. Fisher, S. Perez and N. W. Stupiansky, "Beliefs, behaviors and HPV vaccine: Correcting the myths and the misinformation," *Preventive Medicine,* vol. 57, no. 5, pp. 414-418, 2013.

[35] K.-C. C. Muthoni, "HPV Vaccination in Kenya: The Challenges Faced and Strategies to Increase Uptake," *Frontiers in Public Health,* vol. 10, 2022.

[36] T. Okita, A. Enzo, Y. Kadooka, M. Tanaka and A. Asai, "The controversy on HPV vaccination in Japan: Criticism of the ethical validity of the arguments for the suspension of the proactive recommendation," *Health Policy,* vol. 124, no. 2, pp. 199-204, 2020.

[37] J. Jankovic, J. C. Mazziotta, S. L. Pomeroy and N. J. Newman, "Pain Management," in *Bradley and Daroff's Neurology in Clinical Practice*, Elsevier, 2022, pp. 753-775.

[38] S. J. Hanley, E. Yoshioka, Y. Ito and R. Kishi, "HPV vaccination crisis in Japan," *The Lancet,* vol. 385, no. 9987, p. 2571, 2015.

[39] K. T. Simms, S. J. B. Hanley, M. A. Smith, A. Keane and K. Canfell, "Impact of HPV vaccine hesitancy on cervical cancer in Japan: a modelling study," *The Lancet,* vol. 5, no. 4, pp. E223-E234, 2020.

[40] D. Normile, "Japan relaunches its HPV vaccination drive. For thousands of women, it may be too late," *Science,* 29 3 2022.

[41] Council for International Organizations of Medical Sciences; World Health Organization, "Definition and Application of Terms for Vaccine Pharmacovigilance: Report of CIOMS/WHO Workign Group on Vaccine Pharmacovigilance," 2012. [Online]. Available: https://cioms.ch/wp-content/uploads/2017/01/report_working_group_on_vaccine_LR.pdf. [Accessed 24 6 2022].

[42] A. Parrella, M. Gold, H. Marshall, A. Braunack-Mayer and P. Baghurst, "Parental perspectives of vaccine safety and experience of adverse events following immunisation," *Vaccine,* vol. 31, no. 16, pp. 2067-2074, 2013.

[43] R. Wilson, P. Paterson, J. Chiu, W. Schulz and H. Larson, "HPV Vaccination in Japan: The Continuing Debate and Global Impacts," 4 2015. [Online]. Available: https://csis-website-prod.s3.amazonaws.com/s3fs-public/legacy_files/files/publication/150422_Wilson_HPVVaccination2_Web.pdf. [Accessed 29 6 2022].

[44] H. Azarpanah, M. Farhaldoo, R. Vahidov and L. Pilote, "Vaccine hesitancy: evidence from an adverse events following immunization database, and the role of cognitive biases," *BMC Public Health,* vol. 21, no. 1686, pp. 1-13, 2021.

[45] Public Health Agency of Canada (PHAC), "Measles in Canada," Government of Canada, 1 4 2019. [Online]. Available: https://www.canada.ca/en/public-health/services/diseases/measles/measles-in-canada.html. [Accessed 28 6 2022].

[46] Public Health Agency of Canada (PHAC), "Measles and Rubella Weekly Monitoring Reports," Government of Canada, 29 June 2022. [Online]. Available: https://www.canada.ca/en/public-health/services/diseases/measles/surveillance-measles/measles-rubella-weekly-monitoring-reports.html. [Accessed 29 June 2022].

[47] Public Health Agency of Canada (PHAC), "Measles: For health professionals," Government of Canada, 10 January 2020. [Online]. Available: https://www.canada.ca/en/public-health/services/diseases/measles/health-professionals-measles.html#s5. [Accessed 28 June 2022].

[48] D. E. Griffin, "Measles virus-induced suppression of immune responses," *Immunological Reviews,* vol. 236, pp. 176-189, 2010.

[49] A. Beckford, R. Kaschula and C. Stephen, "Factors associated with fatal cases of measles: A retrospective autopsy study," *South African Medical Journal,* vol. 68, no. 12, p. 858–863, 1985.

[50] M. J. Mina, T. Kula, Y. Leng, M. Li, R. D. de Vries, M. Knip, H. Siljander, M. Rewers, D. F. Choy, M. S. Wilson, H. B. Larman, A. N. Nelson, D. E. Griffin, R. L. de Swart and S. J. Elledge, "Measles virus infection diminishes preexisting antibodies that offer protection from other pathogens," *Science,* vol. 336, no. 6465, pp. 599-606, 2019.

[51] A. Hagen, "Measles and immune amnesia," American Society for Microbiology (ASM), 18 5 2019. [Online]. Available: https://asm.org/Articles/2019/May/Measles-and-Immune-Amnesia. [Accessed 28 6 2022].

[52] Public Health Agency of Canada (PHAC), "Measles vaccine: Canadian Immunization Guide," Government of Canada, 23 11 2021. [Online]. Available: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-12-measles-vaccine.html. [Accessed 28 6 2022].

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