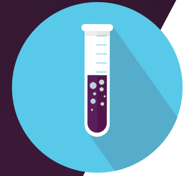
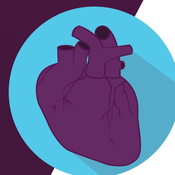
As One Of Canada's Top Killers, Why Isn't Pneumonia Taken More Seriously?





March 2019
(Updated December 2024)

NATIONAL INSTITUTE ON AGEING

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About the National Institute on Ageing

The National Institute on Ageing (NIA) improves the lives of older adults and the systems that support them by convening stakeholders, conducting research, advancing policy solutions and practice innovations, sharing information and shifting attitudes. Our vision is a Canada where older adults feel valued, included, supported and better prepared to age with confidence.

National Institute on Ageing Immunization Series

Suggested Citation:
National Institute on Ageing. (2024). As One of Canada's Top Killers, Why Isn't Pneumonia Taken More Seriously? Toronto, ON: National Institute on Ageing White Paper.

ISBN: 978-1-77417-061-8

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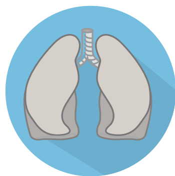
Disclaimer: The NIA has developed this document to provide a summary of general information about the burden of pneumococcal disease and the benefit of the pneumococcal vaccine, as well as provide evidence-informed recommendations to support uptake of the pneumococcal vaccine. The NIA's work is guided by the current evidence. This document can be reproduced without permission for non-commercial purposes, provided that the NIA is acknowledged.

Funding for this report and the 2023 report update was generously provided by Pfizer Canada in the form of an unrestricted educational grant. Funding for the 2024 report update was made possible through the financial support of Merck Canada Inc. All of the research, writing and recommendations herein have been independently produced by the NIA on the basis of sound evidence. The involvement of Pfizer Canada and Merck Canada Inc. was limited to providing only financial support.

Executive Summary

For over a decade, the Public Health Agency of Canada (PHAC) has set an 80% target vaccination coverage rate with the pneumococcal vaccine for those aged 65 years and older[1] — however, estimates suggest that, as of 2023, only 54.7% of older Canadians had received their pneumococcal vaccination.[2] The target vaccination coverage rate for children under the age of two was set at 95% at the same time,[3] and research shows children are doing much better. Conservative estimates suggest that 85.1% of Canadian children have been vaccinated against pneumococcal disease.[4]

Pneumonia represents only one possible manifestation of pneumococcal disease or infection. It is a common lung infection that can have many symptoms including difficulty breathing, coughing, fever, fatigue, nausea and vomiting, chest pain, changes in heartbeat, confusion or delirium, and diarrhea.[5]



Pneumonia can be serious and sometimes fatal, especially for older adults, infants and young children.[6]

Pneumonia can be caused by bacteria, viruses (including influenza and SARSCoV2) and more rarely by fungi.[7] The most common cause of bacterial pneumonia is a bacteria called Streptococcus pneumoniae.[8] S. pneumoniae can lead to a more serious condition called invasive pneumococcal disease, which is when the bacteria enters parts of the body where it is not typically found.[9] This can result in meningitis and bacteremia.[10]

Pneumonia has a disproportionately negative effect on the health and wellbeing of older Canadians, which can be seen across various hospitalization indicators (e.g., incidence, length of stay and mortality).[11] Additionally, in 2022, it was found that adults aged 60 years and older had the highest rate of reported cases of invasive pneumococcal disease (IPD) in Canada.[12]

Pneumonia is among one of the top 10 reasons that people went to Emergency Departments (ED) in Canada, with over 139,800 pneumonia-related ED visits in 2019-20.[13]

Similarly, over the past several years, pneumonia has been one of the top 10 diagnoses leading to hospitalizations.[14-18] Together with influenza, pneumonia was also the eighth leading cause of death in Canada in 2022.[19]

While pneumonia-related ED visits and hospitalizations have significantly reduced during the initial phase of the COVID-19 pandemic owing to the impact of public health measures reducing the spread of respiratory viruses, it is expected that with the lifting of several public health measures, these numbers will rise significantly once again.[20-22]

Lack of availability of specific diagnostic tests means that the true burden of pneumonia across the country is likely underestimated.[23] Better ways to test for and determine the cause of disease will allow for better vaccine development, but there is a lack of good data on how many people are vaccinated. In Canada, the reality is that we do not know how many people have been vaccinated.
Vaccination is an effective way to protect against pneumococcal disease. Vaccines help the immune system develop antibodies that protect us from getting sick when infected with that particular bacteria or virus.[24] Two main types of vaccines for S. pneumoniae are currently available — polysaccharide and conjugate vaccines.[25,26] Conjugate vaccines were created to provide a stronger and more durable immune response,[27] with these vaccines being recommended as the only option for children and the preferred choice among adults.[28]

In Canada, it is recommended that adults aged 65 years and older, children, and individuals at high-risk of developing IPD are vaccinated against pneumococcal disease.[29]

Providers play a significant role in increasing vaccination rates. In order to improve vaccination rates there is a need to improve education among both the public and health-care professionals as there still exists a general lack of awareness about which vaccines Canadians should receive and when. Based on examination of the current evidence, additional work must be done to improve the prevention of pneumonia and pneumococcal disease in Canada.

The following recommendations provide evidence-informed policy and practice approaches that can be used by health authorities and organizations to support vaccination and overall prevention across Canada.

1. Promote General Preventive Practices in Addition to Vaccination

2. Promote a Life-Course Vaccination Schedule that includes Older Adults

3. Improve Diagnosis and Surveillance of Pneumococcal Disease

4. Improve Monitoring of Pneumococcal Vaccination Rates

5. Continue Working Toward Developing Better Pneumococcal Vaccines

6. Provide Clinician Education and Support for Primary Care Providers and Pharmacists to Deliver Vaccinations

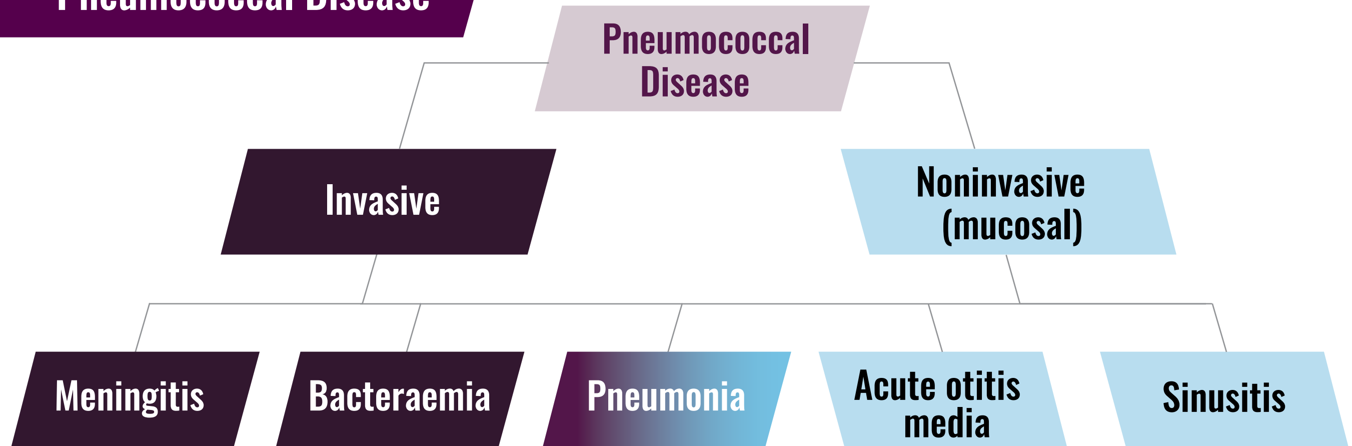
7. Harmonize the Funding and Messaging for Pneumococcal Vaccinations for Target Populations Across Canada

8. Recommend the Administration of the Pneumococcal Vaccine in Conjunction with Influenza and COVID-19 Vaccination

9. Promote Following the Current National Advisory Committee on Immunization (NACI) Statement for Pneumococcal Vaccination

10. Promote Pneumococcal Vaccination for Residents of LTC Homes

Background and Context



What is Pneumonia? And Why Should We Care About It?

Pneumonia versus Pneumococcal Disease

Pneumococcal disease is any disease caused by the bacteria called *Streptococcus pneumoniae* (also known as *S. pneumoniae*, Strep pneumo, or pneumococcus).[30] As depicted in the chart above, the various disease manifestations of pneumococcal disease can be broadly separated into invasive and non-invasive types of illnesses.[31] Pneumonia is the most common serious manifestation of pneumococcal disease, especially among older adults.[32]

In addition to bacteria, pneumonia can be caused by viruses (including influenza and SARS-CoV-2), and more rarely by fungi.[33] The most common cause of bacterial pneumonia is the *S. pneumoniae,* which normally lives in the human nose and throat.[34] It can be transmitted through direct mouth-to-mouth contact, coughing or sneezing, or through indirect contact with someone who carries the bacteria asymptomatically.[35]

When bacteria, virus or fungus enters an individual's lungs it can lead to pneumonia in one of the lungs, or both, causing them to become infected and inflamed.[36] When the lungs are infected, it can become harder to breathe and the lungs may become filled with mucus, making it more difficult for oxygen to reach the lungs and the bloodstream.[37]

In addition to difficulty breathing or shortness of breath, symptoms of pneumonia may include:

- Feeling very tired or weak
- Coughing (may include mucus)
- Fever, sweating and chills
- Nausea and vomiting
- Chest pain — particularly during coughing or inhaling
- Experiencing a faster than normal heartbeat
- Confusion or delirium (in older adults)
- Experiencing a lower than normal body temperature (in older adults and those with weak immune systems)
- Diarrhea[38,39]

Pneumonia can be serious and, in some cases, fatal. It is one of the leading causes of death and hospitalizations in older adults, and for adults living with chronic conditions.[40] Pneumonia can also be serious for infants and young children.[41]

As can be seen on the left-hand side of Figure 1 on page ten, there are also invasive types of pneumococcal disease. In these cases, when bacteria enters parts of the body where it is not typically found — for example, the bloodstream or central nervous system — the patient is diagnosed with invasive pneumococcal disease (IPD).[42] In children under the age of two, IPD typically manifests as bacteremia or meningitis.[43] Meningitis occurs when the pneumococcal disease infects the tissue that covers the brain and the spinal cord that may cause symptoms such as stiff neck, fever, headache, eye sensitivity to light, and confusion.[44] Bacteremia is an infection of the blood, which leads to symptoms that include fever, chills and lack of alertness.[45] In adults, IPD typically pre sents as something called "bacteremic pneumococcal pneumonia," which can be a common complication of influenza.[46,47] IPD is more common in the very young, older adults and high-risk groups during winter/spring months in countries with temperate climates.[48,49]

What is Community-Acquired Pneumonia (CAP)?

Types of pneumonia are often classified based on where the disease was contracted. Community-acquired pneumonia (CAP) refers to a pneumonia that was contracted in the community — during daily activities such as going to school, work or generally being out in the community.[50,51] Health-care associated or hospital-acquired pneumonia (HAP) refers to a pneumonia that was contracted while in the care of a hospital or a LTC home. HAP is often more severe than CAP because patients are already sick before becoming infected.[53] In addition, their infection may be due to a more virulent or antibody resistant strain of bacterial.[54] Walking pneumonia refers to a pneumonia where the symptoms may be quite mild.[55] Generally people with this type of pneumonia are able to function and may think that they only have a cold.[56] One study found that patients who had CAP had increased rates of hospitalizations and ED visits when compared to patients who never had CAP.[57] The rate of mortality for CAP is highest among those older than 65 years.[58]

The Burden of Pneumonia in Canada

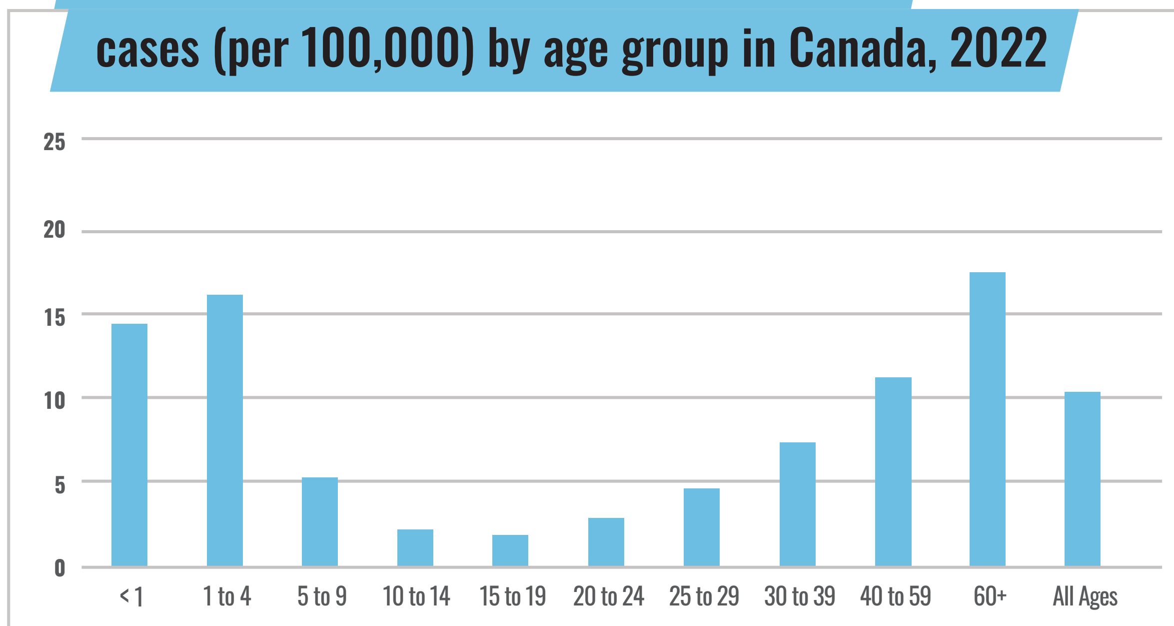
Older Canadians Are at Greatest Risk

Pneumonia also has a disproportionately negative effect on the health and wellbeing of older Canadians. A national multi-year study in Canada found adults aged 70 years and older consistently have the highest annual incidence rates, lengths of stay and mortality rates for hospitalizations due to pneumonia.[59]

The incidence of pneumonia is also expected to increase as Canada's population continues to age. This is evident as a study on the incidence of CAP in Ontario and British Columbia found that rates increase with age, especially among older adults. In Ontario specifically, it was noted that from 2010 to 2018, even though the CAP incidence rate in the 65 to 74 age group was just over 1.5 times the total population rate, the 85 and older age group had a CAP incidence rate that was over five times the total population rate.[60]

Older adults also have a high incidence of IPD compared to the population average. In 2022, the rate of reported cases of IPD in Canada was 10.23 per 100,000 people, but it was 17.56 per 100,000 people for adults aged 60 years and older (Figure 2).[61]

Figure 2: Annual Incidence of IPD reported cases (per 100,000) by age group in Canada, 2022



Source: Public Health Agency of Canada

The Canadian Institute for Health Information (CIHI) found that in 2019-20, pneumonia was among the top 10 main diagnoses among ED visits in Canada,[62] with over 139,800 ED visits.[63] In addition, compared to the other top 10 main diagnoses of ED visits, those diagnosed with pneumonia as the main problem had a considerably higher length of stay in the ED. This was evident by how 90% of individuals in this group spent just under 18.7 hours in the ED, whereas 90% of individuals in the next highest main diagnosis group spent just under 9.0 hours.[64] Also, those with pneumonia as their main ED diagnosis had considerably higher admission percentages to the hospital. This was evident by how 27.1% of individuals in this group were admitted, compared to only 10% of individuals being admitted in the next highest main ED diagnosis group.[65] Adults aged 65 years and older accounted for 34.8% of pneumonia-related ED visits (48,723) in 2019-20.[66]

More recent estimates suggest that ED visits due to pneumonia during the pandemic decreased substantially, with just under 45,800 ED visits in 2020-21, a value that has never been reached in the past 17 years of available CIHI data (Table 1).[67] CIHI has noted that the impact of public health measures during the initial phases of the pandemic (e.g., masks, physical distancing), which reduced the severity of various respiratory conditions, including pneumonia, were likely responsible for this overall decrease.[68] ED visits due to pneumonia increased in 2021-22 (Table 1). However, they are still less than half of the value from 2019-20 (139,805 ED visits).[69]

Table 1: Number of ED Visits due to Pneumonia Fiscal Year 2021-22

Age Group	Total ED Visits	Percentage
0-19	13,299	21.0%
20-44	9,154	14.5%
45-64	13,491	21.3%
65+	27,300	43.2%
Total	63,244	

Source: Canadian Institute for Health Information

In Canada, CIHI has noted that over the past several years (2015 to 2020), pneumonia was ranked as one of the 10 diagnoses with the highest number of inpatient hospitalizations. During this time span, the number of annual inpatient hospitalizations ranged from around 67,000 (2015-16) to over 70,000 (2017-18).

From 2015 to 2020, all the provinces and territories also had pneumonia within their top 10 diagnoses with the highest inpatient hospitalizations, with the rankings going as high as second place.[70-74] As the number of high-volume inpatient hospitalizations by age group was only reported from 2016, it was found that pneumonia was consistently ranked within the top 10 for the following age groups: zero to four years, five to 17 years, and 65 years and older. However, most of the total pneumonia-related inpatient hospitalizations were in people aged 65 years and older, consistently accounting for around 60%. Also, the average acute length of stay (LOS) in the first two age groups ranged from three to four days, while the average acute LOS for those aged 65 years and older was about eight days.[75-78] In addition, hospitalization rates for pneumonia among Canadians aged 75 years and older are almost five times higher than among Canadians aged 65 to 69 years.[79]

Similar to declining ED visits, pneumonia-related hospitalizations decreased substantially during the pandemic. This was seen across two years of CIHI data (2020-21, 2021-22) which no longer listed pneumonia as a top 10 high-volume cause of inpatient hospitalization in Canada.[80,81] Across these two years, pneumonia still made the top 10 list in those aged 65 years and older,[82,83] despite the number of inpatient hospitalizations having decreased by around 40% in comparison with previous years.[84-88] The reason for this change was also due to the reduced spread of respiratory viruses and bacteria from the various public health measures implemented during the initial phases of the COVID-19 pandemic.[89] However, recent CIHI data (2022-23) has shown that pneumonia-related hospitalizations have come back to their pre-pandemic levels and are being ranked again as a top 10 high-volume cause of inpatient hospitalization in Canada, across all jurisdictions and within certain age groups (zero to four years, five to 17 years and 65 years and older).[90]

Together with influenza, pneumonia was also the eighth leading cause of death in Canada in 2022.[91]

As noted earlier, together with influenza, pneumonia was also the eighth leading cause of death in Canada and collectively responsible for 5,985 deaths in 2022.[92] This has been the case for the past 22 years, where pneumonia has consistently ranked between sixth to tenth on the list of annual leading causes of death in Canada.[93] The overwhelming majority (90%, 5,375 deaths) were among those aged 65 years and older, with more than half (3,180) of pneumonia-related deaths occurring among individuals aged 85 years and older.[94]

One study that tested for CAP and IPD in nine hospitals across five provinces (BC, ON, QC, NB and NS) found that mortality was the highest for those older than 50 years in comparison to younger age groups.[95] As age increased, so did the length of the hospital stay.[96] Pneumococcal CAP and IPD, when compared to all-cause CAP, led to more severe outcomes, including being admitted to an intensive care unit, needing a ventilator, developing additional complications when in the hospital, and an increased 30-day mortality rate.[97]

In 2010, *S. pneumoniae* was reported to be among the top 10 most burdensome infectious diseases in Ontario, along with influenza, HIV/AIDS, hepatitis C and B, and others.[98] Most of the burden associated with *S. pneumoniae* was related to premature mortality and living for additional years with reduced functioning.[99] This may still be the case today, despite a drop in overall numbers due to the earlier noted impact of public health measures during the COVID-19 pandemic.

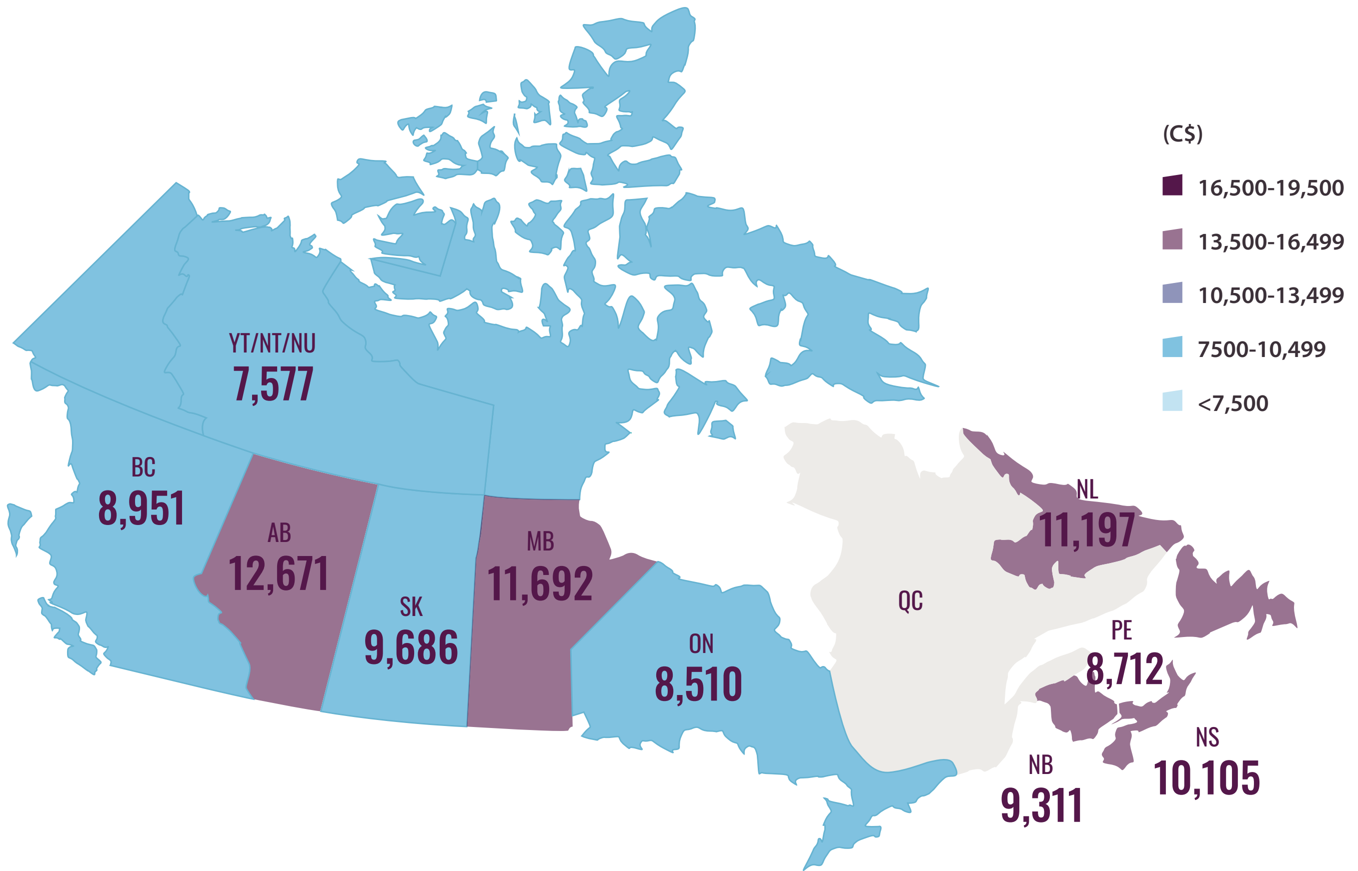
The Cost of Pneumonia in Canada

Pneumonia is a costly disease due to its associated costs of hospitalizations and other treatments.[100] According to the PHAC, respiratory infections (including pneumonia, influenza and other infections) have a total direct cost of $6.5 billion, which includes hospital care, physician care, prescription drug costs and formal caregiving. In terms of indirect costs, respiratory infections have a total of $3.1 billion, this includes unpaid caregiving and lost productivity due to morbidity and premature mortality.[101] It is important to note that among other diseases, respiratory infections had the third-highest amount of total indirect costs, along with the highest percentage of indirect costs in comparison to total costs (16.30%).[102]

PHAC has also provided specific information about pneumonia-related direct costs. It has been found that in 2010, pneumonia resulted in close to $622 million in hospital care expenditures.[103] Of these expenditures, 57% ($354.1 million) were among those aged 65 and older and 43% ($268.3 million) were among those aged 75 years and older.[104,105] This has also been the case with the pneumonia-related physician care expenditures ($129.4 million), where 56% ($72.5 million) were attributed to those aged 65 years and older and 41% ($52.7 million) to those aged 75 and older.[106] Pneumonia also accounted for close to $73 million in prescription drug expenditures.[107]

A 2017 report estimating the average cost per case of pneumonia (direct costs of treating pneumonia and the cost of hospitalization) until 2025 found that from 2010 to 2025, the costs for adults aged 65 to 69 years is predicted to increase from $8,075 to $12,619, from $7,766 to $11,956 for adults aged 70 to 74 years and from $8,993 to $10,369 for those aged 75 years and older.[108]

Figure 3: Pneumonia Average Cost per Case by Province, 2015[109]



Note: Data from Quebec are not available.

Sources: The Conference Board of Canada; Canadian Institute for Health Information

In 2012, a study from the United States compared the costs per year after a person was admitted to hospital for pneumonia versus an admission without pneumonia and found approximately $15,000 increase in costs over a year for those with an index-pneumonia admission.[110] The predicted hospital cost per case by province in 2015 was found to range from a low of $8,510 in Ontario to $12,671 in Alberta (Figure 3).[111] Projections suggest that by 2025 the costs per case of pneumonia will range from a low of $8,689 in PEI to a high of $18,340 in Manitoba.[112] This difference in costs is likely due to regional differences in the cost of services — for example, Alberta has a higher average cost but it also has a higher average length of stay.[113] This is in comparison to the territories that have a lower cost per case, but also report a lower length of stay.[114]

Who is at Higher Risk for Pneumonia?

Older adults, people with chronic conditions such as heart, kidney, lung or liver disease, diabetes, smokers and individuals with immuno-deficiencies, such as HIV or transplants, are at higher risk for contracting pneumonia.[115,116] These groups are also at an increased risk of complications and death.[117] See Table 2 for NACI's table on the risk factors that place individuals at increased risk of IPD.[118]

Children who are younger than the age of two, in addition to the conditions noted above, are also at increased risk.[119]

Older Adults:

With ageing, the effectiveness of the human immune system declines, commonly referred to as **immunosenescence**.[120] Immunosenescence causes older adults to be more likely to contract pneumonia and other infections, and less likely to respond to vaccines.[121] There have been attempts to better address the lack of vaccine-efficacy in adults older than 65 years, including using new vaccines that have been developed to address the changes in immune function.[122] Please see "The History of the Pneumococcal Vaccine" box on page 27.

Due to physical changes in the lungs as an individual ages, including changes to the elasticity of the lungs and decreases in the strength of the muscles needed to breathe, there may be a further decreased ability to deal with any lung infections that may occur.[123] The presence of functional impairments (i.e., needing help bathing or walking), having a low body weight and recent weight loss among older adults is also related to an increased risk of developing CAP, which may be related to frailty.[124]

Table 2: Adult Risk Factors Resulting in an Increased Risk of IPD According to Canada's NACI

Medical Conditions

- Hematopoietic stem cell transplant recipients
- Chronic cerebrospinal fluid (CSF) leak
- Cochlear implants, including those who are to receive implants
- Congenital immunodeficiencies involving any part of the immune system, including B-lymphocyte (humoral) immunity, T-lymphocyte (cell) mediated immunity, complement system (properdin, or factor D deficiencies) or phagocytic functions
- Immunocompromising conditions or immunosuppressive therapy within the past two years, including use of long-term corticosteroids, chemotherapy, radiation therapy and immunosuppressive biologics
- Active malignant neoplasmsa[a], including leukemia and lymphoma
- Candidates and recipients of solid organ or islet transplants
- Chronic kidney disease, particularly those individuals with stages 4 and 5 chronic kidney disease, and those with nephrotic syndrome, on dialysis or renal transplant recipients
- Chronic liver disease, including: cirrhosis, biliary atresia and chronic hepatitis
- HIV infection
- Functional or anatomic asplenia (congenital or acquired) or splenic dysfunction, including sickle cell disease and other hemoglobinopathies
- Chronic neurologic conditions that may impair clearance of oral secretions
- Chronic heart disease requiring regular medication and follow-up for ischemic heart disease, congenital heart disease, chronic heart failure or hypertension with cardiac complications
- Diabetes mellitus, particularly in those over 50 years of age
- Chronic lung disease (particularly chronic obstructive pulmonary disease, emphysema, bronchiectasis, interstitial lung fibrosis and cystic fibrosis), including asthma that required medical care in the preceding 12 months

Social, Behavioural, and Environmental factors

- Individuals who are unhoused
- Individuals living in communities or settings experiencing sustained high IPD rates, including those who are in residential care[b,c]
- Smoking, particularly in those over 50 years of age
- Substance use (i.e., alcohol misuse, cocaine use and injection drug use)
- Occupational risk with long-term continuous exposure to metal fumes (i.e., welders)

* Some conditions listed above carry higher risk than others.

[a] Immunocompromised status can vary over time depending upon the disease state, which may or may not involve immunosuppressive medication.

[b] Including long-term care homes.

[c] Individuals should be vaccinated with a vaccine that covers serotypes circulating in the community.

Source: Public Health Agency of Canada

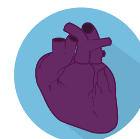
Understanding the Greater Association of Pneumonia in People Living with Chronic Conditions:

Underlying Heart Conditions

Pneumonia (specifically community-acquired) has been associated with an increased risk of heart failure. Individuals who have experienced a pneumonia event have a 12% increased risk of developing heart failure when compared to people who have not had pneumonia.[125] In a 2017 article, Eurich et al. studied patients admitted to hospital for CAP and followed them after discharge and found that those who had been hospitalized for CAP versus those not hospitalized for CAP had a 50% increase in "incident heart failure," defined as any heart failure admission to hospital after CAP admission. This increased risk should be considered when aiming screening and prevention towards populations with underlying cardiac issues and looking for other heart disease risk factors that can be modified.[126]

In one study, it was found that the excess risk of developing CAP among older adults was highly related to having underlying congestive heart failure, when compared to those with heart diseases other than congestive heart failure.[127]

In addition, research has found that patients with heart disease who have influenza will have an increased risk of developing pneumonia, being admitted to hospital and needing a ventilator.[128] Due to its strong connection with heart failure, there is an increased need to prevent pneumonia, which suggests that both pneumococcal and influenza vaccines are important, particularly for people at higher risk of developing pneumonia and all those with cardiovascular conditions.[129]



Underlying Respiratory Conditions

Individuals living with chronic respiratory diseases including chronic obstructive pulmonary disorder (COPD), chronic bronchitis and/or asthma are at increased risk of CAP and IPD when compared to individuals who do not have respiratory diseases.[130] Age matters as well, with one UK study demonstrating that people older than 65 years living with COPD were at increased risk of developing CAP versus younger people living with COPD.[131] Older adults with lung diseases, even those not currently on medication or oxygen, are at twice the risk of developing CAP, while those with severe lung disease were found to be at an eight-fold risk of developing CAP.[132] In addition, being previously hospitalized for COPD complications was associated with a greater chance of developing CAP.[133]

Adults living with asthma have been found to be more likely to have IPD when compared to adults without asthma.[134] The severity of the asthma is important, with the risk of IPD becoming greater as the asthma severity increases.[135] As such, in 2014, NACI added asthma as a high-risk condition.[136] Individuals who require medical attention for asthma should be given the appropriate vaccine for their age group.[137]

Cognitive Impairment

One prospective cohort study found that approximately 25% of patients who were hospitalized with CAP had moderate-to-severe cognitive impairment that lasted for at least a year after developing CAP and approximately 33% had mild cognitive impairment.[138] Cognitive impairment was found in both older and younger adults, many of whom were completely healthy prior to their episode of CAP.[139]

Other studies have found that hospitalization for pneumonia is associated with functional decline and a nearly 2.5 times increase in risk of developing moderate-to-severe cognitive impairment.[140] Similar to other studies, it was also found that these associations are present in individuals who were only hospitalized once and without comorbidities.[141] These results are not limited to older adults who require the most critical care.[142]

Other Chronic Conditions

Individuals living with diabetes also have an increased risk of developing CAP.[143] Diabetes has the largest impact on the development of IPD and CAP in people under the age of 64.[144] Additionally, individuals previously hospitalized with diabetes had an increased risk of developing different types of pneumonia and meningitis.[145] Interestingly, unlike heart failure or COPD/asthma, rates of pneumococcal disease in individuals with diabetes were found to be higher among those under the age of 60 versus those over age 60.[146]

Obesity, defined as having a Body Mass Index over 30, was found to be associated with an increased risk of being hospitalized for respiratory diseases (including pneumonia) during periods of seasonal influenza.[147]

Finally, it has been found that a hospitalization for pneumonia increases the risk of developing depressive symptoms by 1.6 times.[148]

Special Populations:

Canada has an International Circumpolar Surveillance (ICS) data collection system that collects data about IPD in the North.[149] This system has shown that despite IPD decreasing over time, the incidence rate in Northern Canada is 2.8 times higher than rest of Canada.[150] Also in this region, the annual IPD incidence rate is statistically higher among Indigenous residents than non-Indigenous residents.[151] In Manitoba, communities that are socio-economically disadvantaged and predominantly Indigenous also have increased rates of IPD.[152]

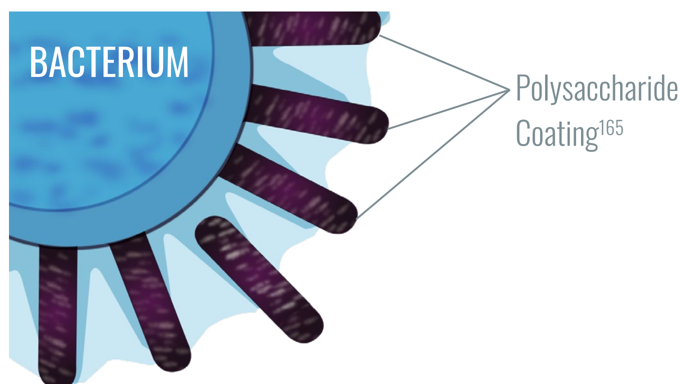
It has been noted that pneumonia-related outcomes are higher among individuals who drink alcohol, use illicit drugs, smoke and experience homelessness.[153] Two systematic reviews have identified the especially strong relationship in terms of tobacco smoke exposure and alcoholism.[154,155] In regards to smoking, an analysis of 13 studies found that those who currently smoke have more than double the risk of developing CAP compared to those who never smoke.[156] Also, alcohol disorders were associated with eight-fold increase in risk of CAP.[157] In terms of homelessness, a Canadian study not only noted the overrepresentation of individuals experiencing homelessness among IPD cases, but found the difference to be a factor of 94 times when compared to those not experiencing homelessness.[158]

Children:

Young children and infants have one of the highest rates of reported IPD cases in Canada, with children 1 to 4 years having a rate of 16.27 per 100,000 compared to the national rate of 10.23 per 100,000 in 2022.[159] The ICS found that in the North the results were similar to Canadian national data, where infants and those aged 65 years and older have higher rates; however, the overall rates in the North were much higher than national rates.[160]

In individuals younger than five years and those aged five to 17 years with high-risk conditions, (including prematurity, asthma, chronic heart disease and chronic lung disease), an increased risk of pneumonia has been demonstrated.[161] For children aged five to 17 years with high-risk conditions, there is a 40-fold increased rate of IPD when compared to children of the same age without these high-risk conditions.[162] Specifically, there were increased rates of IPD, pneumococcal pneumonia and all-cause pneumonia in immunocompetent children with high-risk conditions — most specifically heart and lung diseases,

including asthma and diabetes.[163] Also, attending a childcare centre was found to increase IPD and acute otitis media (AOM) risk by two to three times among children younger than five years.[164]



How Do Pneumococcal Vaccines Protect Us?

Vaccines are used to "show" the immune system a bacteria or virus before the body encounters it naturally.[166,167] This allows the body to develop antibodies, which protect and prevent us from getting sick.[168,169] There are two ways of developing antibodies — the first being naturally when an individual gets sick and survives the infection.[170] Vaccines are the second way to help create antibodies, which are protein molecules that help to kill and get rid of the bacteria.[171,172]

S. pneumoniae has a coating called a "polysaccharide capsule."[173] It is this capsule, or covering, that prevents it from being killed by immune cells.[174]

S. pneumoniae has over 100 serotypes (or strains).[175] The invasive disease caused by 24 of these serotypes can be prevented by vaccinating against these specific types.[176] Certain serotypes are prevalent at various rates across age groups.[176a]

The vaccines are created against specific serotype or strain.[177] Both of the existing types of pneumococcal vaccine are inactivated, which means that they do not contain a live organism so they cannot cause the disease that they are preventing.[178,179]

There are two main types of pneumococcal vaccines available: **polysaccharide** and **conjugate vaccines**. See the section below for further explanations of the differences between these vaccines.

After the implementation of immunization programs for children, "serotype replacement" may occur.[180] This is when there is an increase in cases caused by serotypes that are not covered in the vaccine.[181] After the introduction of the PCV7 vaccine, PCV7 cases decreased across all age groups and there were increases in the number of cases caused by serotypes not covered by PCV7.[182] There was an increase in a specific serotype 19A,[183] which is now included in the PCV13 vaccine.[184] Since PCV7 and PCV13 has been introduced in children, there have been reductions in diseases due to included serotypes in people aged 65 years and older.[185]

Different Types of Pneumococcal Vaccines

Pneumococcal Polysaccharide 23-Valent Vaccine (PPV23)

Polysaccharide vaccines are made up of long chains of different sugar molecules (saccharides) that make up the surface "polysaccharide" capsule of certain bacteria.[186] In Canada, this vaccine goes by the name of "Pneumovax23" and protects against 23 serotypes of the pneumococcus.[187] Young children under the age of two do not respond very well to polysaccharide vaccinations.[188] This is because their immune systems are still developing.[189]

Pneumococcal Conjugate Vaccine (PCV)

In the 1980s, scientists discovered that if the vaccine was conjugated, it could fix the problems with the polysaccharide vaccines that made them less effective in children.[190] This process requires that the polysaccharide be combined with a protein molecule, which allows for a better immune response in infants and other immunocompromised populations.[191] In addition, it is able to provide a "booster" effect that the polysaccharide vaccines lack.[192] This "booster" effect occurs when a person is given repeated dosages, which causes the antibody levels to go higher and higher.[193]

There are currently five authorized PCVs in Canada: pneumococcal 10-valent conjugate vaccine (PCV10, SYNFLORIX®); pneumococcal 13-valent conjugate vaccines (PCV13, Prevnar®13); pneumococcal 15-valent conjugate vaccine (PCV15, VAXNEUVANCE®); pneumococcal 20-valent conjugate vaccine (PCV20, PREVNAR 20™); pneumococcal 21-valent conjugate vaccine (PCV21, CAPVAXIVE®).[194-197] The associated number for each of the five vaccines indicates the number of serotypes of pneumococcal disease the vaccine protects the recipient from. All the authorized PCVs, besides PCV10, are for use in adults. Table 3 below shows the overlap in protection against these serotypes of pneumococcal disease across the various vaccines.[198-200]

Conjugated vaccines have always been used routinely in Canada for infant immunization programs. Recently, numerous provinces and territories have replaced adult immunization programs that used the polysaccharide vaccine with PCV20.

Table 3: *S. Pneumoniae* Serotypes Included in Authorized Pneumococcal Vaccines in Canada

Vaccine	Serotypes in Pneumococcal Vaccines																														
	4	9V	6B	14	18C	19F	23F	1	5	7F	3	6A	19A	2	8	9N	10A	11A	12F	15B	17F	20	22F	33F	15A	15C	16F	23A	23B	24F	31	35B
PCV10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																						
PCV13	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																			
PCV15	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y										Y	Y								
PCV20	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y		Y	Y	Y	Y			Y	Y								
PCV23	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y								
PCV21										Y	Y	Y	Y		Y	Y	Y	Y	Y		Y	Y*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

* Specifically, S. pneumoniae serotype 20A is included in PCV21.

Sources: Government of Canada; Merck Canada Inc.

The History of the Pneumococcal Vaccine

Development of the first pneumococcal vaccine began with gold miners in South Africa by Sir Almorth Wright.[202]

In 1886, gold was discovered in Johannesburg, South Africa, and large numbers of people were being brought in to work in the mines.[203] The rate of pneumonia was as high as 100 cases per 1,000 persons per year, with a fatality rate of 25%.[204]

Due to these numbers, pneumonia was seen as one of the greatest threats to the South African mining industry.[205]

Sir Almorth Wright and three colleagues arrived in 1911 to begin trying to develop an effective pneumococcal vaccine.[206]
Sir Almorth Wright left South Africa before completing his trials and F. Spencer Lister, a protégé of Wright, took over the work on the vaccine.[207]

Development of a new vaccine in the 1960s:

- In the 1960s, pneumococcal disease still caused illness and death even with the development and widespread use of antibiotics.[208]
- This led to the development of polysaccharide vaccines.[209]
- However, polysaccharide vaccines were less effective in children, who were getting pneumococcal disease at very high rates.[210]

Development of conjugating vaccines in the 2000s:

- The realization that polysaccharide vaccines could be linked, or "conjugated," lead to the development of pneumococcal conjugate vaccines (PCVs) that are widely used now.[211]
- The first ones became available in 2000 and were found to be more effective for children affected by this disease.[212]

Pneumococcal Vaccines in Canada

- PPV23 (PNEUMOVAX®23), a polysaccharide vaccine, was approved for use in Canada in 1983, and by 2001 all provinces and territories offered and paid for the vaccine for adults aged 65 years and older and adults under the age of 65 who are at high risk for IPD due to chronic medical conditions.[213]
- The first conjugate vaccine approved for use in Canada was PCV7 (Prevnar®) in 2001, with all provinces and territories funding this vaccine for children under the age of two by 2006.[214,215]
- However, PCV7 has now been replaced with PCV10 (SYNFLORIX®220 authorized in 2008), and PCV13 (Prevnar®13, authorized in 2009).[216,217] By 2011, all jurisdictions used PCV13 for children's vaccination programs,[218] with Quebec switching back to using PCV10 in 2018[219] and then to a mixed PCV10/PCV13 schedule in 2020.[220]
- Health Canada approved PCV15 (VAXNEUVANCE®) for use in 2021 and PCV20 (PREVNAR 20™) in 2022.[221,222] Apart from British Columbia,[222a] all jurisdictions use PCV15 for childhood vaccination programs, with PCV20 for children at high risk for IPD. Quebec uses PCV15 and PCV20 for children at high risk for IPD, based on risk factor and vaccination history.[222b] Numerous provinces and territories have also made adult vaccination programs solely use PCV20.
- PCV21 (CAPVAXIVE®) was approved for use in July 2024.[223]

S. *pneumoniae* has over 100 known serotypes (or strains).[224] The invasive disease caused by 24 of these serotypes can be prevented by vaccinating against these specific types.[225] Certain serotypes are prevalent at various rates across age groups.[225a]

Although expanding the number of serotypes in the vaccines seems logical, there must also be comprehensive measures to improve current vaccination adherence.[226] Due to difficulties in adding serotypes into the vaccines, there are current limits on how many serotypes can be included.[227] New vaccines with more coverage that are also affordable and that have longer-lasting immunity (particularly for older adults) are also needed.[228]

Additionally, a phenomenon called "serotype replacement" may take place in certain populations, whereby after vaccination there are increases in disease caused by serotypes that are not covered in the vaccine.[229] This needs to be further understood.[230]

NACI Recommendations

Current NACI Recommendations for Pneumococcal Vaccination in Adults

NACI recommends that one dose of PCV20 or PCV21 should be given for the following groups, regardless of previous vaccination with PCV13, PCV15 or PPV23:

- Adults 65 years and older
- Adults 18 to 64 years at increased risk of IPD (see Table 2)[231]

This recommendation is due to the risk of IPD increasing with age and the number of risk factors. Both PCV20 and PCV21 are found to be immunogenic and safe.[232]

For adults previously immunized, the interval from the last dose will depend on the type of vaccine previously received and individual factors (e.g., immunocompromised conditions). Based on expert opinion, the recommended interval can range from one year to as short as eight weeks.[233]

As an alternative, PCV15 should be used only when PCV20 or PCV21 are unavailable or inaccessible.[234]

NACI notes that for adults who are not included in publicly funded vaccine programs providing PCV20 or PCV21, they may receive these vaccines in consultation with their health care provider.[235]

The reason PPV23, which protects against more serotypes, is not recommended is that conjugate vaccines provide protection which may be both better and of longer duration, resulting in fewer cases of pneumococcal disease.[236,237] Additionally, over the coming months, PPV23 may no longer be available as immunization programs incorporate the use of PCV20 or PCV21.[238]

The only adults currently recommended to receive both PCV20 and PCV21 are individuals who received an HSCT, after consultation with their transplant specialist.[239]

For policymakers, which vaccine to choose will depend on the regional epidemiology in serotype circulation, vaccine eligibility and other considerations (e.g., economics, pneumococcal vaccines that are used for children vaccination programs).[239a]

Current NACI Recommendations for Pneumococcal Vaccination in Younger Canadians:

For children two months to five years with no risk factors, PHAC recommends using PCV15 or PCV20. The number of doses varies based on age and pneumococcal conjugate vaccination history. If these vaccines are not available or are inaccessible within the province or territory, other pneumococcal conjugate vaccines may be used. Children with no risk factors who have completed the entire vaccine series with PCV13 do not need to be given PCV15 or PCV20.[240]

For children two months to 18 years at increased risk of IPD, PHAC recommends using PCV20. The number of doses varies based on age, pneumococcal conjugate vaccination history and risk factors (only for hematopoietic stem cell transplant recipients). Children at increased risk who have completed the entire vaccine series with PCV13 or PCV15 should receive one dose of PCV20.[241]

Along with older adults, IPD is most common among very young children.[242] Increasing the number of children vaccinated protects individuals aged 65 years and older indirectly through the principle of herd immunity (i.e., vaccinating those around others who are at greater risk).[243,244]

Concurrent Administration of Vaccines

Pneumococcal vaccines may be co-administered with other vaccines including influenza, COVID-19 and shingles vaccines.[244a] It is important to note that shivering and fever were more commonly reported among adults 50 years and older when PPV23 and Shingrix (shingles vaccine) were co-administered.[245]

The only exception with co-administration is the use of different formulations of pneumococcal vaccines, such as polysaccharide and conjugate vaccines together.[246]

Research on Vaccinations

Vaccine Effectiveness

In children younger than five years, the effectiveness of PCV13 after completion of the entire vaccine series has been reported to vary between 67% to 96% against the IPD serotypes that are covered in the vaccine. Additionally, the effectiveness against pneumonia has been reported to vary between 20% to 77%.[247]

Two recent systematic reviews have been conducted surrounding vaccine effectiveness of PCV13 and PPV23 against IPD and pneumococcal pneumonia among adults. One review found vaccine effectiveness against pneumococcal pneumonia caused by vaccine-contained serotypes to be around 38–68% for PCV13 (based on two observational studies), whereas the pooled vaccine effectiveness for PPV23 was only 18% (based on three observational studies).[248] Another review found the pooled vaccine effectiveness against IPD caused by vaccine-contained serotypes to be 56% for PCV13 (based on three observation studies), whereas it was only 38% for PPV23 (based on 12 observational studies).[249]

There is currently no data on vaccine effectiveness for PCV15, PCV20 and PCV21 in the adult population.[250] However, the decision to authorize and recommend these vaccines, which are modifications of previous vaccines, is usually made based on assessments of immunogenicity and safety.[251,252,253] Vaccine effectiveness can and should be evaluated once the vaccine is used in a given population.

Impact of Vaccination on Cases

Numerous studies have looked into the impact of PCVs on pneumococcal disease. A retrospective analysis examining the period from 2005 to 2015 found PCV programs in Canada have avoided around 14,990 IPD cases, 735,700 pneumonia cases, 3,697,993 AOM cases and 6,631 deaths.[254] A study in Ontario has also suggested that publicly-funded immunization programs for PCV7, PCV10 and PCV13 have been associated with decreases in hospitalizations of pneumococcal disease for younger children in the province.[255] Benefits were extended to older children and older adults who did not receive the vaccine.[256] In 2010, a study in Manitoba found that switching to the PCV13 vaccine for infants versus the previous PCV7 version significantly decreased rates of disease among children.[257]

The indirect impact (herd immunity) of pneumococcal vaccination was evident in the United States, where there were initially spikes of IPD cases among adults aged older than 50 years during the winter holidays, a time of seasonal social gatherings.[258] The impact of these interactions was seen by how there were a higher amount of IPD cases in these adults that had serotypes more frequently found among children aged younger than five years.[259] After the introduction of PCV7 in 2000, however, these annual spikes were drastically reduced.[260]

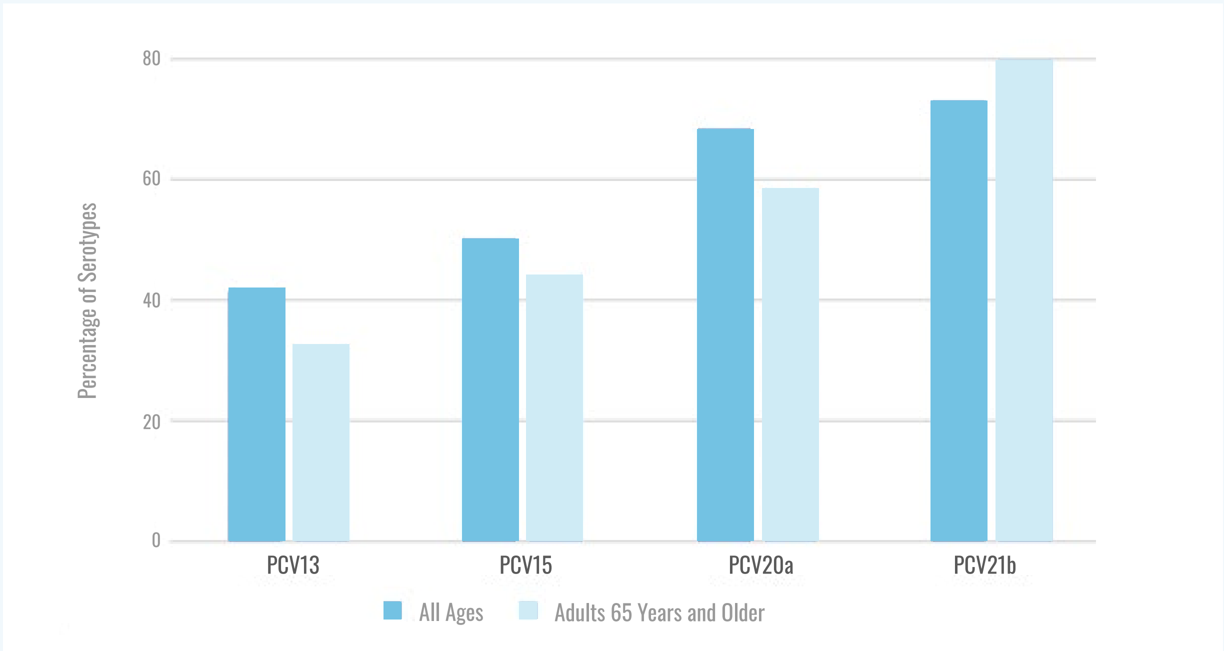
With regard to PCV13, since 2010 (the beginning of implementation of these vaccines in pediatric immunization programs), the percentage of PCV13-serotype IPD in Canada has decreased from 55% to 30% in 2017.[261] It is important to point out that in children aged younger than five years this decrease was from 67% to 18%, whereas for adults aged 65 years and older it decreased from 50% to 23%.[262] This was similarly seen from 2010 to 2017 in Ontario, where there was a significant decreasing trend in PCV13-serotype IPD, with the greatest differences seen in children younger than five years and adults aged 65 years and older.[263] This further highlights the direct and indirect effects of pediatric pneumococcal vaccination programs.

In both of the above studies it was found, however, that there was no downward trend in IPD cases from 2010 to 2017, with Dion et al. noting the highest number of cases reported in the final year.[264] Despite PCV13-serotype IPD decreasing over time, it has been found in Ontario that IPD incidence due to PPV23-serotypes and non-vaccine-preventable serotypes have significantly increased over time.[265] Potential reasons for the increase in PPV23-serotype IPD incidence are lower vaccine effectiveness, inadequate vaccine coverage or vaccine failure of PPV23.[266]

The impact of the more recently approved PCV20 and PCV21 vaccines on IPD cases moving forward is evident from the serotype distribution among IPD cases in 2022 (Figure 4). As could be seen, vaccine-related serotype prevalence varies across age groups, with vaccine-related serotypes being more or less prevalent among adults 65 years and older, compared to all ages. The PCV20-related serotypes among IPD cases are 68.4% across all ages and 58.5% among older adults, whereas the PCV21-related serotypes are 73.1% across all ages and 79.9% among older adults.[267]

As will be discussed below, the PCV20 vaccines have only been included in publicly funded programs for adults since 2023,[267a] as PCV21 has only been approved for use in Canada since July 2024.[267b]

Figure 4: *S. Pneumoniae* Serotype Prevalence Among IPD Cases Across All Age Groups and Adults 65 Years and Older Categorized by Pneumococcal Conjugate Vaccines (2022)



[a] Due to difficulty in differentiation, serotypes 15B and 15C were grouped together, providing one value. This was used in the calculation, even though PCV20 may not prevent disease cause by serotype 15C.

[b] As only data for serotype 20 was available, its value was used as a proxy for serotype 20A.

Source: Griffith et al., 2024

Impact of Vaccination on Costs

From the previously noted retrospective analysis, it was found that between 2005 and 2015, PCV programs led to a cost savings of $1.76 billion in Canada.[268] Even though most of the cost savings were from children younger than the five years, around 25% were from adults aged 65 years and older.[269] Similarly, publicly-funded pneumococcal vaccinations with increasing serotype coverage has led to decreases in health-care costs along with other costs in Ontario and elsewhere.[270]

In 2023, NACI's modelling of various age-based pneumococcal vaccination recommendations (PCV15, PCV20 and/ or PPV23 vaccines) in the Canadian population found that PCV20 used alone and PCV15 followed by PPV23 at age 65 years or 75 years are likely cost-effective approaches.[271] In NACI's 2024 statement, using an updated model from 2023, it was found that the PCV21 vaccine is more cost-effective than PCV20 among older adults. The cost-effectiveness of PCV21 increases when considering the impact of introducing PCV15 or PCV20 for children vaccination programs (e.g., indirect effects, serotype replacement). Among this population group, PCV21-related serotypes are more prevalent than PCV20-related serotypes among IPD cases in Canada. Among other adult groups focused on per NACI recommendations (e.g., individuals 18 to 49 years with immunocompromising conditions), the more prevalent group of serotypes (PCV20 or PCV21) varied over the years. It was found that the more cost-effective vaccine between PCV20 or PCV21 depended on serotype prevalence and consideration of impact from children pneumococcal vaccination programs using PCV15 or PCV20.[271a] Either way, PCV20 or PCV21 is expected to be cost-effective for adults at high risk.

Highlight on Influenza and Pneumonia in Older Adults

People infected with influenza who subsequently contract pneumonia develop worse outcomes and experience increased incidence of hospitalization, likely due to damage to the lungs and airway caused by influenza.[272,273]

Due to the combined effects of pneumonia and influenza, it is recommended that those aged 65 years and older are vaccinated against both of these infections. An analysis of studies found that older adults receiving both influenza and pneumococcal vaccination were associated with a significantly lower all-cause mortality rate compared to older adults that just received influenza vaccination.[274] One study from Japan also showed reductions in medical costs for those older than 75 years who were vaccinated against influenza in the first year after receiving their pneumococcal vaccinations.[275]

Pneumococcal Vaccination Policies in Canada

Decisions about public funding for pneumococcal vaccine are made by provincial and territorial governments. Table 4 below describes the funding and availability of the various pneumococcal vaccines for adults across Canada's provinces and territories. Provinces and territories make decisions based on NACI recommendations, and in some cases, advice from provincial immunization advisory committees and on provincial budget impact.[276,277] In the past year, with the release of the NACI recommendations for the use of PCV20 and PCV15 has led to numerous changes in pneumococcal vaccination policies.

All of Canada's provinces and territories cover either polysaccharide (PPV23) or PCV20 vaccines for all or some groups of older adults, which can be categorized into four groups:

- Six jurisdictions cover all older adults: British Columbia, Newfoundland and Labrador, Northwest Territories, Nunavut, Prince Edward Island and Yukon
- Three jurisdictions cover only older adults who have not received previous pneumococcal vaccination: Alberta, Nova Scotia and Ontario
- Three jurisdictions only cover older adults who have either not received previous vaccination or have high-risk conditions: Manitoba, New Brunswick and Saskatchewan
- One jurisdiction covers either PPV23 or PCV20 for certain older adults: Quebec

The coverage of pneumococcal vaccines for adults with certain medical or lifestyle risks (e.g., chronic heart disease, diabetes, illicit drug use) drastically varies in vaccine and populations covered. All provinces and territories that cover PCV20 as part of their routine adult vaccination programs also cover the PCV20 vaccine for additional high-risk groups of adults. The other jurisdictions that cover PPV23 as part of their routine adult vaccination programs cover the use of one or more pneumococcal vaccines for specific high-risk groups.

Coverage for high-risk populations varies significantly across jurisdictions and does not always align with NACI's list of factors defining high-risk populations (Table 2). In the table below, click on the cited references to obtain the list of high-risk population covered for each jurisdiction.

The PCV21 vaccine is not currently funded by any of the provinces or territories.

The large variance among jurisdictions is also seen in vaccine administration policies and practices. All provinces and territories, except for the Northwest Territories and Nunavut, allow pharmacists to administer pneumococcal vaccines. However, only Alberta, British Columbia, Manitoba and Quebec permit pharmacists to administer publicly funded pneumococcal vaccines. Also, within certain jurisdictions, not all health care provider offices or pharmacies provide pneumococcal vaccination.

Pneumococcal Vaccine Coverage in Canada

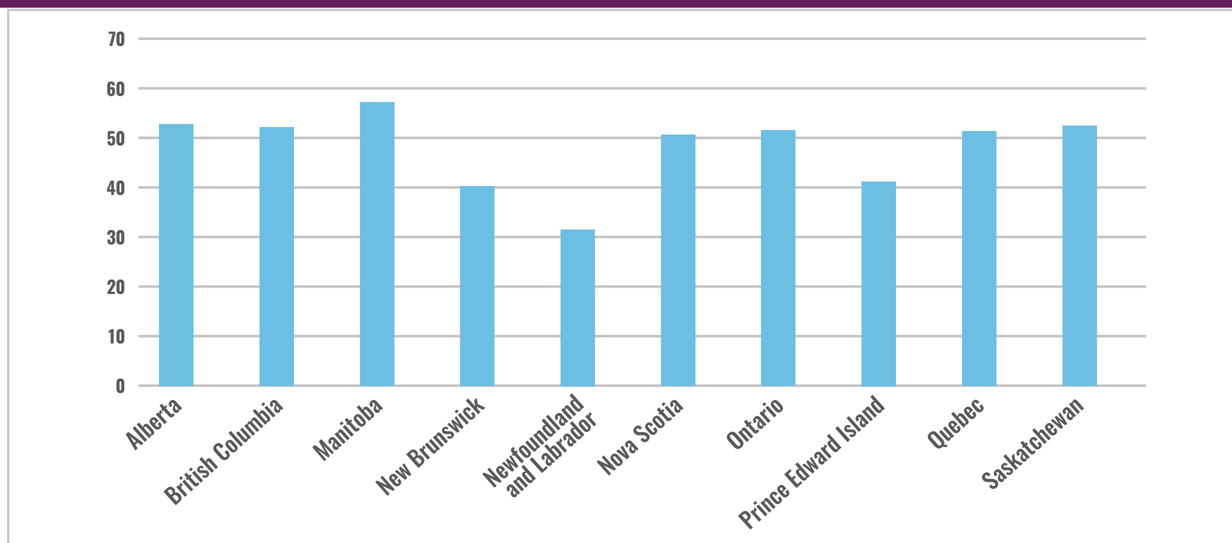
Since 2006, pneumococcal vaccine coverage rates in adults have been measured bi-annually by PHAC across various surveys: Adult National Immunization Coverage Survey (aNICS) (2006-2016, 2023) and Seasonal Influenza Vaccination Coverage Survey (2019, 2021).[279,280] Statistics Canada have also provided vaccine coverage rates (2019/2020) specifically for adults 65 years and older through the Canadian Health Survey on Seniors (CHSS).[281] The most recent findings from the 2023 aNICS found 54.7% of those aged 65 years and older reported having received a pneumococcal vaccine as an adult.[282] The CHSS and Seasonal Influenza Vaccination Survey also reported similar values among adults 65 years and older (51.1% in 2019-2020, 54.8% in 2021).[283] Both aNICS and CHSS found increased pneumococcal vaccine coverage rates in higher older age groups, with the 2023 aNICS finding 62.8% adults 80 years and older reported having received a pneumococcal vaccine as an adult.[284,285] All of these estimates fall well short of the 80% target vaccination coverage rate for the pneumococcal vaccine for those aged 65 years and older by 2025 set by PHAC.[286]

Across these surveys, important distinctions were found when considering sociodemographic factors. It was found through the Seasonal Influenza Vaccination Surveys (2019, 2021) and CHSS that, among older adults, females had significantly higher pneumococcal vaccination coverage.[287,288,289] Within aNICS and CHSS, despite having different groups of respondents, both noted that either White or non-Indigenous, non-racialized individuals have the highest pneumococcal vaccine coverage.[290,291] aNICS found that four out of the six other ethnicities reported had significantly lower vaccine coverage rates compared to the national average.[292] CHSS found

that five of the other six ethnicities reported had significantly lower coverage rates compared to the non-Indigenous, non-racialized group among older adults.[293] CHSS also found that compared to Canadian-born older adults, older immigrants have a significantly lower pneumococcal vaccination coverage.[294] This demonstrates that to increase pneumococcal vaccination rates, more attention needs to be given to various sociodemographic groups.

At the provincial level, the percentage of older adults who have received a pneumococcal vaccine varies significantly across Canada. Between 2019 to 2020, Statistics Canada estimated that coverage varied from 31.5% in Newfoundland and Labrador to 57.2% in Manitoba.[295] Figure 5 below notes vaccination coverage rates across all the provinces in 2019/2020. The 2023 aNICS findings analyzed pneumococcal vaccine rates among a larger age group of adults in Canada and also found rates to vary greatly across Canada's provinces and territories, with the Yukon having the highest reported pneumococcal vaccine coverage rate.[296]

Figure 5: Percentage of Adults Aged 65 Years and Older Who Have Received a Pneumococcal Vaccine as an Adult Across Canadian Provinces (2019/2020)



Source: Statistics Canada

The Seasonal Influenza Vaccination Surveys (2019, 2021) and the CHSS have reported reasons why adult Canadians have not received the pneumococcal vaccine.[297-299] Across all three surveys, the most commonly reported reason among adults 65 years and older was not thinking the pneumococcal vaccine was necessary. Also, the next two commonly reported reasons were the same across all three surveys (in varying order), stating the doctor did not mention the vaccine or never hearing about the vaccine.[300-302] The findings from the CHSS indicated that these three reasons were significantly more reported than other reasons for not receiving the pneumococcal vaccine.[303] It is important to highlight that these were the three most commonly reported reasons (in varying order) among adults aged 18 to 64 years with a chronic medical condition within the PHAC surveys.[304,305] This indicates that more work needs to be done in the areas of raising awareness and educating Canadians about pneumococcal vaccines.

For children under the age of two, PHAC has established a 95% vaccination target for the pneumococcal vaccine.306 In general, Canadian children are doing far better at getting vaccinated, with the most recent childhood National Immunization Coverage Survey indicating that 85.1% of children under the age of two had been vaccinated against pneumococcal disease in 2021.[307]

Table 4: Jurisdictional Pneumococcal Vaccination Policies for Adults as of September, 2024

* Please view the referenced source for more information on conditions.

* Currently, PCV21 is not funded by any jurisdiction, with the vaccines only available to be purchased privately.

Province/ Territory	Where can you get it? *There are sometimes fees associated with administration in pharmacies*	Who can administer vaccines?	Funding PCV20	Funding PPV23	Funding PCV13
British Columbia	Publicly-funded vaccines: Health units, some doctors' offices, and most pharmacies Non-publicly funded vaccines: most pharmacies and travel clinics[308]	Public health nurses, doctors, nurses, and pharmacists[309]	None[310]	All adults aged 65 years and older Adults with medical or lifestyle risks*[311]	Adults with HIV infection or who are recipients of stem cell transplants[312]
Alberta	PPV23: Public health office, doctor, or pharmacies[313] PCV13: Public health office (funded), travel health clinic, doctor or pharmacies[314]	Doctor, nurse, pharmacist[315, 316]	Adults aged 65 years and older who have not previously received PPV23 or PCV20 Adults 18 years and older who are at an increased risk for IPD and did not receive the previously recommended doses of pneumococcal vaccines*[317]	None[318]	None[319]
Saskatchewan	Publicly funded: Public health clinics or some health-care provider offices[320] Only privately-funded: pharmacies[321]	Doctor, nurse practitioner, physician, nurse, licensed practical nurse, pharmacist (only privately funded)[322,323]	Adults 65 years and older who have not received any previous pneumococcal vaccines Long-term care, personal care home or group home residents	None[325]	None[326]

Table 4: Jurisdictional Pneumococcal Vaccination Policies for Adults as of September, 2024

* Please view the referenced source for more information on conditions.

* Currently, PCV21 is not funded by any jurisdiction, with the vaccines only available to be purchased privately

Saskatchewan			Transplant patients (HSCT, solid organ and Islet cell) Adults with certain medical or lifestyle risks*[324]		
Manitoba	Public health offices, nursing stations, doctor’s offices, pharmacies, QuickCare Clinics and ACCESS Centres[327]	Physicians, public health nurses, pharmacists (only PPV23), physician assistants, nurses and nurse practitioners[328]	Adults 65 years and older who have certain medical conditions or who have not yet received PPV23 since turning 65 years* Adults 18 to 64 years of age with certain medical or lifestyle risks* Adults with immuno-compromised conditions* Certain individuals who are currently under the care of a haematologist or oncologist from Cancer Care Manitoba*[329]	None[330]	None[331]
Ontario	Doctors office, walk-in clinic, community health units or some pharmacies[332, 333, 334]	Primary health-care provider (e.g., doctor, nurse practitioner), pharmacists (only paid)[335]	Adults 18 to 64 years of age who are at an increased risk for IPD and did not receive or complete all eligible publicly funded doses of pneumococcal vaccines* Adults 65 years and older who did not	None[337]	None[338]

Table 4: Jurisdictional Pneumococcal Vaccination Policies for Adults as of September, 2024

* Please view the referenced source for more information on conditions.

* Currently, PCV21 is not funded by any jurisdiction, with the vaccines only available to be purchased privately

Ontario			receive or complete all eligible publicly funded doses of pneumococcal vaccines*[336]		
Quebec	CLSC, clinic or pharmacies[339]	Primary health-care provider, nurse, and pharmacist (can also prescribe) [340, 341,342]	Adults with certain medical or lifestyle risks*[343]	Adults aged 65 years and older who have not received PCV20* Adults with certain medical or lifestyle risks who have not received PCV20*[344]	None[345]
Nova Scotia	Doctor’s office, public health offices,[346] and most pharmacies[347]	Physician, nurse practitioners, nurse, pharmacist (also prescribe but can only provide paid vaccines)[348, 349]	Adults 65 years and older who have not completed their pneumococcal vaccine series as an adult Adults with certain medical or lifestyle risks who have not completed their pneumococcal vaccine series*[350]	None[351]	None[352]
New Brunswick	Clinics or pharmacies[353]	Doctors, nurse practitioners, pharmacist[354]	Adults 65 years and older who have never received a dose of PPV 23 Adults with certain medical or lifestyle risks*[355]	None[356]	None[357]

Table 4: Jurisdictional Pneumococcal Vaccination Policies for Adults as of September, 2024

* Please view the referenced source for more information on conditions.

* Currently, PCV21 is not funded by any jurisdiction, with the vaccines only available to be purchased privately

Prince Edward Island	Publicly-funded PPV23: doctors or nurse practitioner clinic, Public Health Nursing office Publicly-funded PPV13: Public Health Nursing office All other vaccines: doctors or nurse practitioner clinic pharmacy[358]	Publicly-funded PPV23: primary health-care provider, public health nurse Publicly-funded PPV13: public health nurses All other vaccines: primary health-care providers, nurses, LTC staff, pharmacist[359]	Adults aged 65 years and older Adults with certain medical or lifestyle risks*[360]	None[361]	None[362]
Newfoundland and Labrador	Available through local health and community services offices[363] and pharmacies[364]	Nurse, pharmacist (also prescribe)[365]	None[366,367]	All adults aged 65 years and older Adults with certain medical and lifestyle risks* Reimmunization: Individuals of any age at high risk of IPD, a single re-immunization with PPV23 is recommended*[368]	Adults with certain medical risks*[369]

Table 4: Jurisdictional Pneumococcal Vaccination Policies for Adults as of September, 2024

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Yukon	Community health centres[370] health practitioner clinic,[371] pharmacy[372]	Doctor, nurse,[373] pharmacist[374]	Adults 65 years and older Adults 50 to 64 years with certain medical or lifestyle risks* Adults 18 to 49 years with immuno-compromised conditions*[375]	None[376]	None[377]
Nunavut	Publicly-funded: Community health clinics and public health offices[378] Privately funded: pharmacy[379]	Nurse practitioners, nurses, midwives[380]	None[381]	Adults aged 50 years and older Adults at increased risk Reimmunization for certain adults with high-risk conditions, maximum number of doses is two[382, 383]	None[384]
Northwest Territories	Health centre or public health unit[385]	Health-care provider or nurse[386]	Adults aged 65 years and older Adults with certain medical or lifestyle risks*[387]	None[388]	None[389]

Pneumococcal Vaccination Around the World

Beyond the authorized pneumococcal vaccination noted in Canada, there are two other vaccines that are used in other countries. One example is a PCV10 vaccine, PNEUMOSIL, which is not only more affordable than other PCVs, but also provides protection from prevalent serotypes in developing countries.[390] In regards to polysaccharide vaccines, there is Sinovac PPV23, which contains 23 serotypes that are commonly found in China.[391]

The European Centre for Disease Prevention and Control notes that 23 of the 30 European Economic Area (EEA) countries have recommendations for pneumococcal vaccination among adults.[392] Despite all but two of these countries providing general recommendations for adults 65 years and older, various vaccine schedules were noted (e.g., PPV23 and/or PCV20).[393] This was similarly seen with recommendations for adults aged 18 to 60 years, with only 10 countries providing any type of recommendations for this age group.[394] Additionally, only 17 countries provide public funding by the national government for pneumococcal vaccination among adults.[395]

In the United States, the Advisory Committee on Immunization Practices (ACIP) updated their recommendations in 2022 and 2023 to include consideration of the use of PCV20 and PCV15 among adults 19 years and older.[396,397] Adults 65 years of age and older, and those aged 19 to 64 years with underlying medical conditions or other risk factors for IPD, who have not received any pneumococcal vaccine or who have an unknown vaccination history are recommended to receive either one dose of PCV15 followed by PPV23 or one dose of PCV20.[398] For those who receive PCV15, the dose of PPV23 should be given at least one year later for most adults (eight weeks in some circumstances).[399] It is important to point out that the ACIP notes, for adults 65 years and older who have completed the previously recommended vaccine series with both PCV13 (at any age) and

PPV23 (when 65 years and older) but have never received PCV20 or PCV15, shared clinical decision-making is recommended regarding receiving PCV20.[400] This implies that the recommendation is not meant for the entire population group but more so for use on an individual basis, guided by a decision process between the individual and health care provider.[401] In regards to funding, older adults and individuals living with certain disabilities/conditions who have Medicare,[402] will be covered under Part B for pneumococcal vaccine shots.[403] On July 2024, ACIP began recommending PCV21 as an option for adults 19 years and older who are recommended to receive a PCV vaccine.[404]

Improving Vaccination Rates

Pneumonia is a serious, potentially fatal disease,[405] and is, in many cases, preventable with vaccination.[406] Despite this, vaccination rates for both children and older Canadians in particular remain below national targets.[407,408] Factors that influence the low rate of vaccinations include a lack of public funding for vaccines and the lack of awareness about which vaccines are needed and when.[409,410] The role of health care providers in recommending vaccines is critical to uptake.[411,412]

Education

Although Canadian adults are generally receptive to receiving vaccines, there is still a significant lack of awareness about which vaccines they need. Since 2019, PHAC's Seasonal Influenza Vaccination Coverage Survey has looked into the knowledge, attitudes and beliefs regarding vaccination. Across every iteration of the survey, findings noted that around 90% of adults in Canada strongly or somewhat agreed that vaccines are important to their health.[413,414] Also, research shows that both the public and health-care providers generally accept the concept of vaccination and understand that prevention is a better option than treatment.[415] However, a study found that only 21.7% of Canadians strongly agreed or agreed that they knew what vaccines they should have received according to public health recommendations.[416] Similarly, a PHAC survey in 2016 reported that despite 88% of Canadians believing they were up-to-date on their vaccinations, only 3% were found to be up-to-date according to Canadian recommended standards.[417]

Furthermore, in one study, 20% of the individuals surveyed who were eligible to receive the pneumococcal vaccination for free, said that they had never heard of the vaccine.[418] In another study, when asked whether they felt pneumonia could be prevented by a vaccine only 43% of adults said yes, compared with 60% saying yes to influenza being preventable by a vaccine.[419] The PneuVUE study found that only 44% of Europeans thought pneumonia was contagious, and less than 30% were aware of the vaccine.[420] Only 13% of people considered themselves "very much at risk" of developing pneumonia, despite approximately 70% of them having had at least one risk factor for developing pneumonia.[421]

Approximately 59% of older adults considered themselves to be only slightly at risk, and 21% who thought they were at no risk.[422]

The above evidence highlights the need for clearer public-health messaging, as research has noted that there is better acceptability of pneumococcal vaccination among Canadians who have a positive attitude about vaccines and who believe it to be needed and important.[423] Also, for both the general public and high-risk groups within Canada, studies have shown better acceptability of pneumococcal vaccination among those who perceive themselves to be susceptible or at risk of pneumococcal disease and desire to protect themselves against the infection.[424]

People aged 65 years and older tend to achieve higher vaccination rates in Canada than adults in general,[425] and this has also been the case with pneumococcal vaccination.[426] However, individuals surveyed who considered themselves to be "well" or "very fit" were less likely to think that they were at high risk for pneumonia in comparison to individuals who were considered to be "well, with treated co-morbid disease" or "apparently vulnerable."[427] Similar small studies have found that adults with comorbidities were more likely to report receiving a pneumococcal vaccination.[428, 429] Future education programs should consider those adults who are apparently healthy, focusing on their risk of pneumonia and IPD, and the likelihood of them having more severe outcomes because of their age.[430] Generally, the older population should be educated consistently emphasizing the importance of vaccination as a way to maintain overall good health.[431]

Provider Influence

Doctors and other health care professionals play a significant role in increasing vaccination rates. A European study found 75% of people who got the vaccine were prompted by their doctor to do so.[432] Only 55% of respondents aged 65 years and older were offered the vaccine by their doctor, despite all qualifying for it.[433] A scoping review found that receiving input from a health-care provider (e.g., information, recommendation or a prescription of pneumococcal vaccination) was an enabler of pneumococcal vaccination across studies in the US, Japan, Poland and France.[434]

The important role of health care professionals in shaping vaccination

behaviour against pneumococcal disease is also evident among Canadians. A systematic review found evidence that recommendation from a health care provider had a positive influence on acceptability of pneumococcal vaccines on the general public and high-risk groups in Canada.[435] Also, a study of Canadian rheumatology patients noted that the strongest independent predictor of influenza, pneumococcal and hepatitis B virus vaccination was physician recommendation.[436] In the recent PHAC's Adult National Immunization Coverage Survey (aNICS) findings, 71.5% of non-immunized adults respondents said they would likely get vaccinated if recommended by their health care provider.[437]

Despite this influence, another PHAC national survey noted that doctors not mentioning the pneumococcal vaccine was one of the top three reasons for non-vaccination among older adults and those aged 18 to 64 years with a chronic medical condition.[438] Also, one study found that only 13.8% of individuals reported that a health-care provider recommended that they receive a pneumonia vaccine, compared with 52.8% who said that their provider recommended an influenza vaccination.[439]

Providing education for clinicians and reminders for clinicians has been associated with achieving greater pneumococcal vaccination rates.[440, 441] This was further emphasized by a systematic review that found acceptability of adult vaccines being less among providers who felt their knowledge to be inadequate.[442] Similarly, a scoping review of research across high-income countries found multiple studies from the providers' perspective, noting that common barriers were lack of knowledge about the pneumococcal vaccination and concern about its safety and efficacy/effectiveness.[443]

There are some successful interventions that have been used to improve pneumococcal vaccine rates among adults in the community. Some of these include changing the provider administering the vaccine from a physician to a nurse; improved patient outreach, including handing out information/brochures prior to the appointment; and through providing clinician education and reminders.[444] These aspects have been noted in recently studied programs that have resulted in improved pneumococcal vaccination administration.[445,446] Additionally, having

vaccines available free of charge increases uptake and reduces both social and health inequities.[447]

With more than 90% of older adults having received the primary series of COVID-19 vaccination, the COVID-19 vaccine rollout has demonstrated that high vaccination uptake among older Canadians is an achievable goal.[448] Targeted efforts by the federal, provincial and territorial governments have been made to increase vaccine awareness and education, along with making vaccine appointments more accessible to all older adults, especially those who are homebound or have limited physical mobility.

What Are Our Governments Doing to Improve Vaccination Rates?

At the national level, various federal and provincial/territorial stakeholders aim to reduce the impact of vaccine-preventable disease through the National Immunization Strategy (NIS).[449] The NIS looks to reduce the incidence of vaccine preventable diseases and to increase the number of Canadians receiving their vaccinations.[450] In 2016, the federal government provided $25 million over five years to improve vaccination rates,[451] and thus the NIS had an updated set of five objectives for 2016 to 202.[452] One of the objectives was to have vaccination coverage goals for 2025,[453] which includes the target of 80% vaccination coverage rate for at least one dose of pneumococcal vaccine for adults aged 65 years and older.[454] Another objective revolves around better understanding un-immunized populations and determinants of vaccine uptake. Canada is currently working to improve how national vaccination coverage surveys are conducted and the Canadian Institute of Health Research (CIHR) has funded research regarding vaccination practices.[455] Third was to ensure timely and equitable access to vaccines, with the NACI's mandate having been expanded to allow for a faster decision-making process.[456]

A fourth objective of the NIS focuses on gaining the evidence to implement interventions to improve vaccination rates. This has been seen through the Canadian Immunization Research Network (CIRN) supporting research on vaccination programs, and out of the $10 million of funding allocated for 2017–22, $2 million will be used for research around vaccination acceptance.[457, 458] The last objective revolves around Canada having a better understanding and investing in the factors associated with immunization coverage. This is evident through the Immunization Partnership Fund (IPF), which looks to bring forward initiatives at various levels to improve vaccination uptake.[459] One example of a completed project is CANImmunize, an app which has been developed that allows Canadians to keep track of their vaccination records so that they are easily accessible and helps ensure that vaccinations can be received on time.[460]

The most recent PHAC departmental plan notes that the agency will launch a renewal process for the NIS through discussions with various stakeholders.[461] As part of this process, PHAC will look to take part in various initiatives including improving public understanding surrounding vaccines, monitoring vaccine uptake across priority populations and providing expert guidance to support jurisdictional decision-making on vaccines.[462] Also, the impact of the COVID-19 pandemic has resulted in more funding towards vaccination initiatives, including a combined $78 million provided to IPF since 2020. Such funding has been for community-led projects, tackling misinformation about COVID-19, and the enhancement of electronic vaccination registries.[463] This increase in funding to support COVID-19 vaccination may also lead to an increase in pneumococcal vaccination uptake over time.

The government has also released new Canadian Immunization Registry Functional Standards (2020–24) to support the various immunization registries in Canada. It provides a minimum set of standards to ensure accurate and complete record collection.[464] These guidelines follow the updated National Immunization Data Elements (NIDE) released in 2018 to note the minimum categories immunization registries must store to encourage interoperability.[465] This focus on immunization registries is needed as provinces and territories have varying immunization information systems, differing in data collection system, reporting capabilities and features.[466] Despite the pandemic creating an urgency to improve vaccination practices, it was noted that provinces and territories are still using a patchwork of systems to keep note of vaccinations.[467]

Not Enough Data Exist to Fully Understand Pneumococcal Disease and Vaccination in Canada

More Data are Needed for Diagnosis, Treatment and Surveillance

Pneumonia is typically diagnosed by a health-care professional after a history is taken and an examination is performed sometimes in combination with an X-ray and/or blood test.[468] Additional or more specific tests may be ordered in certain cases, such as in older adults or those with chronic conditions.[469]

Diagnostic testing for patients presenting with CAP has been debated among experts in this field including respirologists and infectious disease specialists.[470] There is a lack of consensus on what the appropriate use of diagnostic tests should be for pneumonia.

In 2000, a committee made up of representatives from the Canadian Infectious Disease Society (CIDS) and the Canadian Thoracic Society (CTS) released recommendations on the initial management of CAP.[471] They suggest that the majority of patients who are treated outside of a hospital do not require specific diagnostic tests, unless there is a specific need determined for diagnostic collection.[472] For patients who are admitted to the hospital, cultures and sputum/mucous (fluid that is coughed up) should be taken; however, treatment should not be delayed if the person is ill and having trouble providing a specimen.[473]

It is also noted that correctly diagnosing CAP can be difficult.[474] In practice, CAP is generally diagnosed based on clinical symptoms and a physical exam.[475] There are some difficulties with the tests that currently exist, including low sensitivity and a delay in receiving lab results.[476] However, where microbiological testing is done, it can provide useful data that would allow for more appropriate treatment and better surveillance on a larger level.[477] There is a need to develop new tests that are more specific and better able to diagnose CAP.[478]

Urinary tests are sometimes used for diagnosis of pneumococcal pneumonia because they are easy to use and non-invasive.[479,480] However, they lack specificity in children and may give false positive results for children.[481,482] Pfizer has developed a non-commercial serotype-specific urinary antigen detection (SSUAD) assay that is more sensitive, developed to determine vaccine efficacy and better assess pneumococcal infections in bacteremic and nonbacteremic CAP.[483,484] This test is not commercially available yet and is only able to identify the serotypes covered in the PCV13 vaccine.[485,486] However, if this test was used in combination with the current urinary tests, it would be able to identify the specific serotype causing CAP.[487,488] There have also been a SSUAD assay developed to identify 24 serotypes (covered in PCV13 and PPV23), along with the cell wall polysaccharide antigen.[489,490]

Non-invasive accurate diagnostic tests would also allow treatment to be targeted more appropriately and ensure that the treatment used is necessary.[491] Determining the cause of illness earlier can lead to patients being provided with the right treatment earlier, improve the effectiveness of treatments, ultimately reducing the spread of disease and the costs associated with treatment and hospitalization.[492,493] This would also allow for proper surveillance data to support vaccination recommendations for Canadians.

Due to some of the challenges with the tests and a lack of consensus on when and whether they should be used, the number of cases of CAP and the complications associated with them are underrepresented.

The current patchwork of data that is available also has limitations. In Canada, national surveillance data of IPD is available, but there is little data available on the actual burden of CAP or on the complications and effects that CAP has on individual Canadians, for example, hospitalization rates, complications from CAP and mortality.[494] However, there are several existing and emerging surveillance systems and networks that are aiming to address this gap (see section on page 55). Better surveillance data would be helpful for prevention and treatment of pneumococcal disease. We currently require a better understanding of serotypes that are causing illnesses among Canadians in order to create better vaccines to reduce the burden of illness.

A Lack of Data on Vaccination Rates Further Compounds the Problem

Canada lacks good data on its actual rates of pneumococcal vaccination. In other words, we do not fully know who is getting the vaccine and who is not. Without this data we are unable to clearly identify where messaging, such as outreach campaigns, or where educational materials should be targeted to best increase vaccination rates overall.

Adult vaccine coverage rates for pneumococcal vaccines in Canada are measured through self-reported surveys. Studies have noted that self-reported pneumococcal vaccination can potentially lead to underestimations due to individuals being unaware of pneumococcal vaccination.[495] This may be due to the vaccine being given several years prior, unlike influenza vaccine, which is given on an annual basis.[496] All these surveys also have experienced response rate issues, which has resulted in certain estimates being suppressed or the increased possibility of non-response bias.[497,498] Additionally, all the surveys only recruit community-dwelling individuals[499,500,501,502] which excludes high-risk groups such as long-term care residents.[503]

A significant issue across the surveys over the past few years is the lack of a consistent set of information that will allow an analysis of the adult groups focused by NACI: adults 65 years and older; adults 18 to 64 years at risk for IPD. Each of the surveys provides different types of information, across different sample groups (Table 5). Within the Seasonal Influenza Vaccination Coverage Surveys (2019, 2021), vaccine coverage data was differentiated based on risk group (e.g., those aged 18 to 64 years with chronic medical conditions, those aged 65 years and older) and sex. The surveys also looked into reasons for non-vaccination.[504,505] The CCHS differentiated vaccine coverage data specifically among adults 65 years and older across numerous factors (e.g., sex, ethno-racial group, jurisdiction). Similar to the previous surveys, it looked into reasons for non-vaccination.[506] The aNICS (2023) differentiated vaccine coverage data across various factors as well and looked into the intention to vaccinate based on health care provider recommendation.[507] However, all the data grouped together the following population groups: 18 to 64 years with chronic health condition(s), adults 65 years and older (50 and older in Nunavut) and current smokers.[508] These differences hinder the ability to compare data and evaluate any trends in pneumococcal vaccine uptake.

Table 5: Information Provided by National Surveys on Pneumococcal Vaccination (2016 to 2024)

	aNICS 2016	Influenza Survey 2019	CHSS 2019/2020	Influenza Survey 2021	aNICS 2023
Vaccine rates among adults 65 years and older	Yes	Yes	Yes	Yes	Yes
Vaccine rates among adults 18 to 64 years with high-risk conditions	Yes	Yes		Yes	*
Vaccine rates across jurisdictions among adults 65 years and older			Yes		*
Vaccine rates across multiple factors among adults 65 years and older	Yes		Yes		*
Reasons for non-vaccination among above population groups		Yes	Yes	Yes	

* Reported findings are for all respondents overall, does not differentiate for this population group.
Sources: Public Health Agency of Canada, Statistics Canada

Additionally, despite the recent aNICS findings providing data across various factors, by grouping together population groups, it does not allow an analysis of the specific groups focused by NACI.[509] With aNICS not having additional pneumococcal vaccine specific questions, such as the reasons for non-vaccination that was noted in other surveys, it does not allow for a complete understanding of the factors contributing to pneumococcal vaccine uptake in Canada.[510,511,512]

Across Canada, it is even difficult to capture those who are receiving pneumococcal vaccinations through physician billing data. For example, in Ontario, there is an Ontario Health Insurance Plan (OHIP) billing code to help capture the administration of the pneumococcal conjugate vaccine (typically given to children), but the pneumococcal polysaccharide vaccine (typically given to older adults) does not have a specific OHIP code to help capture its administration.[513]

A Snapshot of Pneumonia Surveillance Systems in Canada

Since 2000, IPD has been identified as a nationally notifiable condition through the Canadian Notifiable Disease Surveillance System (CNDSS).[514] IPD is considered a priority for monitoring as it can lead to many serious outcomes.[515] Once a disease is notifiable, provinces and territories voluntarily provide IPD data to the federal government.[516] This system collects epidemiological trends and reports on the rates and cases of IPD; it also collects basic demographic information including age and sex.[517]

Additionally, limited data on IPD is collected through the National Microbiology Laboratory (NML) Streptococcus Disease Surveillance, which began in 2010.[518] This laboratory data includes serotype data,[519] and antimicrobial susceptibility,[520] but it is not nationally representative and is limited by reporting differences between jurisdictions.[521] Other limitations exist, for example, currently only approximately 50% of invasive cases are sent to the NML and it is not linked to the epidemiological data in the CNDSS.[522]

Two specialized pneumonia surveillance programs exist for specific populations, the Immunization Monitoring Program, ACTive (IMPACT) and International Circumpolar Surveillance (ICS). IMPACT is a paediatric hospital-based surveillance network and ICS is surveillance for the three territories, northern Labrador and regions of Quebec.[523, 524] Both of these link epidemiologic and laboratory data (i.e., demographic information and serotypes).[525] These are good data collection systems but, because they are collecting results specific to children and northern populations, their results cannot be generalized.[526]

There is a need for a more enhanced national surveillance system that would be able to combine epidemiological data with more specific laboratory data to monitor the serotypes that are causing disease.[527, 528] The Enhanced National Invasive Pneumococcal Disease Surveillance System (eIPDSS) pilot was launched in 2011.[529] It was piloted in New Brunswick to determine the feasibility of conducting timely data collection and linking epidemiologic and laboratory data.[530] The pilot was not able

to be expanded to other provinces due to challenges linking epidemiological and laboratory data.[531] If these challenges are able to be overcome, it would create better understanding of IPD trends, serotype distribution, antimicrobial susceptibility and abnormal clusters across Canada.[532]

In 2009, the Serious Outcomes Surveillance (SOS) Network, a hospital-based surveillance system that collects information about patients admitted to hospital with either influenza or pneumonia was created.[533] SOS has provided real-time surveillance data for influenza and CAP in adults, but surveillance for CAP is no longer included due to funding constraints.[534,535,536] Currently the network has participating hospitals from Alberta, Ontario, Quebec, New Brunswick and Nova Scotia that provide data.[537,538]

Our ability to develop more effective pneumococcal vaccines will depend on whether the serotypes that are causing the most significant morbidity, mortality and burden are covered in the vaccines.[539] Data is needed to determine which serotypes are found in hospitalized or ill individuals so that the vaccines can be adapted to ensure they are covering the serotypes that are most affecting Canadians.

Evidence-informed Recommendations

Based on examination of current evidence, Canadian and international policies, and our existing estimated vaccination rates, there is much more work to be done to improve prevention of pneumonia and other pneumococcal diseases in Canada. The following recommendations provide evidence-informed policy and practice approaches that can be used by health authorities and organizations to support vaccination and overall prevention across Canada.

1. Promote General Preventive Practices in Addition to Vaccination

There are other mechanisms of prevention that will be helpful to prevent the spread of pneumonia and other respiratory conditions. We should continue to encourage the routine adoption of these practices in addition to vaccination.

Other Means to Prevent Pneumonia[540]

- Don't smoke
- Avoid second-hand or third-hand smoke
- Receive the annual flu shot
- Wash hands often and properly
- Avoid those individuals around you who may be sick
- Don't share cutlery or cups with individuals who may be sick

2. Promote a Life-Course Vaccination Schedule that includes Older Adults

Primary care physicians, nurses and, in many jurisdictions, pharmacists are able to administer pneumococcal vaccinations and should be discussing vaccination options with their patients. However, due to the connection with specified conditions (including heart, lung, and kidney disease, diabetes and cognitive impairment) specialists should also be discussing this option with their patients. Studies have found that professionals play a significant role in increasing pneumococcal vaccination acceptability and uptake within Canada.

Consistent messaging around which vaccinations should be given and when they should be given is required. Universal vaccination schedules for children are commonly accepted as part of routine care; however, routine vaccinations are also important for adults. Establishing a life-course vaccination schedule that includes both children and older adults would streamline messaging and practice for providers and the general public to support increased vaccination rates. Although public health agencies and governments communicate the importance of adult immunizations, there is inconsistent messaging around which vaccinations should be given or when.

3. Improve Monitoring of Pneumococcal Disease Rates

As previously discussed, we lack an easy way to test and treat for pneumonia. Currently, most pneumonia cases are diagnosed using X-rays, which does not allow the doctors to determine which serotype is causing the disease.

The lack of specific diagnostic tests available means the true burden of pneumonia across the country is likely underestimated.[541] In Canada, national surveillance data of IPD is available, but there are few available data on the burden of CAP.[542] This means that there is a lack of good quality national data on the complications and effects of CAP on individual Canadians, for example, hospitalization rates, complications from CAP and mortality.[543] If we can link the serotype and other laboratory data to the epidemiological data it would result in better data and potentially lead to the creation of better vaccines.[544]

4. Improve Reporting and Surveillance of Pneumococcal Vaccination

Over the past few years, estimated Canadian vaccination rates have been based on various self-reported surveys, the

Seasonal Influenza Vaccination Coverage Survey (2019, 2021), Canadian Health Survey on Seniors (CHSS) (2019/2020) and Adult National Immunization Coverage Survey (aNICS) (2023).[545,546,547,548] Common issues across these surveys include potential for underestimations of pneumococcal vaccine coverage, not including certain high-risk populations (e.g., long-term care residents) along with the impact of low response rates. Most importantly, each of these surveys provide different information across different sample groups, hindering the ability to compare and evaluate any trends in pneumococcal vaccine uptake.

Better and consistent data on who has received a vaccination is needed in order to determine how far Canada is from the 80% target vaccination rate for adults and 95% for children. This will help understand where additional effort is needed to get more people vaccinated and address potential equitable access issues.

An avenue of change is to reduce the patchwork of immunization information systems that have been apparent across Canadian provinces and territories.[549] Governments could look to enforce the Canadian IRFS and NIDE to update immunization registries to ensure not only accurate data collection, but also interoperability across jurisdictions. This would assist with providing faster and accurate vaccination rates, along with information on trends.

Provinces and territories have established strategies to identify, target and monitor COVID-19 incidences, deaths and vaccine uptake rates among older adults, which can be leveraged to improve the monitoring of pneumococcal disease and vaccine uptake. These systems were implemented at the community level, helping to identify and support older adults and other vulnerable populations. For example, the Ontario COVID-19 Science Advisory Table conducted several studies using vaccination data to identify key characteristics that influence older adults' vaccination uptake. It recommended specific strategies to target these populations, including targeting homebound older adults and adults living in naturally occurring retirement communities (NORCs) in high-risk neighborhoods. The vaccine registries and monitoring systems used to identify and target eligible populations during the COVID-19 vaccination rollout should also be used to identify and target the older adult population for pneumococcal vaccination. This is particularly crucial for those facing greater barriers to access, such as homebound older adults.[550]

5. Continue Working Toward Developing Better Pneumococcal Vaccines

New vaccines that are developed will need to be affordable and will need to cover against more strains that are prevalent.[551] Additionally, there is a need to focus on vaccines with longer-lasting immunity effects with more strains for the ageing population.[552] It is evident how serotype prevalence among IPD cases differ across age groups, with vaccine-related serotypes being more or less prevalent among adults 65 years and older, compared to all ages (Figure 4).

There are, however, risks associated with developing higher valence vaccines, including potentially facing interference in immune response by the increase in molecules and continuing the phenomenon of serotype replacement that has been witnessed for PCV7 in Canada.[553,554]

Ideally, universal pneumococcal vaccines would be useful for older populations.[555] However, conjugate and polysaccharide vaccines are serotype specific; therefore, future directions may also focus on a vaccine against a surface protein on pneumococci versus each serotype.[556,557]

Currently, there are numerous vaccine candidates that are being tested beyond the vaccines currently available in Canada. These include PCVs that contain as many or more serotypes (up to 31).[558] There are also other types of pneumococcal vaccines at the clinical stages including protein-based, live vector and inactivated whole cell vaccines.[559]

6. Provide Clinician Education and Support for Primary Care Providers and Pharmacists to Better Deliver Vaccinations

As can be seen from Table 4 above (pages 33-37), there are many differences among the provinces and territories on who can administer the vaccination, which vaccinations are recommended and which populations are funded to receive the vaccine. This can lead to confusion for the general population about whether they should be vaccinated, which will be funded for them and where they can get it. Pharmacists should be able to administer pneumococcal vaccinations to their target populations. This will reduce confusion around messaging about where to receive the vaccine, which will reduce barriers to its uptake by a larger population of appropriately eligible Canadians.

7. Harmonize the Funding and Messaging for Pneumococcal Vaccinations for Target Populations Across Canada

It is also important that we harmonize the funding and messaging of the vaccines for the same target populations. Right now, there are differences across the country in the coverage of pneumococcal vaccinations. For example, nine provinces and territories cover the PCV20 vaccine for adults aged 65 years and older, whereas the remaining provinces and territories cover the PPV23 vaccine for this age group (50 years and older in Nunavut). Vaccine coverage is even more varied for adults with certain medical and lifestyle risks, for both groups and type of vaccine covered. Provinces and territories cover one of the following four vaccine series for high-risk adult groups: PCV20, PPV23, PCV20 and PPV23, or PPV23 and PCV13 vaccines. By harmonizing funding and coverage policies, a common message may be given to all Canadians and their care providers regarding pneumococcal vaccination.

8. Recommend the Administration of Pneumococcal Vaccine in Conjunction with the Influenza and COVID-19 Vaccination

Influenza and pneumonia as a cause of death are often recorded together. Those who acquire both influenza and pneumonia have worse outcomes, increased hospitalization and sustain more damage to their lungs.[560] Studies have found significantly lower all-cause mortality rates when older adults are vaccinated against both diseases, compared to just influenza.[561]

It is safe to administer both the influenza and pneumococcal vaccine at the same time. As influenza is provided annually, it provides a good opportunity for health-care professionals to inquire about pneumococcal vaccination status annually and, if necessary, provide both vaccines at the same time.

Currently, NACI recommends that the COVID-19 vaccines can be delivered in conjunction with other vaccines (including live and non-live vaccines).[562] Therefore, COVID-19 vaccines may be given at the same time, or any time before

or after, other vaccines.[563] This creates an opportunity to improve immunization rates for other vaccine-preventable diseases, such as pneumonia, by also reducing other barriers to appointments, such as transportation to a clinic or physical limitations.

9. Promote Following the Current NACI Statement for Pneumococcal Vaccination

The NIA recommends that Canadians continue to follow the suggested vaccination schedule that NACI recommends. Vaccination is recommended for adults 65 years and older, individuals with high-risk conditions and infants/children. We believe that these are strong recommendations based on the current data available. The NIA recommends that individuals discuss with their health-care provider which option is best for them.

Please refer to **https://www.canada.ca/en/public-health/services/immunization/national-advisory-committee-on-immunization-naci.html** for all current recommendations for Canadians.

10. Promote Pneumococcal Vaccination for Residents of LTC Homes

PHAC has listed that LTC home residents of all ages are at an increased risk for IPD.[564] PHAC also notes that it is particularly important for residents of LTC homes to consider the influenza, COVID-19, respiratory syncytial virus, pneumococcal and herpes zoster (shingles) vaccinations.[565,566,567] The NIA has previously recommended that requiring influenza vaccinations should be considered for those living in LTC homes. Studies have shown that receiving both influenza and pneumococcal vaccinations was associated with a significantly lower all-cause mortality rate among older adults in comparison to just influenza vaccination.[568] The NIA therefore recommends promoting pneumococcal vaccination for all LTC residents as well.

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