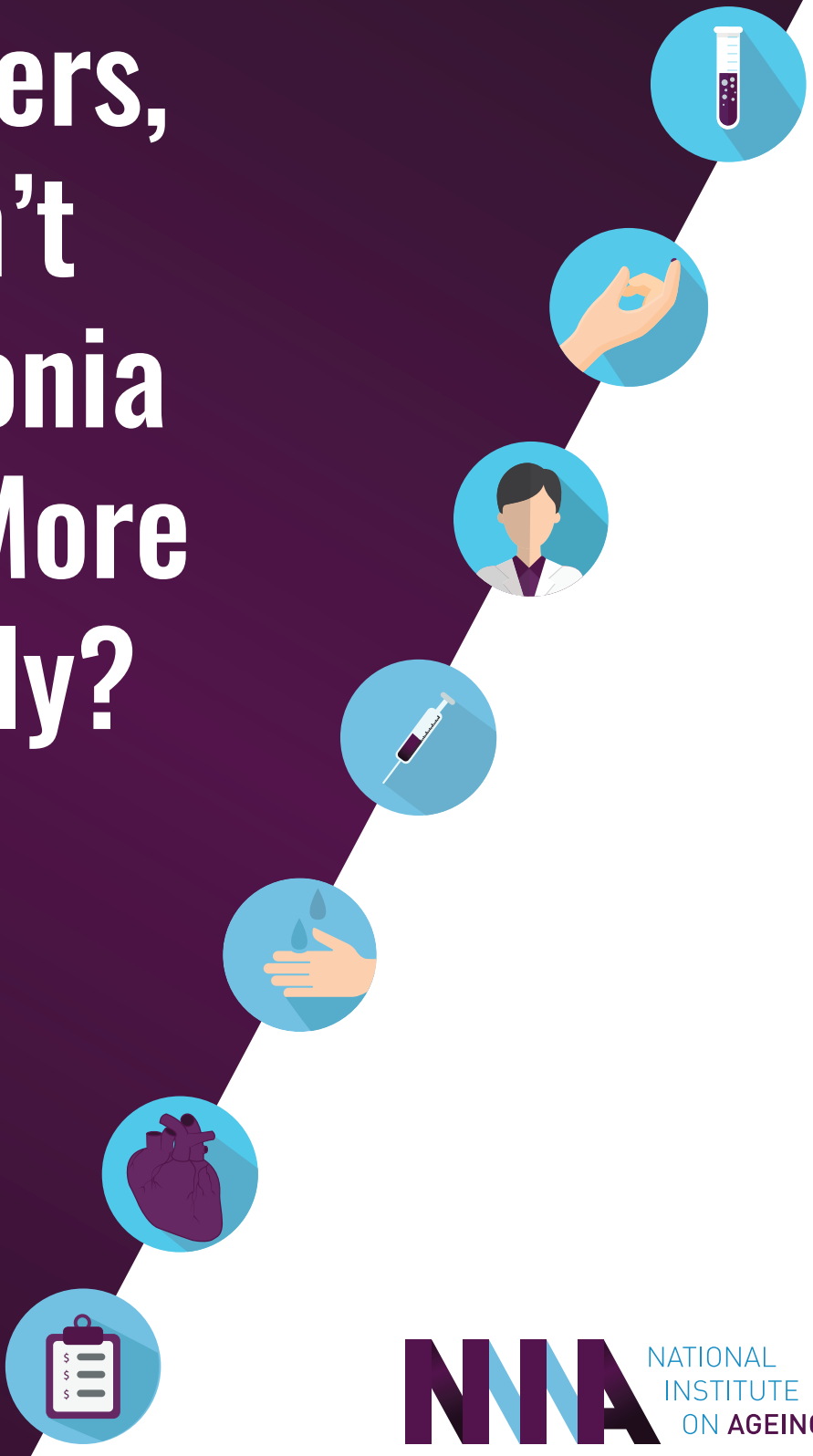
As One Of Canada's Top Killers, Why Isn't Pneumonia Taken More Seriously?



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NIA NATIONAL INSTITUTE ON AGEING

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About the National Institute on Ageing

The National Institute on Ageing (NIA) is a public policy and research centre based at Toronto Metropolitan University (formerly Ryerson University). The NIA is dedicated to enhancing successful ageing across the life course. It is unique in its mandate to consider ageing issues from a broad range of perspectives, including those of financial, psychological, and social well-being.

The NIA is focused on leading cross-disciplinary, evidence-based, and actionable research to provide a blueprint for better public policy and practices needed to address the multiple challenges and opportunities presented by Canada's ageing population.

The NIA is committed to providing national leadership and public education to productively and collaboratively work with all levels of government, private and public sector partners, academic institutions, ageing related organizations, and Canadians.

National Institute on Ageing Immunization Series

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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.

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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 2020-21, only 55% 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 80% of Canadian children have been vaccinated against pneumococcal disease.[4] While many Canadians believe that they are up-to-date on their recommended vaccinations, the reality is quite different. In 2016, 88% of Canadians responding to a PHAC survey reported that they were up-to-date on their vaccinations, but only 3% were found to be up-to-date based on Canadian recommended standards.[5]

Pneumonia represents only one possible manifestation of pneumococcal disease or infection. Pneumonia 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.[6]

Many Canadians believe that they are up-to-date on their recommended vaccinations, but the reality is quite different. In 2016, 88% of Canadians responding to a PHAC survey reported that they were up-to-date on their vaccinations, but only 3% were found to be up-to-date according to Canadian recommended standards.[7]

It can be serious and sometimes fatal – especially for older adults, infants and young children.[8] Pneumonia can be caused by bacteria, viruses (including influenza and SARS-CoV-2) and more rarely by fungi.[9]

The most common cause of bacterial pneumonia is a bacteria called *Streptococcus pneumoniae*.[10] *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.[11] This can result in meningitis and bacteremia.[12]

The incidence of pneumonia among adults is highest with older Canadians.[13] There are increased rates of pneumonia in older adults when compared to those under the age of 65, with residents of long-term care (LTC) homes having even higher rates.[14]

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.[15] Similarly, over the past several years, pneumonia has been one of the top 10 diagnoses with the highest hospitalizations.[16-20] Together with influenza, pneumonia was the eighth leading cause of death in Canada in 2020.[21] 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.[22,23]

Pneumonia is among one of the top 10 reasons that people went to ED in Canada, with over 139,800 pneumonia-related ED visits in 2019-20.[24]

Lack of availability of specific diagnostic tests means that the true burden of pneumonia across the country is likely underestimated.[25] 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.[26] Two main types of vaccines for *S. pneumoniae* are currently available — polysaccharide and conjugate vaccines.[27,28] Polysaccharide vaccines are recommended for healthy older adults, as well as younger adults and children at high risk of invasive pneumococcal disease,[29] while conjugate vaccines were created to provide a stronger and more durable immune response, particularly for children under two years of age, and for immunocompromised populations.[30]

In Canada, it is recommended that adults aged 65 years and older, children, and individuals at high-risk of developing invasive pneumococcal disease are vaccinated against pneumococcal disease.[31]

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

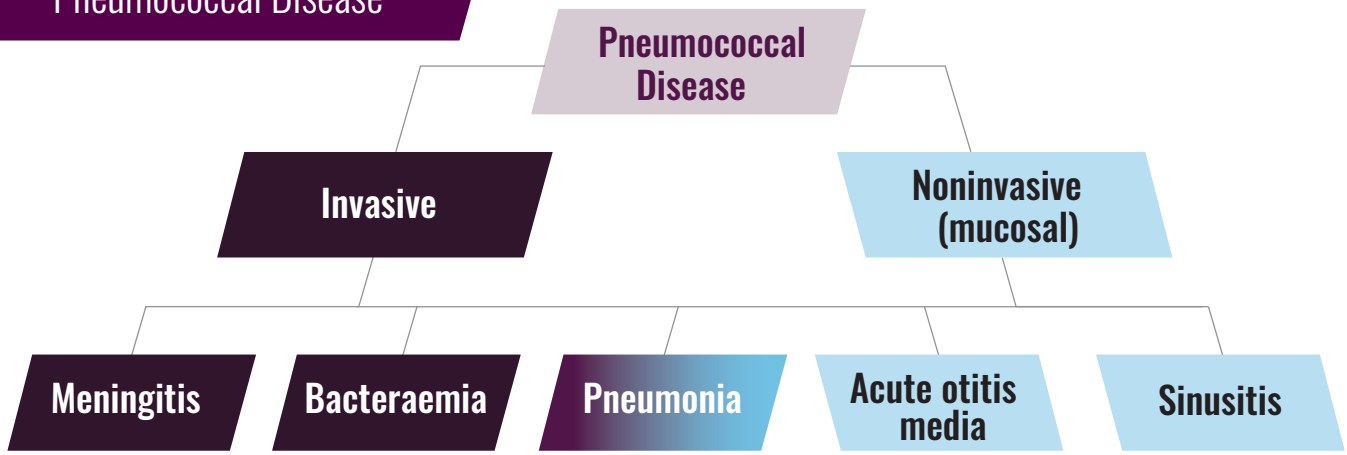
8. Recommend the Administration of the Pneumococcal Vaccine in Conjunction with Influenza and COVID-19 Vaccination

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

Figure 1:
Pneumococcal Disease



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).[32] 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.[33] Pneumonia is the most common serious manifestation of pneumococcal disease, especially among older adults.[34]

In addition to bacteria, pneumonia can be caused by viruses (including influenza and SARS-CoV-2), and more rarely by fungi.[35] The most common cause of bacterial pneumonia is the *S. pneumoniae,* which normally lives in the human nose and throat.[36] It can be transmitted through direct mouth-to-mouth contact, coughing or sneezing, or through indirect contact with someone who carries the bacteria asymptomatically.[37]

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.[38] 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.[39]

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[40,41]

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.[42] Pneumonia can also be serious for infants and young children.[43]

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).[44] In children under the age of two, IPD typically manifests as bacteremia or meningitis.[45] 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.[46] Bacteremia is an infection of the blood, which leads to symptoms that include fever, chills and lack of alertness.[47] In adults, IPD typically presents as something called "bacteremic pneumococcal pneumonia," which can be a common complication of influenza.[48,49] IPD is more common in the very young, older adults and high-risk groups during winter/spring months in countries with temperate climates.[50,51]

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.[52,53] 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.[54] HAP is often more severe than CAP because patients are already sick before becoming infected.[55] In addition, their infection may be due to a more virulent or antibody resistant strain of bacterial.[56] Walking pneumonia refers to a pneumonia where the symptoms may be quite mild.[57] Generally people with this type of pneumonia are able to function and may think that they only have a cold.[58] One study found that patients who had CAP had increased rates of hospitalizations and ED visits when compared to patients who never had CAP.[59] The rate of mortality for CAP is highest among those older than 65 years.[60]

The Burden of Pneumonia in Canada

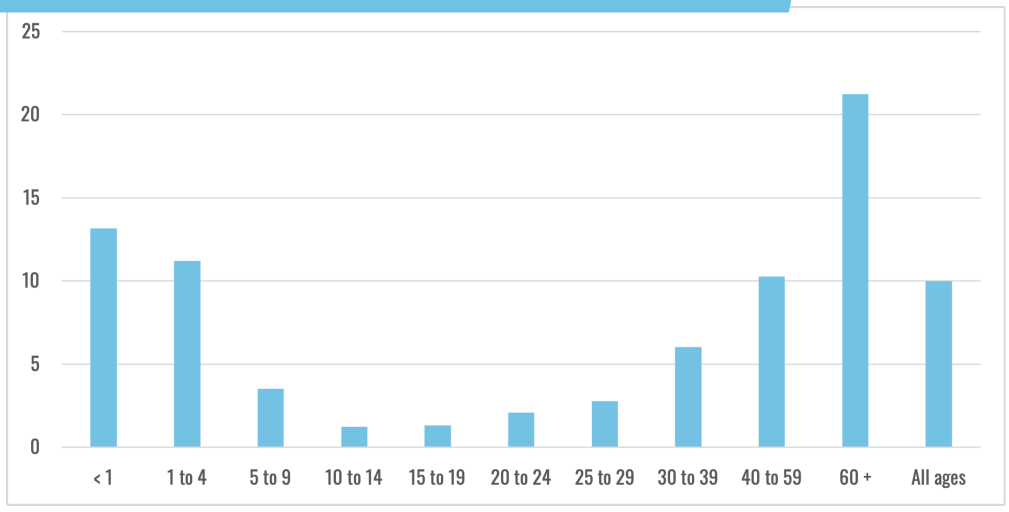
Older Canadians Are at Greatest Risk

Pneumonia also has a disproportionate effect on older Canadians. The rates of pneumonia in older adults are higher when compared to those younger than 65 years, especially among older adults living in LTC homes.[61] Estimates of the annual incidence of pneumonia among those aged 65 years and older vary from 2.5% to 4.4%, up to four times that of those younger than 65 years.[62] In comparison, estimates suggest that the annual incidence rate for adults aged 65 years and older living in a LTC home range from 3.3% to 11.4%.[63]

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.[64]

Older adults also have the highest incidence of IPD. In 2019, the rate of reported cases of IPD in Canada was 10 per 100,000 people, but it was 21 per 100,000 people for adults aged 60 years and older.[65] The extent of the impact on older adults is further highlighted by the fact that the next highest rate of IPD was only 13.18 per 100,000 people among children younger than one year (Figure 2).[66] Moreover, the oldest Canadians remain the most impacted — the incidence among individuals aged 85 years and older was 42 cases per 100,000 people in 2015.

Figure 2: Annual Incidence of IPD Reported Cases (per 100,000) by Age Group in Canada, 2019



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,[67] with over 139,800 ED visits.[68] 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.[69] 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.[70] Adults aged 65 years and older accounted for 34.8% of pneumonia-related ED visits (48,723) in 2019-20.[71]

More recent estimates from 2020-21 suggest that ED visits from pneumonia during the pandemic decreased substantially to just under 45,800 ED visits, a value that has never been reached in the past 17 years of the CIHI data (Table 1).[72] Despite total ED visits having dropped from over 15 million in 2019-20 to just over 11.6 million in 2020-21,[73] 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.[74] However, the size of the decrease in pneumonia cases was much lower in older adults than in younger adults and children, such that the percentage of adults aged 65 years and older among pneumonia-related ED visits, increased from 34.8% in 2019-20 to 51.9% in 2020-21.[75]

Table 1: Number of ED Visits due to Pneumonia Fiscal Year 2020-21

Age Group	Total ED Visits	Percentage
0-19	3,123	6.8%
20-44	7,121	15.6%
45-65	11,777	25.7%
65+	23,755	51.9%
Total	45,776	

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.[76-80] 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.[81-84] 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.[85]

Similar to emergency department visits, pneumonia-related hospitalizations decreased substantially during the pandemic, with recent CIHI data (2020-21) no longer listing pneumonia as a top 10 high-volume inpatient hospitalization in Canada.[86] Only two jurisdictions — Saskatchewan and Northwest Territories — had pneumonia listed in their rankings.[87] In terms of age group, pneumonia only made it to the top 10 list in those aged 65 years and older.[88] Even within this age group, the number of inpatient hospitalizations has decreased by close to 40% in comparison to previous years.[89-93] The reason for this change was also due to the reduced spread of respiratory viruses and bacteria from the various public health measures during the initial phases of the COVID-19 pandemic.[94]

Together with influenza, pneumonia was the eighth leading cause of death in Canada in 2020.[95]

As noted earlier, together with influenza, pneumonia is the eighth leading cause of death in Canada, collectively responsible for 5,931 deaths in 2020.[96] This has been the case for the past 20 years, where pneumonia has consistently ranked between sixth to eighth on the list of annual leading causes of death in Canada.[97] The overwhelming majority (90%, 5,312 deaths) were among those aged 65 years and older, with more than half (3,238) of the deaths occurring among individuals aged 85 years and older.[98]

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.[99] As age increased, so did the length of the hospital stay.[100] 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.[101]

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.[102] Most of the burden associated with *S. pneumoniae* was related to premature mortality and living for additional years with reduced functioning.[103] 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.[104] 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.[105] 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%).[106]

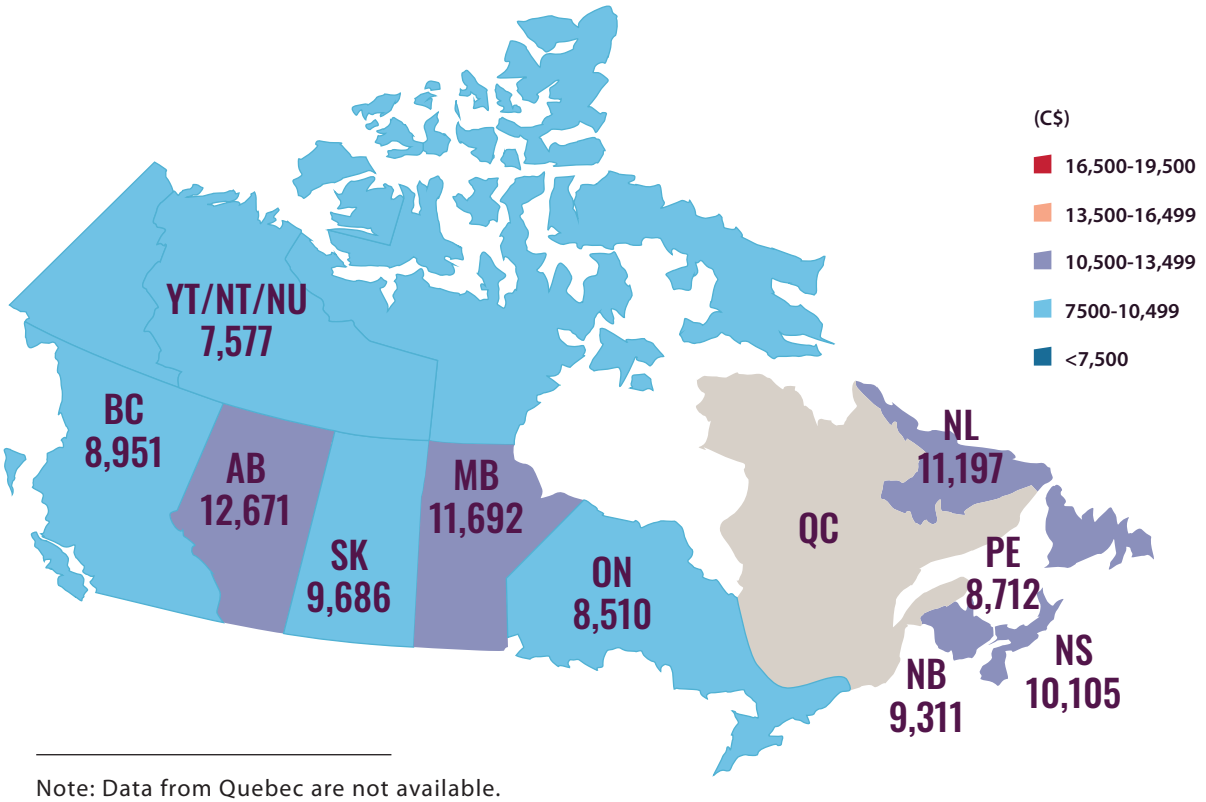
The PHAC has also provided specific information about pneumonia-related direct costs. It has been found that in 2010, pneumonia resulted in close to $622 million in hospital care expenditures.[107] Of these expenditures, 57% ($354.1 million) were among those aged 65 and older and 43% ($268.3 million) were among those aged 75 years and older.[108,109] 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.[110] Pneumonia also accounted for close to $73 million in prescription drug expenditures.[111]

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.[112]

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.[114] 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).[115] 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.[116] 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.[117] This is in comparison to the territories that have a lower cost per case, but also report a lower length of stay.[118]

Figure 3: Pneumonia Average Cost per Case by Province, 2015[113]



Note: Data from Quebec are not available.

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

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.[119,120] These groups are also at an increased risk of complications and death.[121] See Table 2 to find a modified version of NACI's table on the risk factors that place individuals at high risk of IPD.[122]

Children who are younger than the age of two, in addition to the conditions noted above, are also at increased risk.[123]

Older Adults:

With ageing, the effectiveness of the human immune system declines, commonly referred to as **immunosenescence**.[124] Immunosenescence causes older adults to be more likely to contract pneumonia and other infections, and less likely to respond to vaccines.[125] 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.[126] Please see "The History of the Pneumococcal Vaccine" box on page 26.

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.[127] 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.[128]

Table 2: Medical Conditions and Other Risk Factors Resulting in High Risk of IPD According to Canada's NACI

Non-immunocompromising conditions	Immunocompromising conditions[a]	Other risk factors
• Chronic cerebrospinal fluid (CSF) leak • Chronic neurologic condition that may impair clearance of oral secretions • Cochlear implants, including children and adults who are to receive implants • Chronic heart disease • Diabetes mellitus • Chronic kidney disease[a] • Chronic liver disease, including hepatic cirrhosis due to any cause[a] • Chronic lung disease, including asthma requiring medical care in the preceding 12 months	• Sickle cell disease, congenital or acquired asplenia, or splenic dysfunction[b] • Congenital immunodeficiencies involving any part of the immune system • Immunocompromising therapy including use of long-term corticosteroids, chemotherapy, radiation therapy, and post-organ transplant therapy • HIV infection • Hematopoietic stem cell transplant (recipient) • Malignant neoplasms, including leukemia and lymphoma • Nephrotic syndrome • Solid organ or islet transplant (candidate or recipient)	Individuals • Who smoke • Who use illicit drugs • With alcohol use disorder • Who are experiencing homelessness • Who live in communities or settings[c] experiencing sustained high IPD rates

[a] Conditions considered to result in the highest risk of IPD

[b] Generally asplenia (functional or anatomic), sickle cell disease and other hemoglobinopathies are not considered immunocompromising conditions, but for the purposes of NACI's pneumococcal vaccine recommendations they are included in this category

[c] Can include LTC facilities

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.[129] 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.[130]

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.[131]

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.[132] 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.[133]

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.[134] 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.[135] 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.[136] In addition, being previously hospitalized for COPD complications was associated with a greater chance of developing CAP.[137]

Adults living with asthma have been found to be more likely to have IPD when compared to adults without asthma.[138] The severity of the asthma is important, with the risk of IPD becoming greater as the asthma severity increases.[139] As such, in 2014, NACI added asthma as a high-risk condition.[140] Individuals who require medical attention for asthma should be given the appropriate vaccine for their age group.[141]

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.[142] Cognitive impairment was found in both older and younger adults, many of whom were completely healthy prior to their episode of CAP.[143]

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.[144] Similar to other studies, it was also found that these associations are present in individuals who were only hospitalized once and without comorbidities.[145] These results are not limited to older adults who require the most critical care.[146]

Other Chronic Conditions

Individuals living with diabetes also have an increased risk of developing CAP.[147] Diabetes has the largest impact on the development of IPD and CAP in people under the age of 64.[148] Additionally, individuals previously hospitalized with diabetes had an increased risk of developing different types of pneumonia and meningitis.[149] 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.[150]

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.[151]

Finally, it has been found that a hospitalization for pneumonia increases the risk of developing depressive symptoms by 1.6 times.[152]

Special Populations:

Canada has an International Circumpolar Surveillance (ICS) data collection system that collects data about IPD in the North.[153] 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.[154] Also in this region, the annual IPD incidence rate is statistically higher among Indigenous residents than non-Indigenous residents.[155] In Manitoba, communities that are socio-economically disadvantaged and predominantly Indigenous also have increased rates of IPD.[156]

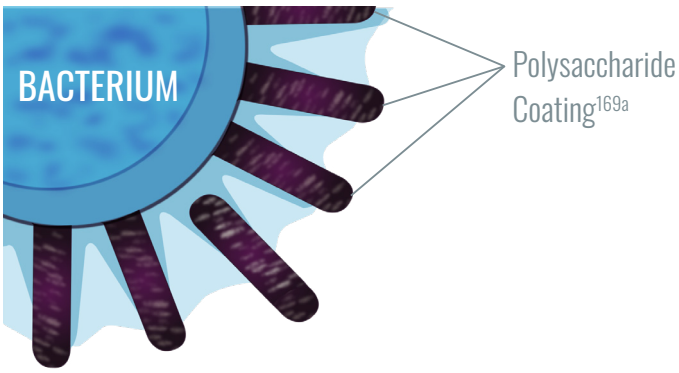
It has been noted that pneumonia-related outcomes are higher among individuals who drink alcohol, use illicit drugs, smoke and experience homelessness.[157] Two systematic reviews have identified the especially strong relationship in terms of tobacco smoke exposure and alcoholism.[158,159] In regards 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.[160] Also, alcohol disorders were associated with eight-fold increase in risk of CAP.[161] 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.[162]

Children:

S. pneumoniae is the leading cause of invasive bacterial infections in children, which includes meningitis, bacteremia, sepsis and pneumonia.[163] The average age-specific incidence rates for IPD from 2000-11 for infants (less than one year) was 34.6 per 100,000 compared to 19.0 per 100,000 adults.[164] 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.[165]

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.[166] 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.[167] 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.[168] 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.[169]



How Do Pneumococcal Vaccines Protect Us?

Vaccines are used to "show" the immune system a bacteria or virus before the body encounters it naturally.[170,171] This allows the body to develop antibodies, which protect and prevent us from getting sick.[172,173] There are two ways of developing anti-bodies — the first being naturally when an individual gets sick and survives the infection.[174] Vaccines are the second way to help create antibodies, which are protein molecules that help to kill and get rid of the bacteria.[175,176]

S. pneumoniae has a coating called a "polysaccharide capsule."[177] It is this capsule, or covering, that prevents it from being killed by immune cells.[178] *S. pneumoniae* has 92 serotypes (or strains).[179] The invasive disease caused by 24 of these serotypes can be prevented by vaccinating against these specific types.[180] The vaccines are created against specific serotype or strain.[181] 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.[182,183]

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.[184] This is when there is an increase in cases caused by serotypes that are not covered in the vaccine.[185] 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.[186] There was an increase in a specific serotype 19A,[187] which is now included in the PCV13 vaccine.[188] 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.[189]

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.[190] In Canada, this vaccine goes by the name of "Pneumovax23" and protects against 23 serotypes of the pneumococcus.[191] Young children under the age of two do not respond very well to polysaccharide vaccinations.[192] This is because their immune systems are still developing.[193]

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.[194] 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.[195] In addition, it is able to provide a "booster" effect that the polysaccharide vaccines lack.[196] This "booster" effect occurs when a person is given repeated dosages, which causes the antibody levels to go higher and higher.[197]

There are currently four 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®); and pneumococcal 20-valent conjugate vaccine (PCV20, PREVNAR 20™).[198-200] The associated number for each of the four vaccines indicate the number of serotypes of pneumococcal disease the vaccine protects the recipient from. Table 3 below shows the overlap in protection against these serotypes of pneumococcal disease across the various vaccines.[201-203]

Conjugated vaccines are used routinely in Canada for the infant immunization programs. Most provinces and territories administer PCV13.[204] Quebec is the only jurisdiction that administers a combined PCV10/PCV13 schedule.[205] These vaccines are funded for children and, in some provinces, for some high-risk adult groups.

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

S. Pneumoniae Serotypes Inlcuded in Authorized Pneumococcal Vaccines in Canada

	Serotypes in Pneumococcal Vaccines																						
Vaccine	4	9V	6B	14	18C	19C	23F	1	5	7F	3	6A	19A	2	8	9N	10A	11A	12F	15B	17F	20	22F	33F
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

Sources: Government of Canada; Merck Canada Inc.; Pfizer Canada ULC

The History of the Pneumococcal Vaccine

Development of the first pneumococcal vaccine began with gold miners in South Africa by Sir Almorth Wright.[206]

In 1886, gold was discovered in Johannesburg, South Africa, and large numbers of people were being brought in to work in the mines.[207] The rate of pneumonia was as high as 100 cases per 1,000 persons per year, with a fatality rate of 25%.[208]

Due to these numbers, pneumonia was seen as one of the greatest threats to the South African mining industry.[209]

Sir Almorth Wright and three colleagues arrived in 1911 to begin trying to develop an effective pneumococcal vaccine.[210] 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.[211]

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.[212]
- This led to the development of polysaccharide vaccines.[213]
- However, polysaccharide vaccines were less effective in children, who were getting pneumococcal disease at very high rates.[214]

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.[215]
- The first ones became available in 2000 and were found to be more effective for children affected by this disease.[216]

Pneumococcal Vaccines in Canada

- In regard to polysaccharide vaccines, PPV23 (PNEUMOVAX®23) 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.[217]
- The first conjugate vaccine approved was PCV7 (Prevnar 20™) in 2001, with all provinces and territories funding this vaccine for children under the age of two by 2006.[218,219]
- However, PCV7 has now been replaced with PCV10 (SYNFLORIX®220 authorized in 2008), and PCV13 (Prevnar®13, authorized in 2009).[220,221] By 2011, all jurisdictions used PCV13 for children's vaccination programs,[222] with Quebec switching back to PCV10 in 2018[223] and then to a mixed PCV10/PCV13 schedule in 2020.[224]
- Recently, two new PCVs have been approved by Health Canada, PCV15 (VAXNEUVANCE®, in 2021) and PCV20 (PREVNAR 20™, in 2022).[225,226] Quebec is the only jurisdiction to fund PCV20 for specific high-risk groups (children and adults) in 2023.[226a]

S. pneumoniae has 92 serotypes (or strains).[227] The invasive disease caused by 24 of these serotypes can be prevented by vaccinating against these specific types.[228]

Although expanding the number of serotypes in the vaccines seems logical, there must also be comprehensive measures to improve current vaccination adherence.[229] Due to difficulties in adding serotypes into the vaccines, there are current limits on how many serotypes can be included.[230] New vaccines with more coverage that are also affordable and that have longer-lasting immunity (particularly for older adults) are also needed.[231]

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.[232] This needs to be further understood.[233]

Who Should Get Vaccinated?

Summary of Current NACI Recommendations for Adults

Please note these recommendations note the most recent NACI recommendations for public health programs.

Age/Condition	PPV23 (Strong Rec.)[b]	PCV20[a] (Strong Rec.)[b]	PCV20[a] (Directionary Rec.)[c]	PCV15 followed by PPV23[a] (Directionary Rec.)[c]
Adults who have not previously been vaccinated or whose vaccine status is unknown				
Adults aged 18–49 years with immunocompromising conditions		✓		✓
Adults aged 18–49 years with non-immunocompromising medical conditions or other risk factors[d] placing them at higher risk of IPD	✓			
Adults aged 50–64 years with medical conditions or other risk factors[c] placing them at higher risk of IPD		✓		✓
Adults aged 65 years and older		✓		✓
Adults aged 65 years and older who have previously received PPV23 alone, or PCV13 and PPV23 in series		✓[e]		
Adults aged 65 years and older who have previously received PCV13 alone			✓	
Adult HSCT recipients		✓		

[a] If PCV20 and/or PCV15 is not available or accessible, other pneumococcal vaccines may be considered.

[b] A strong NACI recommendation applies to most populations and should be followed most of the time.

[c] A discretionary NACI recommendation may be considered for some populations in some situations.

[d] See Table 2.

[e] An additional dose of PPV23 may be given a year later for those at highest risk of IPD (Table 2).

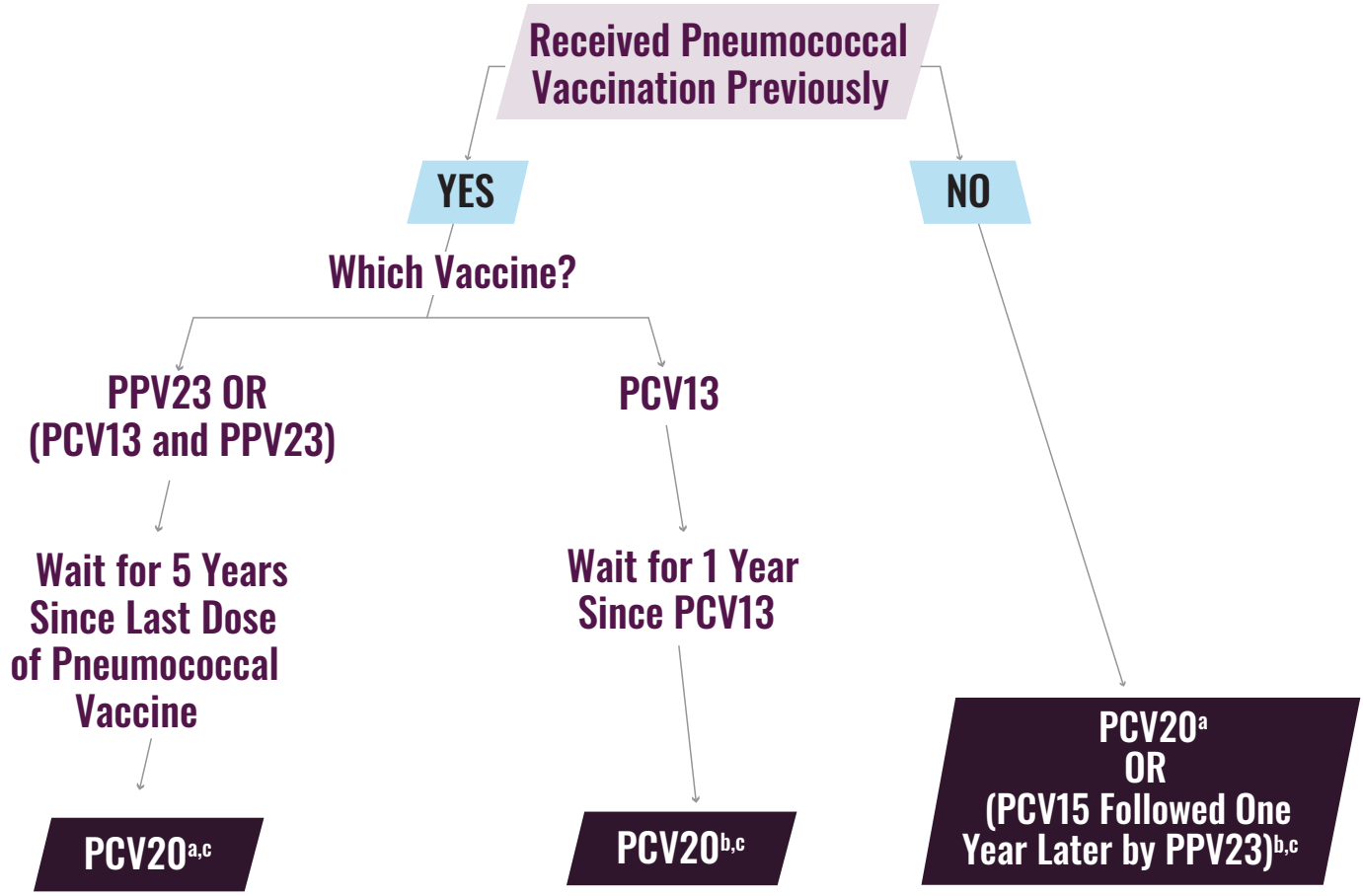
Source: Public Health Agency of Canada

Current NACI Recommendations for Pneumococcal Vaccination in Older Canadians:

NACI recommends that PCV20 should be offered to adults aged 65 years and older, if they have not previously received a pneumococcal vaccine or if their vaccination status is unknown. This recommendation is due to older adults having the highest rate of IPD incidence in comparison to other adult age groups. This group may be offered PCV15 followed by PPV23 (at least a year after) may be offered as an alternative to PCV20. The reason PCV20 and PCV15 are recommended over PPV23 alone, which protects against more serotypes, is due to conjugate vaccines providing protection which may be both better and of longer duration, thus resulting in fewer cases of pneumococcal disease.[234] As PCV15 covers fewer serotypes, it is recommended that PCV15 be supplemented by PPV23; however, the increase in coverage by PPV23 compared to PCV20 is small enough that the NACI does not recommend PPV23 in series with PCV20.[235]

For older adults who have previously received pneumococcal vaccination, a certain interval of time is required before being offered PCV20 depending on the pneumococcal vaccine. NACI recommends that for older adults who have been immunized with PPV23 alone or PCV13 and PPV23 in a series, PCV20 should be offered if it has been at least five years from the last dose of a pneumococcal vaccine. For older adults who have been immunized with PCV13 alone, PCV20 may be offered if it has been one year from the last dose of PCV13. The varying time intervals look to ensure appropriate protection in a time-effective manner based on the vaccines that have already been received. If PCV20 is unavailable or inaccessible, providers may offer other pneumococcal vaccines to older adults who have previously received PPV23 or PCV13 alone.[237]

Figure 4: Recommended Vaccination Process for Older Adults Who Need or Wish to Protect Themselves Against Pneumococcal Disease



[a] A strong NACI recommendation, applies to most populations and should be followed most of the time.

[b] A discretionary NACI recommendation, may be considered for some populations in some situations.

[c] If unavailable or inaccessible, other pneumococcal vaccines may be offered.

Source: Public Health Agency of Canada

Current NACI Recommendations for Pneumococcal Vaccination in Younger Canadians:

The PHAC calls for the routine immunization of all infants (two months to less than 12 months of age) with PCV13 or PCV15.[238,238a] In addition, any healthy children (12 months to less than five years of age) are recommended to receive PCV13 or PCV15 based on PCV history.[239,239a] For children (two months to less than 18 years) who are at a high risk due to medical conditions of IPD (Table 2) are recommended to receive PCV13 or PCV15, along with PPV23, with those at highest risk of IPD recommended to receive a booster dose of PPV23. [240,240a] IPD is more common among very young children.[241] 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).

Current NACI Recommendations for People Living with Chronic Conditions:

For people living with chronic conditions, it is recommended that they get vaccinated because they are at an overall increased risk of infection or developing more serious complications should they get an infection in the first place.[242] Vaccines may not elicit as strong of a response in certain populations and conditions, this is why the PHAC has created specific recommendations for additional doses or higher doses for certain populations or conditions.[243] Please see Recommendation 9 below for the full recommended schedules for all populations.

Research on Vaccinations

Vaccine Effectiveness

In children younger than five years, the effectiveness of the conjugate vaccine against IPD has been found to be in the range of 86% to 97% against the IPD serotypes that are covered in the vaccine.[244]

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).[245] 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).[246]

There are currently no data on vaccine effectiveness for PCV15 or PCV20 in the adult population.[247] However, the decision to authorize and recommend these new vaccines, which are modifications of previous vaccines whose antibody levels are known to correlate with protection from disease, is usually made based on assessments of immunogenicity and safety.[248,248a] 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.[249] 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.[250] Benefits were extended to older children and older adults who did not receive the vaccine.[251] 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.[252]

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.[253] 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.[254] After the introduction of PCV7 in 2000, however, these annual spikes were drastically reduced.[255]

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.[256] 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%.[257] 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.[258] This further highlights the direct and indirect effects of pediatric pneumococcal vaccination programs.

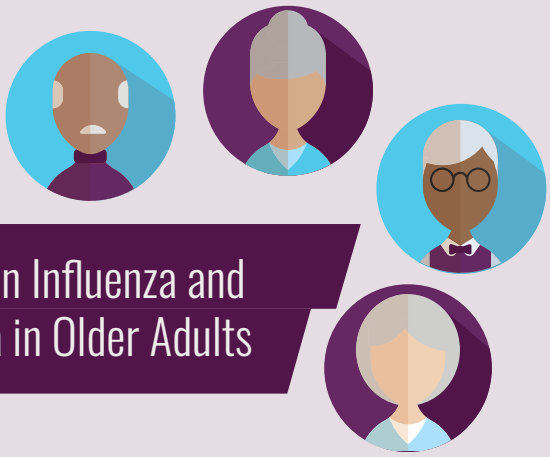
In both of the above studies it was found, however, that there was no downward trend in IPD cases from 2010 to 2017, with Dion et al. noting the highest number of cases reported in the final year.[259] Despite PCV13-serotype IPD decreasing over time, it has been found in Ontario that IPD incidence due to PPV23-serotypes and non-vaccine-preventable serotypes have significantly increased over time.[260] Potential reasons for the increase in PPV23-serotype IPD incidence are lower vaccine effectiveness, inadequate vaccine coverage or vaccine failure of PPV23.[261]

Over the next few years (2016 to 2020) the percentage of IPD cases covered by the various vaccines were relatively stable in Canada. As of 2020, the PCV15- and PCV20-serotypes (including PCV13 serotypes) were associated with 45.9% and 66.8% of IPD cases.[262] With the PCV15 and PCV20 recently being approved by Health Canada, they may be able to address these IPD cases.

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.[263] 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.[264] 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.[265]

NACI's recent modelling of various age-based pneumococcal vaccination recommendations (using 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.[266]



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.[267,268]

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. One study in Sweden found a 29% reduction in all-cause pneumonia and a 35% reduction in death for people who got both vaccines.[269] Furthermore, for individuals who were hospitalized for either pneumonia or influenza, shorter hospital stays were achieved if they were immunized against influenza and pneumonia.[270] 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.[271]

In one study, the influenza vaccination was associated with a reduction in the risk of hospitalization with community-acquired pneumonia, and it also reduced risk of death during the influenza season,[272] although it did not have an effect on the occurrence of outpatient pneumonia or pneumococcal bacteremia.[273] Studies have found that influenza vaccination for LTC residents may reduce pneumonia among residents and death related to both pneumonia and influenza.[274,275]

Vaccination Policies and Their Outcomes 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, in some case advice from provincial immunization advisory committees and on provincial budget impact.[276,277]

All of the provinces and territories cover the polysaccharide (PPV23) vaccine for adults aged 65 years and older, with Nunavut providing coverage for all adults aged 50 years and older. Apart from Nova Scotia, all the jurisdictions provide coverage of the PPV23 vaccine for adults with certain medical or lifestyle risks (e.g., chronic heart disease, diabetes, illicit drug use).

Similar to the polysaccharide vaccine, the majority of provinces and territories, apart from Nunavut, provide coverage for the conjugate (PCV) vaccines for adults who are immunocompromised or otherwise at a high risk of IPD. Coverage varies drastically across jurisdictions, with some provinces covering multiple groups, whereas the Yukon only provides coverage for HIV-infected individuals and the Northwest Territories determines coverage on a case-by-case basis. Quebec is the only jurisdiction which provides coverage for PCV20 for adults who are immunocompromised or part of certain high-risk groups. PCV15 is not currently funded by any jurisdiction.

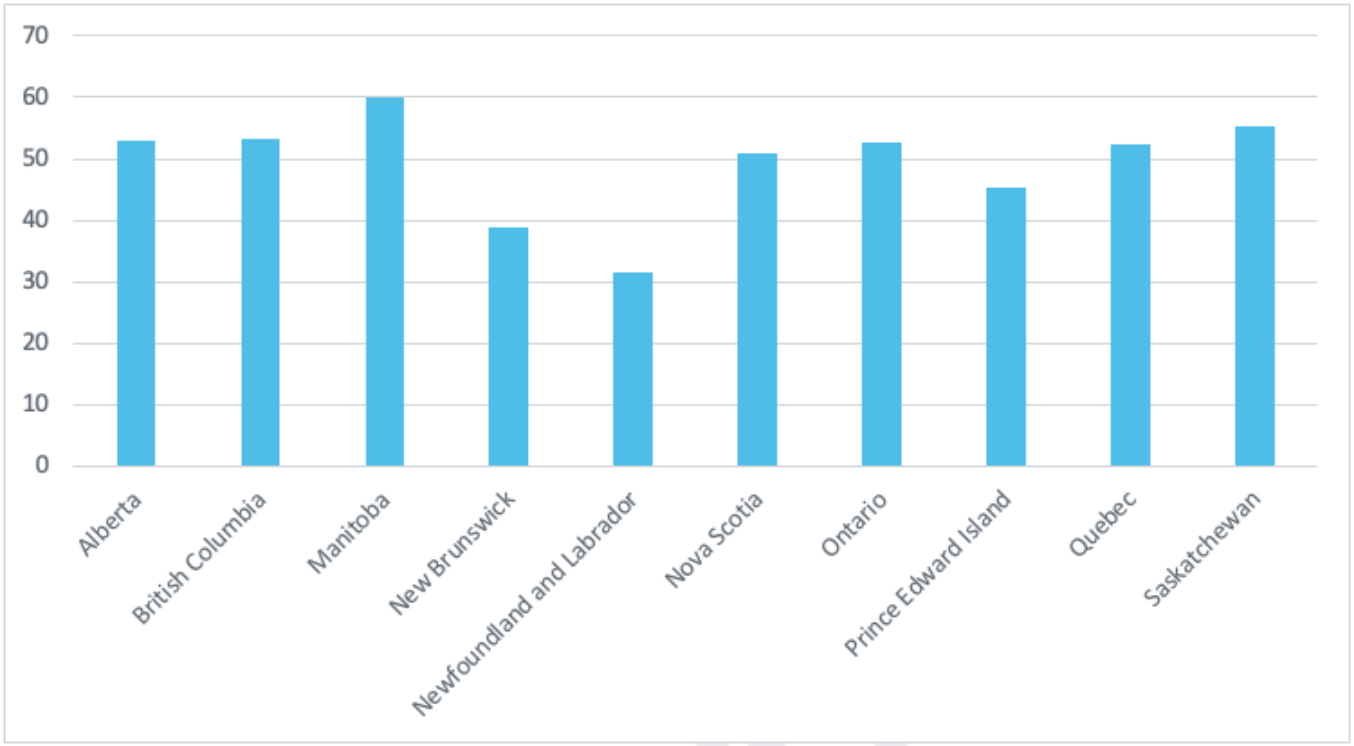
The large variance among jurisdictions is also seen in vaccine administration policies and practices. All provinces and territories, except for the Northwest Territories and Nunavut, allow pharmacists to administer pneumococcal vaccines. However, only Alberta, British Columbia, Manitoba and Quebec permit pharmacists to administer publicly-funded pneumococcal vaccines.[279] Also, within certain jurisdictions, not all doctor's offices or pharmacies provide pneumococcal vaccination.

Over the past few years, coverage rates in adults have been measured bi-annually via the PHAC's Seasonal Influenza Vaccination Coverage Survey and

occasionally by Statistics Canada through the Canadian Health Survey on Seniors (CHSS).[280,281] According to the PHAC, in 2020-21, 55% of those aged 65 years and older reported receiving a pneumococcal vaccine as an adult, while only 26% of those aged 18 to 64 years with a chronic medical condition reported receiving the vaccine as an adult.[282] Similarly, Statistics Canada noted that in 2020, 52.1% of Canadians aged 65 years and older (excluding the territories) reported receiving the pneumococcal vaccine as an adult.[283] Both 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 the PHAC.[284]

At the provincial level, the percentage of older adults who have received a pneumococcal vaccine varies significantly across Canada. In 2020, Statistics Canada estimated that coverage varied from 31.4% in Newfoundland and Labrador to 59.9% in Manitoba.[285] Figure 5 below notes vaccination coverage rates across all the provinces in 2020.

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



Source: Statistics Canada

The Seasonal Influenza Vaccination Coverage Survey has also reported the reasons why adult Canadians have not received the pneumococcal vaccine. In the 2020-21 survey, the most commonly reported reason among adults aged 65 years and older was not thinking the pneumococcal vaccine was necessary (32.0%), whereas for adults aged 18 to 64 years with a chronic medical condition, it was never hearing about the pneumococcal vaccine (24.7%).[286] It is important to highlight that these were also the most commonly reported reasons for both population groups in the 2018-19 survey,[287] indicating 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, the PHAC has established a 95% vaccination target for the pneumococcal vaccine.[288] In general, Canadian children are doing far better at getting vaccinated, with the most recent childhood National Immunization Coverage Survey indicating that 84.4% of children under the age of two had been vaccinated against pneumococcal disease in 2019.[289]

Table 4: Provincial Pneumococcal Vaccination Policies for Adults (as of August, 2022)

Currently, PCV15 and PCV20 are not funded by any jurisdiction (apart from Quebec[a]), with the vaccines only able 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 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 290	Public health nurses, doctors, nurses, and pharmacists 291	All adults aged 65 years and older Adults with medical or lifestyle risks Adults living in residential care or assisted living facilities 292	Adults with HIV infection or who are recipients of stem cell transplants 293
Alberta	PPV23: Public health office, doctor, or pharmacies[294] PCV13: Public health office (funded), travel health clinic, doctor or pharmacies[295]	Doctor, nurse, pharmacist 296,297	All adults aged 65 years and older All residents of LTC facilities All individuals two years of age and older with certain health conditions 298	Adults who have cochlear implants, chronic CSF leak, or immunocompromised conditions resulting in the highest risk of IPD[b] 299
Saskatchewan	Publicly funded: Public health clinics or some health-care provider offices[300] Only privately-funded: pharmacies[301]	Doctor, nurse practitioner, physician, nurse, licensed practical nurse, pharmacist (only privately funded) 302,303	Adults aged 65 years and older who have not received a previous dose(s) for any reason Residents of extended or intermediate care facilities Individuals aged two to 64 years with certain conditions* ** Individuals with these specific health conditions have a high risk of getting*	Adults with immunocompromising conditions resulting in the highest risk of IPD[c] 305

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			pneumococcal disease, and are eligible for a second vaccine dose at least five years after their first dose. [304]	
Manitoba	Public health offices, nursing stations, doctor's offices, pharmacies, QuickCare Clinics and ACCESS Centres [306]	Physicians, public health nurses, pharmacists (only PPV23), physician assistants, nurses and nurse practitioners [307]	Individuals aged two to 64 years with at least one of the following high-risk criteria are eligible to receive one dose All adults aged 65 years and older are eligible for the vaccine Individuals younger than 65 years who are at highest risk for IPD are eligible for one lifetime booster dose. Individuals aged 65 years and older who are newly diagnosed as being at highest risk of IPD are eligible for one lifetime booster dose. [308]	Specific groups of adults with immunocompromising conditions that results in the highest risk of IPD [309]
Ontario	Doctors office, walk-in clinic, community health units or some pharmacies [310-312]	Primary health-care provider (e.g., doctor, nurse practitioner), pharmacists (only paid) [313]	Adults aged 65 years and older Adults younger than 65 years who have high-risk medical conditions Adults at all ages who have high-risk medical conditions given one reimmunization at least five years after the first dose [314]	Adults aged 50 years and older with immunocompromising conditions resulting in the highest risk of IPD[c] [315]
Quebec	CLSC, clinic or pharmacies [316]	Primary health-care provider, nurse, and pharmacist (can also prescribe) [317-319]	Adults aged 65 years and older Adults with certain medical or lifestyle risks [320]	None[a] [321]

Table 4: Provincial Pneumococcal Vaccination Policies for Adults (as of August, 2022)

Currently, PCV15 and PCV20 are not funded by any jurisdiction (apart from Quebec[a]), with the vaccines only able to be purchased privately

Nova Scotia	Doctor's office, public health offices,[322] and most pharmacies [323]	Physician, nurse practitioners, nurse, pharmacist (also prescribe, but can only provide paid vaccines) [324,325]	Adults aged 65 years and older [326,327]	Adults with immunocompromising conditions resulting in the highest risk of IPD[c] [328]
New Brunswick	Clinics or pharmacies [329]	Doctors, nurse practitioners, pharmacist [330]	All adults aged 65 and older Individuals newly admitted to a LTC facility All individuals aged two years and older, not previously immunized and with health conditions that place them at greater risk of IPD One re-immunization can be considered for individuals at highest risk of developing IPD [331]	Adults with immunocompromising conditions resulting in the highest risk of IPD[c] [332]
Prince Edward Isalnd	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 [333]	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 [334]	All adults aged 65 years and older Immunocompetent adults younger than 65 years in LTC facilities Certain groups of adults younger than 65 years who are at risk for IPD Adults at highest risk of IPD (with certain immunocompromise conditions) are eligible to receive one booster dose of PPV23, with a minimum spacing of five years from the initial dose [335]	Adults with immunocompromising conditions resulting in the highest risk of IPD[b] [336]

Table 4: Provincial Pneumococcal Vaccination Policies for Adults (as of August, 2022)

Currently, PCV15 and PCV20 are not funded by any jurisdiction (apart from Quebec[a]), with the vaccines only able to be purchased privately

Newfoundland Labrador	Available through local health and community services offices[337] and pharmacies [338]	Nurse, pharmacist (also prescribe) [339]	All adults aged 65 years and older All persons who are residents of LTC or residential facilities Aboriginal population All persons receiving or with cochlear implants All persons with chronic conditions requiring regular medical treatment and follow up Other chronic conditions which increase an individual's risk for pneumococcal invasive disease Reimmunization: Individuals of any age at high risk of IPD, a single re-immunization with PPV23 is recommended five years after the initial immunization with PPV23 vaccine [340]	Adults who have cochlear implants, or immunocompromised conditions resulting in the highest risk of IPD[b] [341]
Yukon	Community health centres,[342] health practitioner clinic,[343] pharmacy[344]	Doctor, nurse,[345] pharmacist [346]	Adults aged 65 years and older All residents of extended or intermediate care facilities All persons aged two years and older with certain high-risk situations (able to also receive reimmunization after the age of 65) All persons aged two years and older with certain health situations (able to also receive up to two reimmunizations, to ensure they receive one after the age of 65) [347]	HIV-infected individuals who have not received PCV13 [348]

Table 4: Provincial Pneumococcal Vaccination Policies for Adults (as of August, 2022)

Currently, PCV15 and PCV20 are not funded by any jurisdiction (apart from Quebec[a]), with the vaccines only able to be purchased privately

Nunavut	Publicly-funded: Community health clinics and public health offices [349] Privately funded: pharmacy [350]	Nurse practitioners, nurses, midwives [351]	All adults aged 50 years and older Adults at increased risk who have not previously received the PPV23 vaccine [352]	None [353]
Northwest Territories	Health centre or public health unit [354]	Health-care provider or nurse [355]	All adults aged 65 years of age and older Adults aged 64 years and younger who are at risk for invasive pneumococcal disease [356]	May be considered on a case-by-case basis for adults with immunocompromising conditions resulting in the highest risk of IPD [357]

[a] Quebec funds PCV20 for certain high-risk groups, including those with immunocompromising conditions resulting in the highest risk of IPD (Table 2).

[b] Immunocompromising conditions resulting in the highest risk of IPD (Table 2).

[c] Includes all the immunocompromising conditions noted in the previous asterisk, apart from nephrotic syndrome.

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.[358] In regards to polysaccharide vaccines, there is Sinovac PPV23, which contains 23 serotypes that are commonly found in China.[359]

The World Health Organization (WHO) recommends that PCVs (PCV10 or PCV13) be included and prioritized in childhood immunization programs globally.[360,361] In the WHO's *Implementing the Immunization Agenda 2030*, one of the seven impact goal indicators is vaccination coverage (including PCV) across the life course, with the 2030 target being 90% global coverage among infants.[362,363] The WHO also notes that in countries that have a developed childhood pneumococcal immunization program, a similar adult program, with PPV23 or PCV13, should look to consider cost-effectiveness and local disease burden.[364]

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.[365] Almost all of these EEA countries (19 out of 23) had recommended the PPV23 to all adults aged 65 years and older, with around half (nine out of 23) of these countries also recommending the PCV13.[366] The recommended vaccinations for adults aged 18 to 65 years varies greatly across EEA countries, with some recommendations for the entire population and others for specific groups, with the vaccine recommended for use also varying.[367] In terms of funding, only 12 of the 30 countries provide public funding, with two countries (Czech Republic and Slovakia) indicating mandatory vaccination for specific adult groups.[368]

In the United States, the Advisory Committee on Immunization Practices (ACIP) updated their recommendations in 2022 to include consideration of the use of PCV20 and PCV15.[369] 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 PCV or who have an unknown vaccination history, are recommended to receive either one dose of PCV15 followed by PPV23 or one dose of PCV20.[370] For those who receive PCV15, the dose of PPV23 should be given at least one year later for most adults (8 weeks in some circumstances).[371] It is important to point out that the ACIP also notes for adults who have received PCV13 but have not received the needed PPV23, can substitute the vaccine with one dose of PCV20 if PPV23 is not available.[372] In regards to funding, older adults and individuals living with certain disabilities/conditions who have Medicare,[373] will be covered under Part B for two different pneumococcal vaccine shots, as long as the latter is given at least a year after the first shot.[374]

Improving Vaccination Rates

Pneumonia is a serious, potentially fatal disease,[375] and is in many cases preventable with vaccination.[376] Despite this, vaccination rates for both children and older Canadians in particular remain below national targets.[377,378] 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.[379,380] The role of health-care providers in recommending vaccines is critical to uptake.[381,382]

Education

Although Canadian adults are generally receptive to receiving vaccines, there is still a significant lack of awareness about which vaccines they need and how they work. In the past two national PHAC surveys, it was found that the majority of Canadian adults (91%–92%), strongly or somewhat agreed that vaccines are important to their health.[383,384] 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.[385] 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.[386] 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.[387]

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.[388] 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.[389] The PneuVUE study found that only 44% of Europeans thought pneumonia was contagious, and less than 30% were aware of the vaccine.[390] 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.[391] Approximately 59% of older adults considered themselves to be only slightly at risk, and 21% who thought they were at no risk.[392]

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.[393] 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.[394]

People aged 65 years and older tend to achieve higher vaccination rates in Canada than adults in general,[395] and this has also been the case with pneumococcal vaccination.[396] 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."[397] Similar small studies have found that adults with comorbidities were more likely to report receiving a pneumococcal vaccination.[398,399] 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.[400] Generally, the older population should be educated consistently emphasizing the importance of vaccination as a way to maintain overall good health.[401]

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.[402] Only 55% of respondents aged 65 years and older were offered the vaccine by their doctor, despite all qualifying for it.[403] 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.[404]

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.[405] Also, a study of Canadian rheumatology patients noted that the strongest independent predictor of influenza, pneumococcal and hepatitis B virus vaccination was physician recommendation.[406]

Despite this influence, a recent 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.[407] 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.[408] In the same study, 59.7% of those respondents reported that if a health-care provider recommended it they would have received the vaccination.[409]

Providing education for clinicians and reminders for clinicians has been associated with achieving greater pneumococcal vaccination rates.[410,411] 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.[412] 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.[413]

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.[414] These aspects have been noted in recently studied programs that have resulted in improved pneumococcal vaccination administration.[415,416] Additionally, having vaccines available free of charge increases uptake and reduces both social and health inequities.[417]

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.[418]

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. The ongoing momentum of the COVID-19 vaccine rollout presents an opportunity to improve the uptake of pneumococcal vaccines among older Canadians.

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).[419] The NIS looks to reduce the incidence of vaccine preventable diseases and to increase the number of Canadians receiving their vaccinations.[420] In 2016, the federal government provided $25 million over five years to improve vaccination rates,[421] and thus the NIS had an updated set of five objectives for 2016 to 2021.[422] One of the objectives was to have vaccination coverage goals for 2025,[423] which includes the target of 80% vaccination coverage rate for at least one dose of pneumococcal vaccine for adults aged 65 years and older.[424] 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.[425] 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.[426]

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.[427,428] 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.[429] One example of a completed project is CANImmunize, an app that has been developed that allows Canadians to keep track of their vaccination records so that they are easily accessible and it helps ensure that vaccinations can be received on time.[430]

The most recent PHAC departmental plan notes that the agency will look to renew the NIS through discussions with various stakeholders in 2022 and 2023.[431] 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.[432] 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 recently 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.[433] 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.[434] 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.[435]

Despite the pandemic creating an urgency to improve vaccination practices, it was noted last year how provinces and territories are still using a patchwork of systems to keep note of vaccinations.[436]

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.[437] Additional or more specific tests may be ordered in certain cases, such as in older adults or those with chronic conditions.[438]

Diagnostic testing for patients presenting with CAP has been debated among experts in this field including respirologists and infectious disease specialists.[439] 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.[440] 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.[441] 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.[442]

It is also noted that correctly diagnosing CAP can be difficult.[443] In practice, CAP is generally diagnosed based on clinical symptoms and a physical exam.[444] There are some difficulties with the tests that currently exist, including low sensitivity and a delay in receiving lab results.[445] 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.[446] There is a need to develop new tests that are more specific and better able to diagnose CAP.[447]

Urinary tests are sometimes used for diagnosis of pneumococcal pneumonia because they are easy to use and non-invasive.[448,449] However, they lack specificity in children and may give false positive results for children.[450,451] 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.[452,452a] This test is not commercially available yet and is only able to identify the serotypes covered in the PCV13 vaccine.[453,454] However, if this test was used in combination with the current urinary tests, it would be able to identify the specific serotype causing CAP.[455,456] There have also been a SSUAD assay developed to identify 24 serotypes (covered in PCV13 and PPV23), along with the cell wall polysaccharide antigen.[456a,456b]

Non-invasive accurate diagnostic tests would also allow treatment to be targeted more appropriately and ensure that the treatment used is necessary.[457] 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.[458,459] 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.[460] 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.

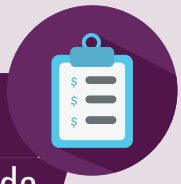
A Lack of Data on Vaccination Rates Further Compounds the Problem

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 collected through PHAC and Statistics Canada. PHAC collects public survey data approximately every two years, currently through the Seasonal Influenza Vaccination Coverage Survey.[461] Data is also 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.[462] Statistics Canada collects data occasionally (2019 and 2020) through the Canadian Health Survey on Seniors.[463] Data is differentiated by jurisdiction (excluding territories), age groups (e.g., 65 to 74, 75 to 84), and sex.[464] The questions within both surveys revolve around pneumococcal vaccination as an adult and the reasons for non-vaccination, despite Statistics Canada data for the latter not being available.[465-467]

From the above two surveys, a clear gap in the data also is the type of pneumococcal vaccination received by adults, as varying groups are recommended different vaccinations (e.g., PCV13, PPV23).[468] Also, with both surveys being conducted over the phone,[469,470] individuals experiencing homelessness may not be included in the findings, who are an at-risk group.[471] In regards to the CHSS, Statistics Canada omits individuals living on reserves and other Indigenous settlements, in addition to not obtaining data from the three territories.[472] Such data are needed as it has been found that IPD incidence is higher in Northern Canada and in Indigenous populations.[473]

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.[474]



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).[475] IPD is considered a priority for monitoring as it can lead to many serious outcomes.[476] Once a disease is notifiable, provinces and territories voluntarily provide IPD data to the federal government.[477] This system collects epidemiological trends and reports on the rates and cases of IPD; it also collects basic demographic information including age and sex.[478]

Additionally, limited data on IPD is collected through the National Microbiology Laboratory (NML) Streptococcus Disease Surveillance, which began in 2010.[479] This laboratory data includes serotype data,[480] and antimicrobial susceptibility,[481] but it is not nationally representative and is limited by reporting differences between jurisdictions.[482] 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.[483]

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.[484,485] Both of these link epidemiologic and laboratory data (i.e., demographic information and serotypes).[486] These are good data collection systems but, because they are collecting results specific to children and northern populations, their results cannot be generalized.[487]

There is a need for a more enhanced national surveillance system that would be able to combine epidemiological data, such as risk factors and immunization status, with more specific laboratory data to monitor the serotypes that are causing disease.[488,489] The Enhanced National Invasive Pneumococcal Disease Surveillance System (eIPDSS) pilot was launched in 2011.[490] It was piloted in New Brunswick to determine the feasibility of conducting timely data collection and linking epidemiologic and laboratory data.[491]

The pilot was not able to be expanded to other provinces due to challenges linking epidemiological and laboratory data.[492] 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.[493]

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.[494] 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.[495-497] Currently the network has participating hospitals from Alberta, Ontario, Quebec, New Brunswick and Nova Scotia that provide data.[498,499]

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.[500] 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[501]

- 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.[502] In Canada, national surveillance data of IPD is available, but there are few available data on the burden of CAP.[503] 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.[504] 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.[505]

4. Improve Reporting and Surveillance of Pneumococcal Vaccination

Currently, Canadians estimate vaccination rates based on self-reported surveys, the Seasonal Influenza Vaccination Coverage Survey by PHAC and Canada Health Survey on Seniors by Statistics Canada.[506,507]

Not only have both experienced response rate issues, but studies have noted that self-reported pneumococcal vaccination can potentially lead to underestimations due to individuals being unaware of pneumococcal vaccination.[508] This may be due to the vaccine being given several years prior, unlike influenza vaccine which is given on an annual basis.[509] Also, both surveys do not note the type of pneumococcal vaccination received, they also potentially exclude high-risk groups (e.g., individuals experiencing homelessness) and CHSS does not obtain data from the three territories.[510-512]

Better 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.[513] 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.[514]

5. Continue Working Toward Developing Better Pneumococcal Vaccines

Although it seems logical to expand the serotypes covered in the vaccine, we must also consider the benefit of a comprehensive measure to improve immunization adherence.[515] Implementation is difficult as there are currently two vaccines recommended that need to be administered using a specific schedule.[516]

New vaccines that are developed will need to be affordable and will need to cover against more or better strains.[517] Additionally, there is a need to focus on longer-lasting immunity effects for more strains, which will particularly benefit our ageing population.[518] The WHO has similarly called for a more efficacious conjugated vaccine or a different type of vaccine that covers the serotypes causing the most serious disease in children and adults.[519] 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.[520,521]

Ideally, universal pneumococcal vaccines would be useful for older populations.[522] However, polysaccharide vaccines are always going to be serotype-specific; therefore, future directions may also focus on a vaccine against a surface protein on pneumococci versus each serotype.[523,524]

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 25).[525] There are also other types of pneumococcal vaccines at the clinical stages including protein-based, live vector and inactivated whole cell vaccines.[526]

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 39-43), 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 both 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, despite all provinces and territories covering the PPV23 vaccine for adults aged 65 years and older, jurisdictions vary in the coverage for adults with certain medical or lifestyle risks. Also, only seven jurisdictions provide PPV23 coverage for adults living in residential care or assisted living facilities (British Columbia, Alberta, Saskatchewan, New Brunswick, Prince Edward Island, Newfoundland and Labrador, and the Yukon). This is apparent with the coverage of PCV vaccines, as it varies on the specific groups of adults across provinces and territories. Therefore, there is a need to harmonize the funding and coverage policies for those with high-risk conditions so that there is a common message being given to all Canadians and their care providers regarding pneumococcal vaccination.

This is even more apparent with two new PCVs having been approved by Health Canada, PCV15 and PCV20. Both of these vaccines provide IPD prevention from more *Streptococcus pneumoniae* serotypes than PCV13 (PCV15, two additional serotypes; PCV20, seven additional serotypes).[527,528] NACI has also provided recommendations on the use of these vaccines for various target populations, including adults aged 65 years and older.[529] Currently, the vaccines have not been included in any provincial or territorial immunization schedules, with the vaccines only able to be purchased privately.[530,531]

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.[532] Studies have found reductions in death and lesser hospital stays and costs when older adults are vaccinated against both diseases.[533,534]

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).[535] Therefore, COVID-19 vaccines may be given at the same time, or any time before or after, other vaccines.[536] 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

The estimated incidence of pneumonia is higher for people living in LTC settings.[537] It has been estimated that people aged 65 years and older in LTC homes have an annual incidence of pneumonia up to 7% higher than those aged 65 years and older in the community (3.3%–11.4% in LTC versus 2.5%–4.4%).[538]

PHAC currently recommends that residents of LTC homes should consider the influenza, pneumococcal and herpes zoster (shingles) vaccination.[539] The NIA has previously recommended that requiring influenza vaccinations should be considered for those living in LTC homes. Studies have shown that influenza vaccination can reduce pneumonia among residents in LTC homes and death due to pneumonia and influenza.[540,541] The NIA therefore recommends promoting pneumococcal vaccination for all LTC residents as well.

References

[1] Government of Canada. (2022). Vaccination coverage goals and vaccine preventable disease reduction targets by 2025. Retrieved from: https://www.canada.ca/en/public-health/services/immunization-vaccine-priorities/national-immunization-strategy/vaccination-coverage-goals-vaccine-preventable-diseases-reduction-targets-2025.html

[2] Public Health Agency of Canada. (2022). Vaccine uptake in Canadian adults 2021. Government of Canada. Retrieved from: https://www.canada.ca/content/dam/phac-aspc/documents/services/immunization-vaccines/vaccination-coverage/highlights-2020-2021-seasonal-influenza-survey/full-report/highlights-2020-2021-seasonal-influenza-survey.pdf

[3] Government of Canada. (2022). Vaccination coverage goals and vaccine preventable disease reduction targets by 2025. Retrieved from: https://www.canada.ca/en/public-health/services/immunization-vaccine-priorities/national-immunization-strategy/vaccination-coverage-goals-vaccine-preventable-diseases-reduction-targets-2025.html

[4] Public Health Agency of Canada. (2022). Highlights from the 2019 childhood National Immunization Coverage Survey (cNICS). Government of Canada. Retrieved from: https://www.canada.ca/en/public-health/services/publications/vaccines-immunization/2019-highlights-childhood-national-immunization-coverage-survey.html

[5] Public Health Agency of Canada. (2018). Vaccine uptake in Canadian adults: Results from the 2016 adult National Immunization Coverage Survey (aNICS). Government of Canada. Retrieved from: https://publications.gc.ca/collections/collection_2018/aspc-phac/HP40-222-2018-eng.pdf

[6] HealthLink BC. (2017). Pneumonia. Retrieved from: https://www.healthlinkbc.ca/health-topics/hw63868

[7] Public Health Agency of Canada. (2018). Vaccine uptake in Canadian adults: Results from the 2016 adult National Immunization Coverage Survey (aNICS). Government of Canada. Retrieved from: https://publications.gc.ca/collections/collection_2018/aspc-phac/HP40-222-2018-eng.pdf

[8] Mayo Clinic. (2020). Pneumonia. Retrieved from: https://www.mayoclinic.org/diseases-conditions/pneumonia/symptoms-causes/syc-20354204

[9] American Lung Association. (2018). What Causes Pneumonia? Retrieved from: http://www.lung.org/lung-health-and-diseases/lung-disease-lookup/pneumonia/what-causes-pneumonia.html

[10] American Lung Association. (2018). What Causes Pneumonia? Retrieved from: http://www.lung.org/lung-health-and-diseases/lung-disease-lookup/pneumonia/what-causes-pneumonia.html

[11] Government of Canada. (2021). Invasive pneumococcal disease. Retrieved from: https://www.canada.ca/en/public-health/services/immunization/vaccine-preventable-diseases/invasive-pneumococcal-disease/health-professionals.html

[12] Government of Canada. (2021). Invasive pneumococcal disease. Retrieved from: https://www.canada.ca/en/public-health/services/immunization/vaccine-preventable-diseases/invasive-pneumococcal-disease/health-professionals.html

[13] The Conference Board of Canada. (April 2017). The Economic Burden of Pneumonia in Canada: A Status Quo Forecast.

[14] Janssens, J. P., & Krause, K. H. (2004). Pneumonia in the very old. The Lancet. Infectious diseases, 4(2), 112–124. https://doi.org/10.1016/S1473-3099(04)00931-4

[15] Canadian Institute for Health Information. (2021). NACRS emergency department visits: Volumes and median lengths of stay, 2003–2004 to 2020–2021 — Supplementary statistics [Data set]. Retrieved from: https://www.cihi.ca/sites/default/files/document/emergency-department-visits-2003-2020-supplementary-data-tables-en.xlsx

[16] Canadian Institute for Health Information. (2021). Inpatient hospitalization, surgery and newborn statistics, 2019–2020 [Data set]. Retrieved from: https://secure.cihi.ca/free_products/dad-hmdb-childbirth-2019-2020-data%20table-en.xlsx

[17] Canadian Institute for Health Information. (2020). Inpatient hospitalization, surgery and newborn statistics, 2018–2019 [Data set]. Retrieved from: https://www.cihi.ca/sites/default/files/document/dad-hmdb-childbirth-quick-stats-2018-2019-en-web.xlsx

[18] Canadian Institute for Health Information. (2019). Inpatient hospitalization, surgery and newborn statistics, 2017–2018. Retrieved from: https://www.cihi.ca/sites/default/files/document/dad-hmdb-childbirth-quick-stats-2017-2018-en.xlsx

[19] Canadian Institute for Health Information. (2018). Inpatient hospitalizations, surgeries and newborn indicators, 2016–2017. Retrieved from: https://www.cihi.ca/sites/default/files/document/hospchild-inpatientalosdiagsurg-2016-2017-en.xlsx

[20] Canadian Institute for Health Information. (2017). Inpatient hospitalizations, surgeries and newborn indicators, 2015–2016. Retrieved from: https://www.cihi.ca/sites/default/files/document/inpatientalosdiagsurg-2015-2016-en.xlsx

[21] Statistics Canada. (2022, August 15). Leading causes of death, total population, by age group (Table 13-10-0394-01) [Data table]. Retrieved from: https://doi.org/10.25318/1310039401-eng

[22] Canadian Institute for Health Information. (2021). COVID-19's impact on emergency departments. Retrieved from: https://www.cihi.ca/en/covid-19-resources/impact-of-covid-19-on-canadas-health-care-systems/emergency-departments

[23] Canadian Institute for Health Information. (2021). COVID-19's impact on hospital services. Retrieved from: https://www.cihi.ca/en/covid-19-resources/impact-of-covid-19-on-canadas-health-care-systems/hospital-services

[24] Canadian Institute for Health Information. (2021). NACRS emergency department visits: Volumes and median lengths of stay, 2003–2004 to 2020–2021 — Supplementary statistics [Data set]. Retrieved from: https://www.cihi.ca/sites/default/files/document/emergency-department-visits-2003-2020-supplementary-data-tables-en.xlsx

[25] Ludwig, E., Bonanni, P., Rohde, G., Sayiner, A., & Torres, A. (2012). The remaining challenges of pneumococcal disease in adults. European respiratory review : an official journal of the European Respiratory Society, 21(123), 57–65. https://doi.org/10.1183/09059180.00008911

[26] Centers for Disease Control and Prevention (CDC). (n.d.). Immunization – You call the Shots: Understanding the Basics: General Recommendations on Immunization. Retrieved from: https://www2a.cdc.gov/nip/isd/ycts/mod1/courses/genrec/11005.asp?student_id=

[27] Government of Canada. (2022). Pneumococcal vaccine: Canadian Immunization Guide. Retrieved from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-16-pneumococcal-vaccine.html

[28] Centers for Disease Control and Prevention [CDC]. (n.d.). Principles of Vaccination. Retrieved from: https://www.cdc.gov/vaccines/pubs/pinkbook/downloads/prinvac.pdf

[29] Government of Canada. (2022). Pneumococcal vaccine: Canadian Immunization Guide. Retrieved from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-16-pneumococcal-vaccine.html

[30] Centers for Disease Control and Prevention [CDC]. (n.d.). Principles of Vaccination. Retrieved from: https://www.cdc.gov/vaccines/pubs/pinkbook/downloads/prinvac.pdf

[31] Government of Canada. (2022). Pneumococcal vaccine: Canadian Immunization Guide. Retrieved from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-16-pneumococcal-vaccine.html

[32] Centers for Disease Control and Prevention. (2022). Pneumococcal disease. Retrieved from: https://www.cdc.gov/pneumococcal/index.html

[33] Ludwig, E., Bonanni, P., Rohde, G., Sayiner, A., & Torres, A. (2012). The remaining challenges of pneumococcal disease in adults. European respiratory review : an official journal of the European Respiratory Society, 21(123), 57–65. https://doi.org/10.1183/09059180.00008911

[34] Blasi, F., Mantero, M., Santus, P., & Tarsia, P. (2012). Understanding the burden of pneumococcal disease in adults. Clinical microbiology and infection : the official publication of the European Society of Clinical Microbiology and Infectious Diseases, 18 Suppl 5, 7–14. https://doi.org/10.1111/j.1469-0691.2012.03937.x

[35] American Lung Association. (2018). What Causes Pneumonia? Retrieved from: http://www.lung.org/lung-health-and-diseases/lung-disease-lookup/pneumonia/what-causes-pneumonia.html

[36] American Lung Association. (2018). What Causes Pneumonia? Retrieved from: http://www.lung.org/lung-health-and-diseases/lung-disease-lookup/pneumonia/what-causes-pneumonia.html

[37] Government of Canada. (2021). Invasive pneumococcal disease. Retrieved from: https://www.canada.ca/en/public-health/services/immunization/vaccine-preventable-diseases/invasive-pneumococcal-disease/health-professionals.html

[38] HealthLink BC. (2017). Pneumonia. Retrieved from: https://www.healthlinkbc.ca/health-topics/hw63868

[39] The Lung Association. (2014). Pneumonia. Retrieved from: https://www.lung.ca/lung-health/lung-disease/pneumonia

[40] Mayo Clinic. (2020). Pneumonia. Retrieved from: https://www.mayoclinic.org/diseases-conditions/pneumonia/symptoms-causes/syc-20354204

[41] HealthLink BC. (2017). Pneumonia. Retrieved from: https://www.healthlinkbc.ca/health-topics/hw63868

[42] The Lung Association. (2014). Pneumonia. Retrieved from: https://www.lung.ca/lung-health/lung-disease/pneumonia

[43] Mayo Clinic. (2020). Pneumonia. Retrieved from: https://www.mayoclinic.org/diseases-conditions/pneumonia/symptoms-causes/syc-20354204

[44] Government of Canada. (2021). Invasive pneumococcal disease. Retrieved from: https://www.canada.ca/en/public-health/services/immunization/vaccine-preventable-diseases/invasive-pneumococcal-disease/health-professionals.html

[45] Government of Canada. (2021). Invasive pneumococcal disease. Retrieved from: https://www.canada.ca/en/public-health/services/immunization/vaccine-preventable-diseases/invasive-pneumococcal-disease/health-professionals.html

[46] Centers for Disease Control and Prevention [CDC]. (2017). Pneumococcal Disease – Symptoms and Complications. Retrieved from: https://www.cdc.gov/pneumococcal/about/symptoms-complications.html

[47] Centers for Disease Control and Prevention [CDC]. (2017). Pneumococcal Disease – Symptoms and Complications. Retrieved from: https://www.cdc.gov/pneumococcal/about/symptoms-complications.html

[48] Government of Canada. (2021). Invasive pneumococcal disease. Retrieved from: https://www.canada.ca/en/public-health/services/immunization/vaccine-preventable-diseases/invasive-pneumococcal-disease/health-professionals.html

[49] Drijkoningen, J. J., & Rohde, G. G. (2014). Pneumococcal infection in adults: burden of disease. Clinical microbiology and infection : the official publication of the European Society of Clinical Microbiology and Infectious Diseases, 20 Suppl 5, 45–51. https://doi.org/10.1111/1469-0691.12461

[50] Government of Canada. (2021). Invasive pneumococcal disease. Retrieved from: https://www.canada.ca/en/public-health/services/immunization/vaccine-preventable-diseases/invasive-pneumococcal-disease/health-professionals.html

[51] Government of Canada. (2022). Pneumococcal vaccine: Canadian Immunization Guide. Retrieved from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-16-pneumococcal-vaccine.html

[52] National Heart, Lung, and Blood Institute [NHLBI]. (n.d.). Pneumonia. Retrieved from: https://www.nhlbi.nih.gov/health-topics/pneumonia

[53] HealthLink BC. (2017). Pneumonia. Retrieved from: https://www.healthlinkbc.ca/health-topics/hw63868

[54] Healthlink BC. (2017). Healthcare-Associated Pneumonia (Nosocomial Pneumonia). Retrieved from: https://www.healthlinkbc.ca/health-topics/ug2993#ug2993-sec

[55] Healthlink BC. (2017). Healthcare-Associated Pneumonia (Nosocomial Pneumonia). Retrieved from: https://www.healthlinkbc.ca/health-topics/ug2993#ug2993-sec

[56] Healthlink BC. (2017). Healthcare-Associated Pneumonia (Nosocomial Pneumonia). Retrieved from: https://www.healthlinkbc.ca/health-topics/ug2993#ug2993-sec

[57] The Lung Association of Ontario. (2018). Pneumonia FAQs. Retrieved from: https://lungontario.ca/disease/flu-pneumonia/overview-and-facts/pneumonia-faqs

[58] The Lung Association of Ontario. (2018). Pneumonia FAQs. Retrieved from: https://lungontario.ca/disease/flu-pneumonia/overview-and-facts/pneumonia-faqs

[59] Eurich, D. T., Marrie, T. J., Minhas-Sandhu, J. K., & Majumdar, S. R. (2015). Ten-Year Mortality after Community-acquired Pneumonia. A Prospective Cohort. American journal of respiratory and critical care medicine, 192(5), 597–604. https://doi.org/10.1164/rccm.201501-0140OC

[60] Eurich, D. T., Marrie, T. J., Minhas-Sandhu, J. K., & Majumdar, S. R. (2015). Ten-Year Mortality after Community-acquired Pneumonia. A Prospective Cohort. American journal of respiratory and critical care medicine, 192(5), 597–604. https://doi.org/10.1164/rccm.201501-0140OC

[61] Janssens, J. P., & Krause, K. H. (2004). Pneumonia in the very old. The Lancet. Infectious diseases, 4(2), 112–124. https://doi.org/10.1016/S1473-3099(04)00931-4

[62] Janssens, J. P., & Krause, K. H. (2004). Pneumonia in the very old. The Lancet. Infectious diseases, 4(2), 112–124. https://doi.org/10.1016/S1473-3099(04)00931-4

[63] Janssens, J. P., & Krause, K. H. (2004). Pneumonia in the very old. The Lancet. Infectious diseases, 4(2), 112–124. https://doi.org/10.1016/S1473-3099(04)00931-4

[64] Nasreen, S., Wang, J., Sadarangani, M., Kwong, J. C., Quach, C., Crowcroft, N. S., Wilson, S. E., McGeer, A., Morris, S. K., Kellner, J. D., Sander, B., Kus, J. V., Hoang, L., Marra, F., & Fadel, S. A. (2022). Estimating population-based incidence of community-acquired pneumonia and acute otitis media in children and adults in Ontario and British Columbia using health administrative data, 2005-2018: a Canadian Immunisation Research Network (CIRN) study. BMJ open respiratory research, 9(1), e001218. https://doi.org/10.1136/bmjresp-2022-001218

[65] Public Health Agency of Canada. (2021). Customize your own chart - Notifiable diseases on-line [bar graph on the rate of reported invasive pneumococcal disease cases in Canada in 2019]. Retrieved from: https://dsol-smed.phac-aspc.gc.ca/notifiable/charts?c=cc

[66] Public Health Agency of Canada. (2021). Customize your own chart - Notifiable diseases on-line [bar graph on the rate of reported invasive pneumococcal disease cases in Canada in 2019]. Retrieved from: https://dsol-smed.phac-aspc.gc.ca/notifiable/charts?c=cc

[67] Canadian Institute for Health Information. (2020). NACRS emergency department visits and length of stay by province/territory, 2019–2020. Retrieved from: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiEvYzdvMT6AhXpk4kEHTFyCkcQFnoECAcQAQ&url=https%3A%2F%2Fwww.cihi.ca%2Fsites%2Fdefault%2Ffiles%2Fdocument%2Fnacrs-emerg-dept-visits-length-of-stay-2019-data-table-en.xlsx&usg=AOvVaw3MvHWSjX_-s4jLioMfmT8j

[68] Canadian Institute for Health Information. (2021). NACRS emergency department visits: Volumes and median lengths of stay, 2003–2004 to 2020–2021 — Supplementary statistics [Data set]. Retrieved from: https://www.cihi.ca/sites/default/files/document/emergency-department-visits-2003-2020-supplementary-data-tables-en.xlsx

[69] Canadian Institute for Health Information. (2020). NACRS emergency department visits and length of stay by province/territory, 2019–2020. Retrieved from: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiEvYzdvMT6AhXpk4kEHTFyCkcQFnoECAcQAQ&url=https%3A%2F%2Fwww.cihi.ca%2Fsites%2Fdefault%2Ffiles%2Fdocument%2Fnacrs-emerg-dept-visits-length-of-stay-2019-data-table-en.xlsx&usg=AOvVaw3MvHWSjX_-s4jLioMfmT8j

[70] Canadian Institute for Health Information. (2020). NACRS emergency department visits and length of stay by province/territory, 2019–2020. Retrieved from: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiEvYzdvMT6AhXpk4kEHTFyCkcQFnoECAcQAQ&url=https%3A%2F%2Fwww.cihi.ca%2Fsites%2Fdefault%2Ffiles%2Fdocument%2Fnacrs-emerg-dept-visits-length-of-stay-2019-data-table-en.xlsx&usg=AOvVaw3MvHWSjX_-s4jLioMfmT8j

[71] Canadian Institute for Health Information. (2021). NACRS emergency department visits: Volumes and median lengths of stay, 2003–2004 to 2020–2021 — Supplementary statistics [Data set]. Retrieved from: https://www.cihi.ca/sites/default/files/document/emergency-department-visits-2003-2020-supplementary-data-tables-en.xlsx

[72] Canadian Institute for Health Information. (2021). NACRS emergency department visits: Volumes and median lengths of stay, 2003–2004 to 2020–2021 — Supplementary statistics [Data set]. Retrieved from: https://www.cihi.ca/sites/default/files/document/emergency-department-visits-2003-2020-supplementary-data-tables-en.xlsx

[73] Canadian Institute for Health Information. (2021). NACRS emergency department visits: Volumes and median lengths of stay, 2003–2004 to 2020–2021 — Supplementary statistics [Data set]. Retrieved from: https://www.cihi.ca/sites/default/files/document/emergency-department-visits-2003-2020-supplementary-data-tables-en.xlsx

[74] Canadian Institute for Health Information. (2021). COVID-19's impact on emergency departments. Retrieved from: https://www.cihi.ca/en/covid-19-resources/impact-of-covid-19-on-canadas-health-care-systems/emergency-departments

[75] Canadian Institute for Health Information. (2021). NACRS emergency department visits: Volumes and median lengths of stay, 2003–2004 to 2020–2021 — Supplementary statistics [Data set]. Retrieved from: https://www.cihi.ca/sites/default/files/document/emergency-department-visits-2003-2020-supplementary-data-tables-en.xlsx

[76] Canadian Institute for Health Information. (2017). Inpatient hospitalizations, surgeries and newborn indicators, 2015–2016. Retrieved from: https://www.cihi.ca/sites/default/files/document/inpatientalosdiagsurg-2015-2016-en.xlsx

[77] Canadian Institute for Health Information. (2018). Inpatient hospitalizations, surgeries and newborn indicators, 2016–2017. Retrieved from: https://www.cihi.ca/sites/default/files/document/hospchild-inpatientalosdiagsurg-2016-2017-en.xlsx

[78] Canadian Institute for Health Information. (2019). Inpatient hospitalization, surgery and newborn statistics, 2017–2018. Retrieved from: https://www.cihi.ca/sites/default/files/document/dad-hmdb-childbirth-quick-stats-2017-2018-en.xlsx

[79] Canadian Institute for Health Information. (2020). Inpatient hospitalization, surgery and newborn statistics, 2018–2019 [Data set]. Retrieved from: https://www.cihi.ca/sites/default/files/document/dad-hmdb-childbirth-quick-stats-2018-2019-en-web.xlsx

[80] Canadian Institute for Health Information. (2021). Inpatient hospitalization, surgery and newborn statistics, 2019–2020 [Data set]. Retrieved from: https://secure.cihi.ca/free_products/dad-hmdb-childbirth-2019-2020-data%20table-en.xlsx

[81] Canadian Institute for Health Information. (2018). Inpatient hospitalizations, surgeries and newborn indicators, 2016–2017. Retrieved from: https://www.cihi.ca/sites/default/files/document/hospchild-inpatientalosdiagsurg-2016-2017-en.xlsx

[82] Canadian Institute for Health Information. (2019). Inpatient hospitalization, surgery and newborn statistics, 2017–2018. Retrieved from: https://www.cihi.ca/sites/default/files/document/dad-hmdb-childbirth-quick-stats-2017-2018-en.xlsx

[83] Canadian Institute for Health Information. (2020). Inpatient hospitalization, surgery and newborn statistics, 2018–2019 [Data set]. Retrieved from: https://www.cihi.ca/sites/default/files/document/dad-hmdb-childbirth-quick-stats-2018-2019-en-web.xlsx

[84] Canadian Institute for Health Information. (2021). Inpatient hospitalization, surgery and newborn statistics, 2019–2020 [Data set]. Retrieved from: https://secure.cihi.ca/free_products/dad-hmdb-childbirth-2019-2020-data%20table-en.xlsx

[85] McNeil, S. A., Qizilbash, N., Ye, J., Gray, S., Zanotti, G., Munson, S., Dartois, N., & Laferriere, C. (2016). A Retrospective Study of the Clinical Burden of Hospitalized All-Cause and Pneumococcal Pneumonia in Canada. Canadian respiratory journal, 2016, 3605834. https://doi.org/10.1155/2016/3605834

[86] Canadian Institute for Health Information. (2022). Inpatient hospitalization, surgery and newborn statistics, 2020–2021. Retrieved from: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiEjo6svsT6AhWZkIkEHQRABAUQFnoECBIQAQ&url=https%3A%2F%2Fwww.cihi.ca%2Fsites%2Fdefault%2Ffiles%2Fdocument%2Fdad-hmdb-childbirth-2020-2021-data-tables-en.xlsx&usg=AOvVaw3nmKjfoVO3Q9cSq8liSEOz

[87] Canadian Institute for Health Information. (2022). Inpatient hospitalization, surgery and newborn statistics, 2020–2021. Retrieved from: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiEjo6svsT6AhWZkIkEHQRABAUQFnoECBIQAQ&url=https%3A%2F%2Fwww.cihi.ca%2Fsites%2Fdefault%2Ffiles%2Fdocument%2Fdad-hmdb-childbirth-2020-2021-data-tables-en.xlsx&usg=AOvVaw3nmKjfoVO3Q9cSq8liSEOz

[88] Canadian Institute for Health Information. (2022). Inpatient hospitalization, surgery and newborn statistics, 2020–2021. Retrieved from: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiEjo6svsT6AhWZkIkEHQRABAUQFnoECBIQAQ&url=https%3A%2F%2Fwww.cihi.ca%2Fsites%2Fdefault%2Ffiles%2Fdocument%2Fdad-hmdb-childbirth-2020-2021-data-tables-en.xlsx&usg=AOvVaw3nmKjfoVO3Q9cSq8liSEOz

[89] Canadian Institute for Health Information. (2018). Inpatient hospitalizations, surgeries and newborn indicators, 2016–2017. Retrieved from: https://www.cihi.ca/sites/default/files/document/hospchild-inpatientalosdiagsurg-2016-2017-en.xlsx

[90] Canadian Institute for Health Information. (2019). Inpatient hospitalization, surgery and newborn statistics, 2017–2018. Retrieved from: https://www.cihi.ca/sites/default/files/document/dad-hmdb-childbirth-quick-stats-2017-2018-en.xlsx

[91] Canadian Institute for Health Information. (2020). Inpatient hospitalization, surgery and newborn statistics, 2018–2019 [Data set]. Retrieved from: https://www.cihi.ca/sites/default/files/document/dad-hmdb-childbirth-quick-stats-2018-2019-en-web.xlsx

[92] Canadian Institute for Health Information. (2021). Inpatient hospitalization, surgery and newborn statistics, 2019–2020 [Data set]. Retrieved from: https://secure.cihi.ca/free_products/dad-hmdb-childbirth-2019-2020-data%20table-en.xlsx

[93] Canadian Institute for Health Information. (2022). Inpatient hospitalization, surgery and newborn statistics, 2020–2021. Retrieved from: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiEjo6svsT6AhWZkIkEHQRABAUQFnoECBIQAQ&url=https%3A%2F%2Fwww.cihi.ca%2Fsites%2Fdefault%2Ffiles%2Fdocument%2Fdad-hmdb-childbirth-2020-2021-data-tables-en.xlsx&usg=AOvVaw3nmKjfoVO3Q9cSq8liSEOz

[94] Canadian Institute for Health Information. (2021, December 9). COVID-19's impact on hospital services. Retrieved from: https://www.cihi.ca/en/covid-19-resources/impact-of-covid-19-on-canadas-health-care-systems/hospital-services

[95] Statistics Canada. (2022). Leading causes of death, total population, by age group (Table 13-10-0394-01) [Data table]. Retrieved from: https://doi.org/10.25318/1310039401-eng

[96] Statistics Canada. (2022). Leading causes of death, total population, by age group (Table 13-10-0394-01) [Data table]. Retrieved from: https://doi.org/10.25318/1310039401-eng

[97] Statistics Canada. (2022). Leading causes of death, total population, by age group (Table 13-10-0394-01) [Data table]. Retrieved from: https://doi.org/10.25318/1310039401-eng

[98] Statistics Canada. (2022). Leading causes of death, total population, by age group (Table 13-10-0394-01) [Data table]. Retrieved from: https://doi.org/10.25318/1310039401-eng

[99] LeBlanc, J. J., ElSherif, M., Ye, L., MacKinnon-Cameron, D., Li, L., Ambrose, A., Hatchette, T. F., Lang, A. L., Gillis, H., Martin, I., Andrew, M. K., Boivin, G., Bowie, W., Green, K., Johnstone, J., Loeb, M., McCarthy, A., McGeer, A., Moraca, S., Semret, M., … Serious Outcomes Surveillance (SOS) Network of the Canadian Immunization Research Network (CIRN) (2017). Burden of vaccine-preventable pneumococcal disease in hospitalized adults: A Canadian Immunization Research Network (CIRN) Serious Outcomes Surveillance (SOS) network study. Vaccine, 35(29), 3647–3654. https://doi.org/10.1016/j.vaccine.2017.05.049

[100] LeBlanc, J. J., ElSherif, M., Ye, L., MacKinnon-Cameron, D., Li, L., Ambrose, A., Hatchette, T. F., Lang, A. L., Gillis, H., Martin, I., Andrew, M. K., Boivin, G., Bowie, W., Green, K., Johnstone, J., Loeb, M., McCarthy, A., McGeer, A., Moraca, S., Semret, M., … Serious Outcomes Surveillance (SOS) Network of the Canadian Immunization Research Network (CIRN) (2017). Burden of vaccine-preventable pneumococcal disease in hospitalized adults: A Canadian Immunization Research Network (CIRN) Serious Outcomes Surveillance (SOS) network study. Vaccine, 35(29), 3647–3654. https://doi.org/10.1016/j.vaccine.2017.05.049

[101] LeBlanc, J. J., ElSherif, M., Ye, L., MacKinnon-Cameron, D., Li, L., Ambrose, A., Hatchette, T. F., Lang, A. L., Gillis, H., Martin, I., Andrew, M. K., Boivin, G., Bowie, W., Green, K., Johnstone, J., Loeb, M., McCarthy, A., McGeer, A., Moraca, S., Semret, M., … Serious Outcomes Surveillance (SOS) Network of the Canadian Immunization Research Network (CIRN) (2017). Burden of vaccine-preventable pneumococcal disease in hospitalized adults: A Canadian Immunization Research Network (CIRN) Serious Outcomes Surveillance (SOS) network study. Vaccine, 35(29), 3647–3654. https://doi.org/10.1016/j.vaccine.2017.05.049

[102] Kwong, J. C., Crowcroft, N. S., Campitelli, M. A., Ratnasingham, S., Daneman, N., Deeks, S. L., & Manuel, D. G. (2010). Ontario Burden of Infectious Disease Study Advisory Group; Ontario Burden of Infectious Disease Study Advisory Group, Ontario Burden of Infectious Disease Study (ONBOIDS): An OAHPP/ICES Report. Ontario Agency for Health Protection and Promotion, Institute for Clinical and Evaluative Sciences. Retrieved from: https://www.ices.on.ca/flip-publication/ontario-burden-of-infectionus-disease/files/assets/basic-html/index.html#1

[103] Kwong, J. C., Crowcroft, N. S., Campitelli, M. A., Ratnasingham, S., Daneman, N., Deeks, S. L., & Manuel, D. G. (2010). Ontario Burden of Infectious Disease Study Advisory Group; Ontario Burden of Infectious Disease Study Advisory Group, Ontario Burden of Infectious Disease Study (ONBOIDS): An OAHPP/ICES Report. Ontario Agency for Health Protection and Promotion, Institute for Clinical and Evaluative Sciences. Retrieved from: https://www.ices.on.ca/flip-publication/ontario-burden-of-infectionus-disease/files/assets/basic-html/index.html#1

[104] The Conference Board of Canada. (April 2017). The Economic Burden of Pneumonia in Canada: A Status Quo Forecast.

[105] Public Health Agency of Canada. (2018). Economic burden of illness in Canada, 2010. Government of Canada. Retrieved from: https://www.canada.ca/content/dam/phac-aspc/documents/services/publications/science-research/economic-burden-illness-canada-2010/economic-burden-illness-canada-2010.pdf

[106] Public Health Agency of Canada. (2018). Economic burden of illness in Canada, 2010. Government of Canada. Retrieved from: https://www.canada.ca/content/dam/phac-aspc/documents/services/publications/science-research/economic-burden-illness-canada-2010/economic-burden-illness-canada-2010.pdf

[107] Public Health Agency of Canada. (2022). Economic burden of illness in Canada custom report [Data set]. Government of Canada. Retrieved from: https://cost-illness.canada.ca/custom-personnalise/results-national-resultats.php?year=2010&province=f5f51505b338dab3911e9d6c3b-90060f&agerange=6b257e3c885e430d-ba2d748775f66754&costsubtype=all&action=agerange

[108] Public Health Agency of Canada. (2022). Economic burden of illness in Canada custom report [Data set]. Government of Canada. Retrieved from: https://cost-illness.canada.ca/custom-personnalise/results-national-resultats.php?year=2010&province=f5f51505b338dab3911e9d6c3b-90060f&agerange=7f0e1a3580a7551ec-ca79a1534ac8d9d&costsubtype=all&action=agerange

[109] Public Health Agency of Canada. (2022). Economic burden of illness in Canada custom report [Data set]. Government of Canada. Retrieved from: https://cost-illness.canada.ca/custom-personnalise/results-national-resultats.php?year=2010&province=f5f51505b338dab3911e9d6c3b-90060f&agerange=53fa37bcea4d-7063b0e05e24936aa416&costsubtype=all&action=agerange

[110] Public Health Agency of Canada. (2022). Economic burden of illness in Canada custom report [Data set]. Government of Canada. Retrieved from: https://cost-illness.canada.ca/custom-personnalise/results-national-resultats.php

[111] Public Health Agency of Canada. (2022). Economic burden of illness in Canada custom report. Government of Canada. Retrieved from: https://cost-illness.canada.ca/custom-personnalise/results-national-resultats.php

[112] Conference Board of Canada. (2017). The Economic Burden of Pneumonia. Retrieved from: https://www.conferenceboard.ca/temp/64b1070c-5e49-4b8f-a638-c96af0e7dd59/8723_The-Economic-Burden-of-Pneumonia-in-Canada_BR.pdf

[113] The Conference Board of Canada. (April 2017). The Economic Burden of Pneumonia in Canada: A Status Quo Forecast.

[114] Thomas, C. P., Ryan, M., Chapman, J. D., Stason, W. B., Tompkins, C. P., Suaya, J. A., Polsky, D., Mannino, D. M., & Shepard, D. S. (2012). Incidence and cost of pneumonia in medicare beneficiaries. Chest, 142(4), 973–981. https://doi.org/10.1378/chest.11-1160

[115] The Conference Board of Canada. (April 2017). The Economic Burden of Pneumonia in Canada: A Status Quo Forecast.

[116] The Conference Board of Canada. (April 2017). The Economic Burden of Pneumonia in Canada: A Status Quo Forecast.

[117] The Conference Board of Canada. (April 2017). The Economic Burden of Pneumonia in Canada: A Status Quo Forecast.

[118] The Conference Board of Canada. (April 2017). The Economic Burden of Pneumonia in Canada: A Status Quo Forecast.

[119] Centers for Disease Control and Prevention. (2020). Risk factors and how it spreads. Retrieved from: https://www.cdc.gov/pneumococcal/about/risk-transmission.html

[120] Torres, A., Blasi, F., Dartois, N., & Akova, M. (2015). Which individuals are at increased risk of pneumococcal disease and why? Impact of COPD, asthma, smoking, diabetes, and/or chronic heart disease on community-acquired pneumonia and invasive pneumococcal disease. Thorax, 70(10), 984–989. https://doi.org/10.1136/thoraxjnl-2015-206780

[121] Torres, A., Blasi, F., Dartois, N., & Akova, M. (2015). Which individuals are at increased risk of pneumococcal disease and why? Impact of COPD, asthma, smoking, diabetes, and/or chronic heart disease on community-acquired pneumonia and invasive pneumococcal disease. Thorax, 70(10), 984–989. https://doi.org/10.1136/thoraxjnl-2015-206780

[122] Public Health Agency of Canada. (2023). Public health level recommendations on the use of pneumococcal vaccines in adults, including the use of 15-valent and 20-valent conjugate vaccines. Government of Canada. Retrieved from: https://www.canada.ca/content/dam/phac-aspc/documents/services/immunization/national-advisory-committee-on-immunization-naci/public-health-level-recommendations-use-pneumococcal-vaccines-adults-including-use-15-valent-20-valent-conjugate-vaccines/recommendations-use-pneumococcal-vaccines-adults-15-20-valent-conjugate.pdf

[123] Centers for Disease Control and Prevention. (2020). Risk factors and how it spreads. Retrieved from: https://www.cdc.gov/pneumococcal/about/risk-transmission.html

[124] Dorrington, M. G., & Bowdish, D. M. (2013). Immunosenescence and novel vaccination strategies for the elderly. Frontiers in immunology, 4, 171. https://doi.org/10.3389/fimmu.2013.00171

[125] Dorrington, M. G., & Bowdish, D. M. (2013). Immunosenescence and novel vaccination strategies for the elderly. Frontiers in immunology, 4, 171. https://doi.org/10.3389/fimmu.2013.00171

[126] Dorrington, M. G., & Bowdish, D. M. (2013). Immunosenescence and novel vaccination strategies for the elderly. Frontiers in immunology, 4, 171. https://doi.org/10.3389/fimmu.2013.00171

[127] Janssens, J. P., & Krause, K. H. (2004). Pneumonia in the very old. The Lancet. Infectious diseases, 4(2), 112–124. https://doi.org/10.1016/S1473-3099(04)00931-4

[128] Jackson, M. L., Nelson, J. C., & Jackson, L. A. (2009). Risk factors for community-acquired pneumonia in immunocompetent seniors. Journal of the American Geriatrics Society, 57(5), 882–888. https://doi.org/10.1111/j.1532-5415.2009.02223.x

[129] Eurich, D. T., Marrie, T. J., Minhas-Sandhu, J. K., & Majumdar, S. R. (2017). Risk of heart failure after community acquired pneumonia: prospective controlled study with 10 years of follow-up. BMJ (Clinical research ed.), 356, j413. https://doi.org/10.1136/bmj.j413

[130] Eurich, D. T., Marrie, T. J., Minhas-Sandhu, J. K., & Majumdar, S. R. (2017). Risk of heart failure after community acquired pneumonia: prospective controlled study with 10 years of follow-up. BMJ (Clinical research ed.), 356, j413. https://doi.org/10.1136/bmj.j413

[131] Jackson, M. L., Nelson, J. C., & Jackson, L. A. (2009). Risk factors for community-acquired pneumonia in immunocompetent seniors. Journal of the American Geriatrics Society, 57(5), 882–888. https://doi.org/10.1111/j.1532-5415.2009.02223.x

[132] Mertz, D., Kim, T. H., Johnstone, J., Lam, P. P., Science, M., Kuster, S. P., Fadel, S. A., Tran, D., Fernandez, E., Bhatnagar, N., & Loeb, M. (2013). Populations at risk for severe or complicated influenza illness: systematic review and meta-analysis. BMJ (Clinical research ed.), 347, f5061. https://doi.org/10.1136/bmj.f5061

[133] Eurich, D. T., Marrie, T. J., Minhas-Sandhu, J. K., & Majumdar, S. R. (2017). Risk of heart failure after community acquired pneumonia: prospective controlled study with 10 years of follow-up. BMJ (Clinical research ed.), 356, j413. https://doi.org/10.1136/bmj.j413

[134] Torres, A., Blasi, F., Dartois, N., & Akova, M. (2015). Which individuals are at increased risk of pneumococcal disease and why? Impact of COPD, asthma, smoking, diabetes, and/or chronic heart disease on community-acquired pneumonia and invasive pneumococcal disease. Thorax, 70(10), 984–989. https://doi.org/10.1136/thoraxjnl-2015-206780

[135] Müllerova, H., Chigbo, C., Hagan, G. W., Woodhead, M. A., Miravitlles, M., Davis, K. J., & Wedzicha, J. A. (2012). The natural history of community-acquired pneumonia in COPD patients: a population database analysis. Respiratory medicine, 106(8), 1124–1133. https://doi.org/10.1016/j.rmed.2012.04.008

[136] Jackson, M. L., Nelson, J. C., & Jackson, L. A. (2009). Risk factors for community-acquired pneumonia in immunocompetent seniors. Journal of the American Geriatrics Society, 57(5), 882–888. https://doi.org/10.1111/j.1532-5415.2009.02223.x

[137] Müllerova, H., Chigbo, C., Hagan, G. W., Woodhead, M. A., Miravitlles, M., Davis, K. J., & Wedzicha, J. A. (2012). The natural history of community-acquired pneumonia in COPD patients: a population database analysis. Respiratory medicine, 106(8), 1124–1133. https://doi.org/10.1016/j.rmed.2012.04.008

[138] Public Health Agency of Canada. (2014). An Advisory Committee Statement (ACS) National Advisory Committee on Immunization (NACI): Update on the use of pneumococcal vaccines: Addition of asthma as a high-risk condition. Government of Canada. Retrieved from: https://www.canada.ca/content/dam/phac-aspc/documents/services/publications/healthy-living/update-use-pneumococcal-vaccines-addition-asthma-high-risk-condition-eng.pdf

[139] Public Health Agency of Canada. (2014). An Advisory Committee Statement (ACS) National Advisory Committee on Immunization (NACI): Update on the use of pneumococcal vaccines: Addition of asthma as a high-risk condition. Government of Canada. Retrieved from: https://www.canada.ca/content/dam/phac-aspc/documents/services/publications/healthy-living/update-use-pneumococcal-vaccines-addition-asthma-high-risk-condition-eng.pdf

[140] Public Health Agency of Canada. (2014). An Advisory Committee Statement (ACS) National Advisory Committee on Immunization (NACI): Update on the use of pneumococcal vaccines: Addition of asthma as a high-risk condition. Government of Canada. Retrieved from: https://www.canada.ca/content/dam/phac-aspc/documents/services/publications/healthy-living/update-use-pneumococcal-vaccines-addition-asthma-high-risk-condition-eng.pdf

[141] Public Health Agency of Canada. (2014). An Advisory Committee Statement (ACS) National Advisory Committee on Immunization (NACI): Update on the use of pneumococcal vaccines: Addition of asthma as a high-risk condition. Government of Canada. Retrieved from: https://www.canada.ca/content/dam/phac-aspc/documents/services/publications/healthy-living/update-use-pneumococcal-vaccines-addition-asthma-high-risk-condition-eng.pdf

[142] Girard, T. D., Self, W. H., Edwards, K. M., Grijalva, C. G., Zhu, Y., Williams, D. J., Jain, S., & Jackson, J. C. (2018). Long-Term Cognitive Impairment after Hospitalization for Community-Acquired Pneumonia: a Prospective Cohort Study. Journal of general internal medicine, 33(6), 929–935. https://doi.org/10.1007/s11606-017-4301-x

[143] Girard, T. D., Self, W. H., Edwards, K. M., Grijalva, C. G., Zhu, Y., Williams, D. J., Jain, S., & Jackson, J. C. (2018). Long-Term Cognitive Impairment after Hospitalization for Community-Acquired Pneumonia: a Prospective Cohort Study. Journal of general internal medicine, 33(6), 929–935. https://doi.org/10.1007/s11606-017-4301-x

[144] Davydow, D. S., Hough, C. L., Levine, D. A., Langa, K. M., & Iwashyna, T. J. (2013). Functional disability, cognitive impairment, and depression after hospitalization for pneumonia. The American journal of medicine, 126(7), 615–24.e5. https://doi.org/10.1016/j.amjmed.2012.12.006

[145] Davydow, D.S., Hough, C.L., Levine, D.A., Langa, K.M., & Iwashyna, T.J. (2013). Functional Disability, Cognitive Impairment, and Depression Following Hospitalization for Pneumonia. American Journal of Medicine, 126(7), 615-624.e5. https://doi.org/10.1016/j.amjmed.2012.12.006

[146] Davydow, D. S., Hough, C. L., Levine, D. A., Langa, K. M., & Iwashyna, T. J. (2013). Functional disability, cognitive impairment, and depression after hospitalization for pneumonia. The American journal of medicine, 126(7), 615–24.e5. https://doi.org/10.1016/j.amjmed.2012.12.006

[147] Torres, A., Blasi, F., Dartois, N., & Akova, M. (2015). Which individuals are at increased risk of pneumococcal disease and why? Impact of COPD, asthma, smoking, diabetes, and/or chronic heart disease on community-acquired pneumonia and invasive pneumococcal disease. Thorax, 70(10), 984–989. https://doi.org/10.1136/thoraxjnl-2015-206780

[148] Torres, A., Blasi, F., Dartois, N., & Akova, M. (2015). Which individuals are at increased risk of pneumococcal disease and why? Impact of COPD, asthma, smoking, diabetes, and/or chronic heart disease on community-acquired pneumonia and invasive pneumococcal disease. Thorax, 70(10), 984–989. https://doi.org/10.1136/thoraxjnl-2015-206780

[149] Seminog, O. O., & Goldacre, M. J. (2013). Risk of pneumonia and pneumococcal disease in people hospitalized with diabetes mellitus: English record-linkage studies. Diabetic medicine : a journal of the British Diabetic Association, 30(12), 1412–1419. https://doi.org/10.1111/dme.12260

[150] Seminog, O. O., & Goldacre, M. J. (2013). Risk of pneumonia and pneumococcal disease in people hospitalized with diabetes mellitus: English record-linkage studies. Diabetic medicine : a journal of the British Diabetic Association, 30(12), 1412–1419. https://doi.org/10.1111/dme.12260

[151] Kwong, J. C., Campitelli, M. A., & Rosella, L. C. (2011). Obesity and respiratory hospitalizations during influenza seasons in Ontario, Canada: a cohort study. Clinical infectious diseases : an official publication of the Infectious Diseases Society of America, 53(5), 413–421. https://doi.org/10.1093/cid/cir442

[152] Davydow, D. S., Hough, C. L., Levine, D. A., Langa, K. M., & Iwashyna, T. J. (2013). Functional disability, cognitive impairment, and depression after hospitalization for pneumonia. The American journal of medicine, 126(7), 615–24.e5. https://doi.org/10.1016/j.amjmed.2012.12.006

[153] Helferty, M., Rotondo, J. L., Martin, I., & Desai, S. (2013). The epidemiology of invasive pneumococcal disease in the Canadian North from 1999 to 2010. International journal of circumpolar health, 72, 10.3402/ijch.v72i0.21606. https://doi.org/10.3402/ijch.v72i0.21606

[154] Huang, G., Martin, I., Tsang, R. S., Demczuk, W. H., Tyrrell, G. J., Li, Y. A., Dickson, C., Reyes-Domingo, F., & Squires, S. G. (2021). Invasive bacterial diseases in northern Canada, 1999 to 2018. Canada communicable disease report = Releve des maladies transmissibles au Canada, 47(11), 491–499. https://doi.org/10.14745/ccdr.v47i11a09

[155] Huang, G., Martin, I., Tsang, R. S., Demczuk, W. H., Tyrrell, G. J., Li, Y. A., Dickson, C., Reyes-Domingo, F., & Squires, S. G. (2021). Invasive bacterial diseases in northern Canada, 1999 to 2018. Canada communicable disease report = Releve des maladies transmissibles au Canada, 47(11), 491–499. https://doi.org/10.14745/ccdr.v47i11a09

[156] Mahmud, S. M., Sinnock, H., Mostaço-Guidolin, L. C., Pabla, G., Wierzbowski, A. K., & Bozat-Emre, S. (2017). Long-term trends in invasive pneumococcal disease in Manitoba, Canada. Human vaccines & immunotherapeutics, 13(8), 1884–1891. https://doi.org/10.1080/21645515.2017.1320006

[157] Government of Canada. (2022). Pneumococcal vaccine: Canadian Immunization Guide. Retrieved from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-16-pneumococcal-vaccine.html

[158] Baskaran, V., Murray, R. L., Hunter, A., Lim, W. S., & McKeever, T. M. (2019). Effect of tobacco smoking on the risk of developing community acquired pneumonia: A systematic review and meta-analysis. PloS one, 14(7), e0220204. https://doi.org/10.1371/journal.pone.0220204

[159] Samokhvalov, A. V., Irving, H. M., & Rehm, J. (2010). Alcohol consumption as a risk factor for pneumonia: a systematic review and meta-analysis. Epidemiology and infection, 138(12), 1789–1795. https://doi.org/10.1017/S0950268810000774

[160] Baskaran, V., Murray, R. L., Hunter, A., Lim, W. S., & McKeever, T. M. (2019). Effect of tobacco smoking on the risk of developing community acquired pneumonia: A systematic review and meta-analysis. PloS one, 14(7), e0220204. https://doi.org/10.1371/journal.pone.0220204

[161] Samokhvalov, A. V., Irving, H. M., & Rehm, J. (2010). Alcohol consumption as a risk factor for pneumonia: a systematic review and meta-analysis. Epidemiology and infection, 138(12), 1789–1795. https://doi.org/10.1017/S0950268810000774

[162] Lemay, J. A., Ricketson, L. J., Zwicker, L., & Kellner, J. D. (2019). Homelessness in Adults with Invasive Pneumococcal Disease (IPD) in Calgary, Canada. Open forum infectious diseases, 6(10), ofz362. https://doi.org/10.1093/ofid/ofz362

[163] Health Canada. (2002). An Advisory Committee Statement (ACS) National Advisory Committee on Immunization – Statement on Recommended Use of Pneumococcal Conjugate Vaccine. Canada Communicable Disease Report, 28, 1-32. Retrieved from: https://www.cfpc.ca/uploadedFiles/Resources/Resource_Items/Health_Professionals/PneumococcalVaccine.pdf

[164] Government of Canada. (2021). Invasive pneumococcal disease. Retrieved from: https://www.canada.ca/en/public-health/services/immunization/vaccine-preventable-diseases/invasive-pneumococcal-disease/health-professionals.html

[165] Helferty, M., Rotondo, J.L., Martin, I., & Desai, S. (2013). The epidemiology of invasive pneumococcal disease in the Canadian North from 1999 to 2010. International Journal of Circumpolar Health, 72. http://dx.doi.org/10.3402/ijch.v72i0.21606

[166] Pelton, S.I., Weycker, D., Farkouh, R.A., Strutton, D.R., Shea, K.M., & Edelsberg, J. (2014). Risk of pneumococcal disease in children with chronic medical conditions in the era of pneumococcal conjugate vaccine. Clinical Infectious Diseases, 59(5), 615-23. Doi: 10.1093/cid/ciu348

[167] Pelton, S.I., Weycker, D., Farkouh, R.A., Strutton, D.R., Shea, K.M., & Edelsberg, J. (2014). Risk of pneumococcal disease in children with chronic medical conditions in the era of pneumococcal conjugate vaccine. Clinical Infectious Diseases, 59(5), 615-23. Doi: 10.1093/cid/ciu348

[168] Pelton, S.I., Weycker, D., Farkouh, R.A., Strutton, D.R., Shea, K.M., & Edelsberg, J. (2014). Risk of pneumococcal disease in children with chronic medical conditions in the era of pneumococcal conjugate vaccine. Clinical Infectious Diseases, 59(5), 615-23. Doi: 10.1093/cid/ciu348

[169] Government of Canada. (2022). Pneumococcal vaccine: Canadian Immunization Guide. Retrieved from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-16-pneumococcal-vaccine.html

[169a] Centers for Disease Control and Prevention. (2023). WB4650 Immunization: You Call the Shots-Module One-General Best Practice Guidelines for Immunization-2023. Retrieved from: https://www2.cdc.gov/nip/isd/ycts/mod1/courses/gbp/index.html

[170] Centers for Disease Control and Prevention [CDC]. (n.d.). Principles of Vaccination. Retrieved from: https://www.cdc.gov/vaccines/pubs/pinkbook/downloads/prinvac.pdf

[171] Centers for Disease Control and Prevention (CDC). (n.d.). Immunization – You call the Shots: Understanding the Basics: General Recommendations on Immunization. Retrieved from: https://www2a.cdc.gov/nip/isd/ycts/mod1/courses/genrec/11005.asp?student_id=

[172] Centers for Disease Control and Prevention [CDC]. (n.d.). Principles of Vaccination. Retrieved from: https://www.cdc.gov/vaccines/pubs/pinkbook/downloads/prinvac.pdf

[173] Centers for Disease Control and Prevention (CDC). (n.d.). Immunization – You call the Shots: Understanding the Basics: General Recommendations on Immunization. Retrieved from: https://www2a.cdc.gov/nip/isd/ycts/mod1/courses/genrec/11005.asp?student_id=

[174] Centers for Disease Control and Prevention [CDC]. (n.d.). Principles of Vaccination. Retrieved from: https://www.cdc.gov/vaccines/pubs/pinkbook/downloads/prinvac.pdf

[175] Centers for Disease Control and Prevention (CDC). (n.d.). Immunization – You call the Shots: Understanding the Basics: General Recommendations on Immunization. Retrieved from: https://www2a.cdc.gov/nip/isd/ycts/mod1/courses/genrec/11005.asp?student_id=

[176] Centers for Disease Control and Prevention [CDC]. (n.d.). Principles of Vaccination. Retrieved from: https://www.cdc.gov/vaccines/pubs/pinkbook/downloads/prinvac.pdf

[177] Centers for Disease Control and Prevention (CDC). (n.d.). Pneumococcal Disease. Retrieved from: https://www.cdc.gov/vaccines/pubs/pinkbook/downloads/pneumo.pdf

[178] Centers for Disease Control and Prevention (CDC). (n.d.). Pneumococcal Disease. Retrieved from: https://www.cdc.gov/vaccines/pubs/pinkbook/downloads/pneumo.pdf

[179] Government of Canada. (2021). Invasive pneumococcal disease. Retrieved from: https://www.canada.ca/en/public-health/services/immunization/vaccine-preventable-diseases/invasive-pneumococcal-disease/health-professionals.html

[180] Government of Canada. (2021). Invasive pneumococcal disease. Retrieved from: https://www.canada.ca/en/public-health/services/immunization/vaccine-preventable-diseases/invasive-pneumococcal-disease/health-professionals.html

[181] Centers for Disease Control and Prevention (CDC). (n.d.). Pneumococcal Disease. Retrieved from: https://www.cdc.gov/vaccines/pubs/pinkbook/downloads/pneumo.pdf

[182] Centers for Disease Control and Prevention [CDC]. (n.d.). Principles of Vaccination. Retrieved from: https://www.cdc.gov/vaccines/pubs/pinkbook/downloads/prinvac.pdf

[183] Centers for Disease Control and Prevention (CDC). (n.d.). Pneumococcal Disease. Retrieved from: https://www.cdc.gov/vaccines/pubs/pinkbook/downloads/pneumo.pdf

[184] Waye, A., Chuck, A.W., Jacobs, P., Tyrrell, G., & Kellner, J.D. (2015). Prevnar 7 Childhood Immunization Program and Serotype Replacement: Changes in Pneumococcal Incidence and Resulting Impact on Health Care Costs in Alberta (2003-2008). Drugs Real World Outcomes, 2(2), 153-161. https://doi.org/10.1007/s40801-015-0024-7

[185] Waye, A., Chuck, A.W., Jacobs, P., Tyrrell, G., & Kellner, J.D. (2015). Prevnar 7 Childhood Immunization Program and Serotype Replacement: Changes in Pneumococcal Incidence and Resulting Impact on Health Care Costs in Alberta (2003-2008). Drugs Real World Outcomes, 2(2), 153-161. https://doi.org/10.1007/s40801-015-0024-7

[186] Bettinger, J.A., Scheifele, D.W., Kellner, J.D., Halperin, S.A., Vaudry, W., Law, B., Tyrrell, G., for the Members of the Canadian Immunization Monitoring Program, Active (IMPACT). (2010). The effect of routine vaccination on

invasive pneumococcal infections in Canadian children, Immunization Monitoring Program, Active 2000-2007. Vaccine, 28, 2130-2136. Doi: 10.1016/j.vaccine.2009.12.026

[187] Bettinger, J.A., Scheifele, D.W., Kellner, J.D., Halperin, S.A., Vaudry, W., Law, B., Tyrrell, G., for the Members of the Canadian Immunization Monitoring Program, Active (IMPACT). (2010). The effect of routine vaccination on invasive pneumococcal infections in Canadian children, Immunization Monitoring Program, Active 2000-2007. Vaccine, 28, 2130-2136. Doi: 10.1016/j.vaccine.2009.12.026

[188] Government of Canada. (2022). Pneumococcal vaccine: Canadian Immunization Guide. Retrieved from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-16-pneumococcal-vaccine.html

[189] Public Health Agency of Canada. (2018). An Advisory Committee Statement (ACS) National Advisory Committee on Immunization (NACI): Update on the use of pneumococcal vaccines in adults 65 years of age and older – A Public Health Perspective. Retrieved from: https://www.canada.ca/content/dam/phac-aspc/documents/services/publications/healthy-living/update-on-the-use-of-pneumococcal-vaccines-in-adult/update-on-the-use-of-pneumococcal-vaccines-in-adult-eng.pdf

[190] Centers for Disease Control and Prevention [CDC]. (n.d.). Principles of Vaccination. Retrieved from: https://www.cdc.gov/vaccines/pubs/pinkbook/downloads/prinvac.pdf

[191] Government of Canada. (2022). Pneumococcal vaccine: Canadian Immunization Guide. Retrieved from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-16-pneumococcal-vaccine.html

[192] Centers for Disease Control and Prevention [CDC]. (n.d.). Principles of Vaccination. Retrieved from: https://www.cdc.gov/vaccines/pubs/pinkbook/downloads/prinvac.pdf

[193] Centers for Disease Control and Prevention [CDC]. (n.d.). Principles of Vaccination. Retrieved from: https://www.cdc.gov/vaccines/pubs/pinkbook/downloads/prinvac.pdf

[194] Centers for Disease Control and Prevention [CDC]. (n.d.). Principles of Vaccination. Retrieved from: https://www.cdc.gov/vaccines/pubs/pinkbook/downloads/prinvac.pdf

[195] Centers for Disease Control and Prevention [CDC]. (n.d.). Principles of Vaccination. Retrieved from: https://www.cdc.gov/vaccines/pubs/pinkbook/downloads/prinvac.pdf

[196] Centers for Disease Control and Prevention [CDC]. (n.d.). Principles of Vaccination. Retrieved from: https://www.cdc.gov/vaccines/pubs/pinkbook/downloads/prinvac.pdf

[197] Centers for Disease Control and Prevention [CDC]. (n.d.). Principles of Vaccination. Retrieved from: https://www.cdc.gov/vaccines/pubs/pinkbook/downloads/prinvac.pdf

[198] Government of Canada. (2022). Pneumococcal vaccine: Canadian Immunization Guide. Retrieved from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-16-pneumococcal-vaccine.html

[199] Merck Canada Inc. (2022). Product monograph including patient medication information: VAXNEUVANCE®. Government of Canada. Retrieved from: https://pdf.hres.ca/dpd_pm/00066824.PDF

[200] Pfizer Canada 2021. (2022). Pfizer announces PREVNAR 20™ (pneumococcal 20-valent conjugate vaccine) is now available in Canada for the prevention of pneumonia and invasive pneumococcal disease in adults 18 years of age and older. Retrieved from: https://www.pfizer.ca/en/media-centre/pfizer-announces-prevnar-20tm-pneumococcal-20-valent-conjugate-vaccine-now-available-canada

[201] Government of Canada. (2022). Pneumococcal vaccine: Canadian Immunization Guide. Retrieved from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-16-pneumococcal-vaccine.html

[202] Merck Canada Inc. (2022). Product monograph including patient medication information: VAXNEUVANCE®. Government of Canada. Retrieved from: https://pdf.hres.ca/dpd_pm/00066824.PDF

[203] Pfizer Canada ULC. (2022). Product monograph including patient medication information: PREVNAR 20^{tm}. Government of Canada. Retrieved from: https://pdf.hres.ca/dpd_pm/00065729.PDF

[204] Government of Canada. (2022). Pneumococcal vaccine: Canadian Immunization Guide. Retrieved from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-16-pneumococcal-vaccine.html

[205] Government du Québec. (2020). Pneumococcal vaccination program. Retrieved from: https://www.quebec.ca/en/health/advice-and-prevention/vaccination/pneumococcal-vaccination-program

[206] Austrian, R. (1999). A Brief History of Pneumococcal Vaccines. Drugs & Aging, 151, 1-10. Doi: 10.2165/00002512-199915001-00001

[207] Austrian, R. (1999). A Brief History of Pneumococcal Vaccines. Drugs & Aging, 151, 1-10. Doi: 10.2165/00002512-199915001-00001

[208] Austrian, R. (1999). A Brief History of Pneumococcal Vaccines. Drugs & Aging, 151, 1-10. Doi: 10.2165/00002512-199915001-00001

[209] Austrian, R. (1999). A Brief History of Pneumococcal Vaccines. Drugs & Aging, 151, 1-10. Doi: 10.2165/00002512-199915001-00001

[210] Austrian, R. (1999). A Brief History of Pneumococcal Vaccines. Drugs & Aging, 151, 1-10. Doi: 10.2165/00002512-199915001-00001

[211] Austrian, R. (1999). A Brief History of Pneumococcal Vaccines. Drugs & Aging, 151, 1-10. Doi: 10.2165/00002512-199915001-00001

[212] World Health Organization. (2012). Weekly epidemiological record. 87(14), 129-144. Retrieved from: http://www.who.int/wer/2012/wer8714.pdf?ua=1

[213] World Health Organization. (2012). Weekly epidemiological record. 87(14), 129-144. Retrieved from: http://www.who.int/wer/2012/wer8714.pdf?ua=1

[214] World Health Organization. (2012). Weekly epidemiological record. 87(14), 129-144. Retrieved from: http://www.who.int/wer/2012/wer8714.pdf?ua=1

[215] World Health Organization. (2012). Weekly epidemiological record. 87(14), 129-144. Retrieved from: http://www.who.int/wer/2012/wer8714.pdf?ua=1

[216] World Health Organization. (2012). Weekly epidemiological record. 87(14), 129-144. Retrieved from: http://www.who.int/wer/2012/wer8714.pdf?ua=1

[217] Government of Canada. (2021). Invasive pneumococcal disease. Retrieved from: https://www.canada.ca/en/public-health/services/immunization/vaccine-preventable-diseases/invasive-pneumococcal-disease/health-professionals.html

[218] Government of Canada. (2021). Invasive pneumococcal disease. Retrieved from: https://www.canada.ca/en/public-health/services/immunization/vaccine-preventable-diseases/invasive-pneumococcal-disease/health-professionals.html

[219] Pfizer Canada Inc. (n.d.). Product monograph: PREVNAR®. Government of Canada. Retrieved from: https://pdf.hres.ca/dpd_pm/00011596.PDF

[220] GlaxoSmithKline Inc. (2019). Product monograph: SYNFLORIX. Government of Canada. Retrieved from: https://pdf.hres.ca/dpd_pm/00053908.PDF

[221] Pfizer Canada ULC 2019. (2019). Product monograph: Prevnar* 13. Government of Canada. Retrieved from: https://pdf.hres.ca/dpd_pm/00052583.PDF

[222] Government of Canada. (2021). Invasive pneumococcal disease. Retrieved from: https://www.canada.ca/en/public-health/services/immunization/vaccine-preventable-diseases/invasive-pneumococcal-disease/health-professionals.html

[223] Gouvernement du Quebec. (2018). Pneumococcal Conjugate Vaccine. Retrieved from: https://www.quebec.ca/en/health/advice-and-prevention/vaccination/pneumococcal-conjugate-vaccine/

[224] Government du Québec. (2020). Pneumococcal vaccination program. Retrieved from: https://www.quebec.ca/en/health/advice-and-prevention/vaccination/pneumococcal-vaccination-program

[225] Merck Canada Inc. (2022). Product monograph including patient medication information: VAXNEUVANCE®. Government of Canada. Retrieved from: https://pdf.hres.ca/dpd_pm/00066824.PDF

[226] Pfizer Canada 2021. (2022). Pfizer announces PREVNAR 20™ (pneumococcal 20-valent conjugate vaccine) is now available in Canada for the prevention of pneumonia and invasive pneumococcal disease in adults 18 years of age and older. Retrieved from: https://www.pfizer.ca/en/media-centre/pfizer-announces-prevnar-20tm-pneumococcal-20-valent-conjugate-vaccine-now-available-canada

[226a] Government du Québec. (2023). Vaccines: Pneu-C: Pneumococcal conjugate vaccine. Retrieved from: https://www.msss.gouv.qc.ca/professionnels/vaccination/piq-vaccins/pneu-c-vaccin-conjugue-contre-le-pneumocoque/

[227] Government of Canada. (2021). Invasive pneumococcal disease. Retrieved from: https://www.canada.ca/en/public-health/services/immunization/vaccine-preventable-diseases/invasive-pneumococcal-disease/health-professionals.html

[228] Government of Canada. (2021). Invasive pneumococcal disease. Retrieved from: https://www.canada.ca/en/public-health/services/immunization/vaccine-preventable-diseases/invasive-pneumococcal-disease/health-professionals.html

[229] Berical, A.C., Harris, D., Dela Cruz, C.S., & Possick, J.D. (2016). Pneumococcal Vaccination Strategies. An Update and Perspective. Annals of the American Thoracic Society, 13(6), 933-944. Doi: 10.1513/AnnalsATS.201511-778FR

[230] Westerink, M.A.J., Schroeder, H.W., & Nahm, M.H. (2012). Immune Responses to pneumococcal vaccines in children and adults: Rationale for age-specific vaccination. Aging and Disease, 3(1), 51-67. Retrieved from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3320805/

[231] Berical, A.C., Harris, D., Dela Cruz, C.S., & Possick, J.D. (2016). Pneumococcal Vaccination Strategies. An Update and Perspective. Annals of the American Thoracic Society, 13(6), 933-944. Doi: 10.1513/AnnalsATS.201511-778FR

[232] World Health Organization. (2012). Weekly epidemiological record. 87(14), 129-144. Retrieved from: http://www.who.int/wer/2012/wer8714.pdf?ua=1

[233] Westerink, M.A.J., Schroeder, H.W., & Nahm, M.H. (2012). Immune Responses to pneumococcal vaccines in children and adults: Rationale for age-specific vaccination. Aging and Disease, 3(1), 51-67. Retrieved from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3320805/

[234] Public Health Agency of Canada. (2023). Public health level recommendations on the use of pneumococcal vaccines in adults, including the use of 15-valent and 20-valent conjugate vaccines. Government of Canada. Retrieved from: https://www.canada.ca/en/public-health/services/immunization/national-advisory-committee-on-immunization-naci/public-health-level-recommendations-use-pneumococcal-vaccines-adults-including-use-15-valent-20-valent-conjugate-vaccines.html

[235] Public Health Agency of Canada. (2023). Public health level recommendations on the use of pneumococcal vaccines in adults, including the use of 15-valent and 20-valent conjugate vaccines. Government of Canada. Retrieved from: https://www.canada.ca/en/public-health/services/immunization/national-advisory-committee-on-immunization-naci/public-health-level-recommendations-use-pneumococcal-vaccines-adults-including-use-15-valent-20-valent-conjugate-vaccines.html

[237] Public Health Agency of Canada. (2023). Public health level recommendations on the use of pneumococcal vaccines in adults, including the use of 15-valent and 20-valent conjugate vaccines. Government of Canada. Retrieved from: https://www.canada.ca/en/public-health/services/immunization/national-advisory-committee-on-immunization-naci/public-health-level-recommendations-use-pneumococcal-vaccines-adults-including-use-15-valent-20-valent-conjugate-vaccines.html

[238] Government of Canada. (2022, September 13). Pneumococcal vaccine: Canadian Immunization Guide. Retrieved from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-16-pneumococcal-vaccine.html

[238a] Public Health Agency of Canada. (2023). Interim guidance on the use of pneumococcal 15-valent conjugate vaccine (PNEU-C-15) in pediatric populations. Government of Canada. Retrieved from: https://www.canada.ca/en/public-health/services/publications/vaccines-immunization/national-advisory-committee-immunization-interim-guidance-pneumococcal-15-valent-conjugate-vaccine-pneu-c-15-pediatric-populations.html

[239] Government of Canada. (2022, September 13). Pneumococcal vaccine: Canadian Immunization Guide. Retrieved from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-16-pneumococcal-vaccine.html

[239a] Public Health Agency of Canada. (2023). Interim guidance on the use of pneumococcal 15-valent conjugate vaccine (PNEU-C-15) in pediatric populations. Government of Canada. Retrieved from: https://www.canada.ca/en/public-health/services/publications/vaccines-immunization/national-advisory-committee-immunization-interim-guidance-pneumococcal-15-valent-conjugate-vaccine-pneu-c-15-pediatric-populations.html

[240] Government of Canada. (2022). Pneumococcal vaccine: Canadian Immunization Guide. Retrieved from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-16-pneumococcal-vaccine.html

[240a] Public Health Agency of Canada. (2023). Interim guidance on the use of pneumococcal 15-valent conjugate vaccine (PNEU-C-15) in pediatric populations. Government of Canada. Retrieved from: https://www.canada.ca/en/public-health/services/publications/vaccines-immunization/national-advisory-committee-immunization-interim-guidance-pneumococcal-15-valent-conjugate-vaccine-pneu-c-15-pediatric-populations.html

[241] Government of Canada. (2022). Pneumococcal vaccine: Canadian Immunization Guide. Retrieved from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-16-pneumococcal-vaccine.html

[242] Government of Canada. (2016). Page 7: Canadian Immunization Guide: Part 3 – Vaccination of Specific Populations. Retrieved from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-3-vaccination-specific-populations/page-7-immunization-persons-with-chronic-diseases.html

[243] Government of Canada. (2016). Page 7: Canadian Immunization Guide: Part 3 – Vaccination of Specific Populations. Retrieved from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-3-vaccination-specific-populations/page-7-immunization-persons-with-chronic-diseases.html

[244] Government of Canada. (2022). Pneumococcal vaccine: Canadian Immunization Guide. Retrieved from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-16-pneumococcal-vaccine.html

[245] Childs, L., Kobayashi, M., Farrar, J. L., & Pilishvili, T. (2021). 13. The efficacy and effectiveness of pneumococcal vaccines against pneumococcal pneumonia among adults: A systematic review and meta-analysis. Open Forum Infectious Diseases, 8(Supplement_1), S130–S131. https://doi.org/10.1093/ofid/ofab466.215

[246] Farrar, J. L., Kobayashi, M., Childs, L., & Pilishvili, T. (2021). 21. Systematic review and meta-analysis of pneumococcal vaccine effectiveness against invasive pneumococcal disease among adults. Open Forum Infectious Diseases, 8(Supplement_1), S134–S135. https://doi.org/10.1093/ofid/ofab466.223

[247] Public Health Agency of Canada. (2023). Public health level recommendations on the use of pneumococcal vaccines in adults, including the use of 15-valent and 20-valent conjugate vaccines. Government of Canada. Retrieved from: https://www.canada.ca/en/public-health/services/immunization/national-advisory-committee-on-immunization-naci/public-health-level-recommendations-use-pneumococcal-vaccines-adults-including-use-15-valent-20-valent-conjugate-vaccines.html

[248] Health Canada. (2020). Regulating vaccines for human use in Canada. Government of Canada. Retrieved from: https://www.canada.ca/en/health-canada/services/drugs-health-products/biologics-radiopharmaceuticals-genetic-therapies/activities/fact-sheets/regulation-vaccines-human-canada.html

[248a] Public Health Agency of Canada. (2023). Public health level recommendations on the use of pneumococcal vaccines in adults, including the use of 15-valent and 20-valent conjugate vaccines. Government of Canada. Retrieved from: https://www.canada.ca/en/public-health/services/immunization/national-advisory-committee-on-immunization-naci/public-health-level-recommendations-use-pneumococcal-vaccines-adults-including-use-15-valent-20-valent-conjugate-vaccines.html

[249] Wilson, M. R., Wasserman, M. D., Breton, M. C., Peloquin, F., Earnshaw, S. R., McDade, C., Sings, H. L., & Farkouh, R. A. (2020). Health and Economic Impact of Routine Pediatric Pneumococcal Immunization Programs in Canada: A Retrospective Analysis. Infectious diseases and therapy, 9(2), 341–353. https://doi.org/10.1007/s40121-020-00294-6

[250] Luca, D. L., Kwong, J. C., Chu, A., Sander, B., O'Reilly, R., McGeer, A. J., & Bloom, D. E. (2018). Impact of Pneumococcal Vaccination on Pneumonia Hospitalizations and Related Costs in Ontario: A Population-Based Ecological Study. Clinical infectious diseases : an official publication of the Infectious Diseases Society of America, 66(4), 541–547. https://doi.org/10.1093/cid/cix850

[251] Luca, D. L., Kwong, J. C., Chu, A., Sander, B., O'Reilly, R., McGeer, A. J., & Bloom, D. E. (2018). Impact of Pneumococcal Vaccination on Pneumonia Hospitalizations and Related Costs in Ontario: A Population-Based Ecological Study. Clinical infectious diseases : an official publication of the Infectious Diseases Society of America, 66(4), 541–547. https://doi.org/10.1093/cid/cix850

[252] Mahmud, S. M., Sinnock, H., Mostaço-Guidolin, L. C., Pabla, G., Wierzbowski, A. K., & Bozat-Emre, S. (2017). Long-term trends in invasive pneumococcal disease in Manitoba, Canada. Human vaccines & immunotherapeutics, 13(8), 1884–1891. https://doi.org/10.1080/21645515.2017.1320006

[253] Walter, N. D., Taylor, T. H., Jr, Dowell, S. F., Mathis, S., Moore, M. R., & Active Bacterial Core Surveillance System Team (2009). Holiday spikes in pneumococcal disease among older adults. The New England journal of medicine, 361(26), 2584–2585. https://doi.org/10.1056/NEJMc0904844

[254] Walter, N. D., Taylor, T. H., Jr, Dowell, S. F., Mathis, S., Moore, M. R., & Active Bacterial Core Surveillance System Team (2009). Holiday spikes in pneumococcal disease among older adults. The New England journal of medicine, 361(26), 2584–2585. https://doi.org/10.1056/NEJMc0904844

[255] Walter, N. D., Taylor, T. H., Jr, Dowell, S. F., Mathis, S., Moore, M. R., & Active Bacterial Core Surveillance System Team (2009). Holiday spikes in pneumococcal disease among older adults. The New England journal of medicine, 361(26), 2584–2585. https://doi.org/10.1056/NEJMc0904844

[256] Dion, S. B., Major, M., Gabriela Grajales, A., Nepal, R. M., Cane, A., Gessner, B., Vojicic, J., & Suaya, J. A. (2021). Invasive pneumococcal disease in Canada 2010-2017: The role of current and next-generation higher-valent pneumococcal conjugate vaccines. Vaccine, 39(22), 3007–3017. https://doi.org/10.1016/j.vaccine.2021.02.069

[257] Dion, S. B., Major, M., Gabriela Grajales, A., Nepal, R. M., Cane, A., Gessner, B., Vojicic, J., & Suaya, J. A. (2021). Invasive pneumococcal disease in Canada 2010-2017: The role of current and next-generation higher-valent pneumococcal conjugate vaccines. Vaccine, 39(22), 3007–3017. https://doi.org/10.1016/j.vaccine.2021.02.069

[258] Wijayasri, S., Hillier, K., Lim, G. H., Harris, T. M., Wilson, S. E., & Deeks, S. L. (2019). The shifting epidemiology and serotype distribution of invasive pneumococcal disease in Ontario, Canada, 2007-2017. PloS one, 14(12), e0226353. https://doi.org/10.1371/journal.pone.0226353

[259] Dion, S. B., Major, M., Gabriela Grajales, A., Nepal, R. M., Cane, A., Gessner, B., Vojicic, J., & Suaya, J. A. (2021). Invasive pneumococcal disease in Canada 2010-2017: The role of current and next-generation higher-valent pneumococcal conjugate vaccines. Vaccine, 39(22), 3007–3017. https://doi.org/10.1016/j.vaccine.2021.02.069

[260] Wijayasri, S., Hillier, K., Lim, G. H., Harris, T. M., Wilson, S. E., & Deeks, S. L. (2019). The shifting epidemiology and serotype distribution of invasive pneumococcal disease in Ontario, Canada, 2007-2017. PloS one, 14(12), e0226353. https://doi.org/10.1371/journal.pone.0226353

[261] Wijayasri, S., Hillier, K., Lim, G. H., Harris, T. M., Wilson, S. E., & Deeks, S. L. (2019). The shifting epidemiology and serotype distribution of invasive pneumococcal disease in Ontario, Canada, 2007-2017. PloS one, 14(12), e0226353. https://doi.org/10.1371/journal.pone.0226353

[262] Public Health Agency of Canada. (2023). Public health level recommendations on the use of pneumococcal vaccines in adults, including the use of 15-valent and 20-valent conjugate vaccines. Government of Canada. Retrieved from: https://www.canada.ca/en/public-health/services/immunization/national-advisory-committee-on-immunization-naci/public-health-level-recommendations-use-pneumococcal-vaccines-adults-including-use-15-valent-20-valent-conjugate-vaccines.html

[263] Wilson, M. R., Wasserman, M. D., Breton, M. C., Peloquin, F., Earnshaw, S. R., McDade, C., Sings, H. L., & Farkouh, R. A. (2020). Health and Economic Impact of Routine Pediatric Pneumococcal Immunization Programs in Canada: A Retrospective Analysis. Infectious diseases and therapy, 9(2), 341–353. https://doi.org/10.1007/s40121-020-00294-6

[264] Wilson, M. R., Wasserman, M. D., Breton, M. C., Peloquin, F., Earnshaw, S. R., McDade, C., Sings, H. L., & Farkouh, R. A. (2020). Health and Economic Impact of Routine Pediatric Pneumococcal Immunization Programs in Canada: A Retrospective Analysis. Infectious diseases and therapy, 9(2), 341–353. https://doi.org/10.1007/s40121-020-00294-6

[265] Luca, D. L., Kwong, J. C., Chu, A., Sander, B., O'Reilly, R., McGeer, A. J., & Bloom, D. E. (2018). Impact of Pneumococcal Vaccination on Pneumonia Hospitalizations and Related Costs in Ontario: A Population-Based Ecological Study. Clinical infectious diseases : an official publication of the Infectious Diseases Society of America, 66(4), 541–547. https://doi.org/10.1093/cid/cix850

[266] Public Health Agency of Canada. (2023). Public health level recommendations on the use of pneumococcal vaccines in adults, including the use of 15-valent and 20-valent conjugate vaccines. Government of Canada. Retrieved from: https://www.canada.ca/en/public-health/services/immunization/national-advisory-committee-on-immunization-naci/public-health-level-recommendations-use-pneumococcal-vaccines-adults-including-use-15-valent-20-valent-conjugate-vaccines.html

[267] Assaad, U., El-Masri, I., Porhomayon, J., & El-Solh, A. A. (2012). Pneumonia immunization in older adults: review of vaccine effectiveness and strategies. Clinical interventions in aging, 7, 453–461. https://doi.org/10.2147/CIA.S29675

[268] Christenson, B., Hedlund, J., Lundbergh, P., & Ortqvist, A. (2004). Additive preventive effect of influenza and pneumococcal vaccines in elderly persons. The European respiratory journal, 23(3), 363–368. https://doi.org/10.1183/09031936.04.00063504

[269] Christenson, B., Hedlund, J., Lundbergh, P., & Ortqvist, A. (2004). Additive preventive effect of influenza and pneumococcal vaccines in elderly persons. The European respiratory journal, 23(3), 363–368. https://doi.org/10.1183/09031936.04.00063504

[270] Christenson, B., Hedlund, J., Lundbergh, P., & Ortqvist, A. (2004). Additive preventive effect of influenza and pneumococcal vaccines in elderly persons. The European respiratory journal, 23(3), 363–368. https://doi.org/10.1183/09031936.04.00063504

[271] Kawakami, K., Ohkusa, Y., Kuroki, R., Tanaka, T., Koyama, K., Harada, Y., Iwanaga, K., Yamaryo, T., & Oishi, K. (2010). Effectiveness of pneumococcal polysaccharide vaccine against pneumonia and cost analysis for the elderly who receive seasonal influenza vaccine in Japan. Vaccine, 28(43), 7063–7069. https://doi.org/10.1016/j.vaccine.2010.08.010

[272] Jackson, L. A., Neuzil, K. M., Yu, O., Benson, P., Barlow, W. E., Adams, A. L., Hanson, C. A., Mahoney, L. D., Shay, D. K., Thompson, W. W., & Vaccine Safety Datalink (2003). Effectiveness of pneumococcal polysaccharide vaccine in older adults. The New England journal of medicine, 348(18), 1747–1755. https://doi.org/10.1056/NEJMoa022678

[273] Jackson, L. A., Neuzil, K. M., Yu, O., Benson, P., Barlow, W. E., Adams, A. L., Hanson, C. A., Mahoney, L. D., Shay, D. K., Thompson, W. W., & Vaccine Safety Datalink (2003). Effectiveness of pneumococcal polysaccharide vaccine in older adults. The New England journal of medicine, 348(18), 1747–1755. https://doi.org/10.1056/NEJMoa022678

[274] Monto, A. S., Hornbuckle, K., & Ohmit, S. E. (2001). Influenza vaccine effectiveness among elderly nursing home residents: a cohort study. American journal of epidemiology, 154(2), 155–160. https://doi.org/10.1093/aje/154.2.155

[275] Chan, T. C., Fan-Ngai Hung, I., Ka-Hay Luk, J., Chu, L. W., & Hon-Wai Chan, F. (2014). Effectiveness of influenza vaccination in institutionalized older adults: a systematic review. Journal of the American Medical Directors Association, 15(3), 226.e1–226.e6. https://doi.org/10.1016/j.jamda.2013.10.008

[276] Ontario Agency for Health Protection and Promotion. (2022). Ontario Immunization Advisory Committee (OIAC). Public Health Ontario. Retrieved from: https://www.publichealthontario.ca/en/About/External-Advisory-Committees/OIAC

[277] Government of Canada. (2022). COVID-19: How provinces and territories make decisions about how, who and when to vaccinate. Retrieved from: https://www.canada.ca/en/public-health/services/diseases/coronavirus-disease-covid-19/vaccines/provinces-territories-decisions-how-who-when-vaccinate.html

[279] Canadian Pharmacists Association. (2022). Injection authority and vaccine administration in pharmacies across Canada. Retrieved from: https://www.pharmacists.ca/cpha-ca/function/utilities/pdf-server.cfm?thefile=/cpha-on-the-issues/Immunization_Authority_Chart.pdf

[280] Public Health Agency of Canada. (2022). Vaccine uptake in Canadian adults 2021. Government of Canada. Retrieved from: https://www.canada.ca/content/dam/phac-aspc/documents/services/immunization-vaccines/vaccination-coverage/highlights-2020-2021-seasonal-influenza-survey/full-report/highlights-2020-2021-seasonal-influenza-survey.pdf

[281] Statistics Canada. (2021). Health characteristics of seniors aged 65 and over, Canadian Health Survey on Seniors (Table 13-10-0789-01) [Data table]. Retrieved from: https://doi.org/10.25318/1310078901-eng

[282] Public Health Agency of Canada. (2022). Vaccine uptake in Canadian adults 2021. Government of Canada. Retrieved from: https://www.canada.ca/content/dam/phac-aspc/documents/services/immunization-vaccines/vaccination-coverage/highlights-2020-2021-seasonal-influenza-survey/full-report/highlights-2020-2021-seasonal-influenza-survey.pdf

[283] Statistics Canada. (2021). Health characteristics of seniors aged 65 and over, Canadian Health Survey on Seniors (Table 13-10-0789-01) [Data table]. Retrieved from: https://doi.org/10.25318/1310078901-eng

[284] Government of Canada. (2022). Vaccination coverage goals and vaccine preventable disease reduction targets by 2025. Retrieved from: https://www.canada.ca/en/public-health/services/immunization-vaccine-priorities/national-immunization-strategy/vaccination-coverage-goals-vaccine-preventable-diseases-reduction-targets-2025.html

[285] Statistics Canada. (2021). Health characteristics of seniors aged 65 and over, Canadian Health Survey on Seniors (Table 13-10-0789-01) [Data table]. Retrieved from: https://doi.org/10.25318/1310078901-eng

[286] Public Health Agency of Canada. (2022). Vaccine uptake in Canadian adults 2021. Government of Canada. Retrieved from: https://www.canada.ca/content/dam/phac-aspc/documents/services/immunization-vaccines/vaccination-coverage/highlights-2020-2021-seasonal-influenza-survey/full-report/highlights-2020-2021-seasonal-influenza-survey.pdf

[287] Public Health Agency of Canada. (2022). Vaccine uptake in Canadian adults 2019. Government of Canada. Retrieved from: https://www.canada.ca/en/public-health/services/publications/healthy-living/2018-2019-influenza-flu-vaccine-coverage-survey-results.html

[288] Government of Canada. (2022). Vaccination coverage goals and vaccine preventable disease reduction targets by 2025. Retrieved from: https://www.canada.ca/en/public-health/services/immunization-vaccine-priorities/national-immunization-strategy/vaccination-coverage-goals-vaccine-preventable-diseases-reduction-targets-2025.html

[289] Public Health Agency of Canada. (2022). Highlights from the 2019 childhood National Immunization Coverage Survey (cNICS). Government of Canada. Retrieved from: https://www.canada.ca/en/public-health/services/publications/vaccines-immunization/2019-highlights-childhood-national-immunization-coverage-survey.html

[290] ImmunizeBC. (2022). Where to get vaccinated. Retrieved from: https://immunizebc.ca/where-get-vaccinated

[291] HealthLinkBC. (2021). B.C. immunization schedules. Retrieved from: https://www.healthlinkbc.ca/bc-immunization-schedules

[292] ImmunizeBC. (2022). Vaccines recommended for adults in BC. Retrieved from: https://immunizebc.ca/sites/default/files/docs/vaccine-schedule-recommended-adults-2021.pdf

[293] Provincial Health Services Authority. (2023). Vaccines in BC. BC Centre for Disease Control. Retrieved from: http://www.bccdc.ca/health-professionals/clinical-resources/vaccines-in-bc

[294] Alberta Health Services. (2021). Pneumococcal polysaccharide (PNEUMO-P) vaccine. Retrieved from: https://www.albertahealthservices.ca/assets/info/hp/cdc/if-hp-cdc-imm-flu-pneumococcal-polysaccharide-vaccine-info-sheet.pdf

[295] Government of Alberta. (2020). Pneumococcal conjugate (PNEU-C13) vaccine. MyHealth.Alberta.ca. Retrieved from: https://myhealth.alberta.ca/Alberta/Pages/immunization-pneumococcal-conjugate-13.aspx

[296] Alberta Health Services. (2021). Pneumococcal polysaccharide (PNEUMO-P) vaccine. Retrieved from: https://www.albertahealthservices.ca/assets/info/hp/cdc/if-hp-cdc-imm-flu-pneumococcal-polysaccharide-vaccine-info-sheet.pdf

[297] Government of Alberta. (2020). Pneumococcal conjugate (PNEU-C13) vaccine. MyHealth.Alberta.ca. Retrieved from: https://myhealth.alberta.ca/Alberta/Pages/immunization-pneumococcal-conjugate-13.aspx

[298] Government of Alberta. (2018). Pneumococcal vaccine, 23-valent polysaccharide (Pneumo-P). Retrieved from: https://open.alberta.ca/dataset/aip/resource/4863c6c6-1d27-4c7e-abfc-c4e06020fee5/download/AIP-BP-Pneu-P-23.pdf

[299] Government of Alberta. (2018). Pneumococcal vaccine, 13-valent conjugate: Prevnar® 13. Retrieved from: https://open.alberta.ca/dataset/aip/resource/1e0e2935-1d18-455c-ade0-4bb728adcec5/download/AIP-BP-Pneu-C-13.pdf

[300] Government of Saskatchewan. (n.d.). Immunization services. Retrieved from: https://www.saskatchewan.ca/residents/health/accessing-health-care-services/immunization-services

[301] Saskatchewan College of Pharmacy Professionals. (2018). Administration of drugs by injection supplementary guidelines for pharmacists. Retrieved from: https://scp.in1touch.org/document/3616/

[302] Ministry of Health. (2018). Saskatchewan immunization manual: Chapter 2 – Authorization to immunize. Retrieved from: https://www.ehealthsask.ca/services/manuals/Documents/sim-chapter2.pdf

[303] Saskatchewan College of Pharmacy Professionals. (2018). Administration of drugs by injection supplementary guidelines for pharmacists. Retrieved from: https://scp.in1touch.org/document/3616/

[304] Government of Saskatchewan. (2022). Pneumococcal polysaccharide 23 vaccine. Retrieved from: https://publications.saskatchewan.ca/api/v1/products/31982/formats/39088/download

[305] Government of Saskatchewan. (2015). Saskatchewan immunization manual: Chapter 7 – Immunization of special populations. Retrieved from: https://www.ehealthsask.ca/services/manuals/Documents/sim-chapter7.pdf

[306] Government of Manitoba. (n.d.). Frequently asked questions and answers about vaccines. Retrieved from: https://www.gov.mb.ca/health/publichealth/cdc/div/about.html#c

[307] Government of Manitoba. (n.d.). Frequently asked questions and answers about vaccines. Retrieved from: https://www.gov.mb.ca/health/publichealth/cdc/div/about.html#c

[308] Government of Manitoba. (2021). Manitoba's immunization program: Vaccines offered free-of-charge (eligibility criteria for publicly-funded vaccines). Retrieved from: https://www.gov.mb.ca/health/publichealth/cdc/vaccineeligibility.html

[309] Government of Manitoba. (2021). Manitoba's immunization program: Vaccines offered free-of-charge (eligibility criteria for publicly-funded vaccines. Retrieved from: https://www.gov.mb.ca/health/publichealth/cdc/vaccineeligibility.html

[310] Eastern Ontario Health Unit. (2022). Pneumococcal disease. Retrieved from: https://eohu.ca/en/my-health/pneumococcal-disease

[311] Niagara Region. (n.d.). Adult immunizations. Retrieved from: https://www.niagararegion.ca/health/vaccinations/adult-immunization.aspx

[312] Public Health Sudbury & Districts. (2021). Pneumococcal vaccine. Retrieved from: https://www.phsd.ca/health-topics-programs/vaccines-immunizations/pneumococcal-vaccine/

[313] Ontario College of Pharmacists. (2017). Pharmacists now authorized to administer additional vaccines. Retrieved from: https://www.ocpinfo.com/wp-content/uploads/documents/OCP_PharmacyConnection_Winter2017_AdditionalVaccines.pdf

[314] Government of Ontario. (2022). Publicly funded immunization schedules for Ontario. Retrieved from: https://www.health.gov.on.ca/en/pro/programs/immunization/docs/Publicly_Funded_ImmunizationSchedule.pdf

[315] Government of Ontario. (2022). Publicly funded immunization schedules for Ontario. Retrieved from: https://www.health.gov.on.ca/en/pro/programs/immunization/docs/Publicly_Funded_ImmunizationSchedule.pdf

[316] Government du Québec. (2020). Pneumococcal vaccination program. Retrieved from: https://www.quebec.ca/en/health/advice-and-prevention/vaccination/pneumococcal-vaccination-program

[317] Canadian Pharmacists Association. (2022). Injection authority and vaccine administration in pharmacies across Canada. Retrieved from: https://www.pharmacists.ca/cpha-ca/function/utilities/pdf-server.cfm?thefile=/cpha-on-the-issues/Immunization_Authority_Chart.pdf

[318] Government du Québec. (2020). Covered pharmacy services. RAMQ. Retrieved from: https://www.ramq.gouv.qc.ca/en/citizens/prescription-drug-insurance/covered-pharmacy-services

[319] Government du Québec. (2020). Pneumococcal vaccination program. Retrieved from: https://www.quebec.ca/en/health/advice-and-prevention/vaccination/pneumococcal-vaccination-program

[320] Government du Québec. (2023). Vaccines: Summary table of pneumococcal vaccines. Retrieved from: https://www.msss.gouv.qc.ca/professionnels/vaccination/piq-vaccins/tableau-synthese-pour-l-utilisation-des-vaccins-contre-le-pneumocoque/#liste-des-autres-conditions

[321] Government du Québec. (2023). Vaccines: Summary table of pneumococcal vaccines. Retrieved from: https://www.msss.gouv.qc.ca/professionnels/vaccination/piq-vaccins/tableau-synthese-pour-l-utilisation-des-vaccins-contre-le-pneumocoque/#liste-des-autres-conditions

[322] Government of Nova Scotia. (2019). Routine immunization schedules for children, youth & adults. Retrieved from: https://novascotia.ca/dhw/CDPC/documents/Routine-Immunization-Schedules-for-Children-Youth-Adults.pdf

[323] Pharmacy Association of Nova Scotia. (2022). Immunizing and injecting. Retrieved from: https://pans.ns.ca/public/pharmacy-services/immunizing-injecting

[324] College of Registered Nurses of Nova Scotia. (2011). Immunization guidelines for registered nurses. Retrieved from: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwirpJzzsrb5AhUUkokEHYcDAukQFnoECCcQAQ&url=https%3A%2F%2Fwww.cdha.nshealth.ca%2Fsystem%2Ffiles%2Fsites%2F8553%2Fdocuments%2Fimmunization-guidelines-registered-nurses.pdf&usg=AovVaw0ZqJ5adI8Ajm6Xb4Cy5vOJ

[325] Pharmacy Association of Nova Scotia. (2022). Immunizing and injecting. Retrieved from: https://pans.ns.ca/public/pharmacy-services/immunizing-injecting

[326] Government of Nova Scotia. (2019). Routine immunization schedules for children, youth & adults. Retrieved from: https://novascotia.ca/dhw/CDPC/documents/Routine-Immunization-Schedules-for-Children-Youth-Adults.pdf

[327] Government of Nova Scotia. (2013). Adult pneumococcal vaccination guide for health care professionals. Retrieved from: https://novascotia.ca/dhw/cdpc/documents/Adult-Pneumococcal-Vaccination-Guide.pdf

[328] Office of the Chief Medical Officer of Health. (2019). Publicly funded vaccine eligibility for individuals at high risk of acquiring vaccine preventable diseases. Government of Nova Scotia. Retrieved from: https://novascotia.ca/dhw/CDPC/documents/Vaccine-Eligibility-for-High-Risk-Conditions.pdf

[329] Horizon Health Network. (2018). Immunization. Retrieved from: http://en.horizonnb.ca/facilities-and- services/services/public-health-prog rams/immunization.aspx

[330] Horizon Health Network. (2018). Immunization. Retrieved from: http://en.horizonnb.ca/facilities-and- services/services/public-health-programs/immunization.aspx

[331] Government of New Brunswick. (2019). Standard 3.3 – Eligibility criteria for publicly funded vaccines/biologics. Retrieved from: https://www2.gnb.ca/content/dam/gnb/Departments/h-s/pdf/en/CDC/HealthProfessionals/NBIPG-standard3-3-e.pdf

[332] Government of New Brunswick. (2019). Standard 3.3 – Eligibility criteria for publicly funded vaccines/biologics. Retrieved from: https://www2.gnb.ca/content/dam/gnb/Departments/h-s/pdf/en/CDC/HealthProfessionals/NBIPG-standard3-3-e.pdf

[333] Prince Edward Island. (2018). Prince Edward Island adult immunization detailed schedule. Department of Health and Wellness Chief Public Health Office: Prince Edward Island. Retrieved from: https://www.princeedwardisland.ca/sites/default/files/publications/ai_detailed_sch_jan2018.pdf

[334] Department of Health and Wellness Chief Public Health Office. (2018). Prince Edward Island adult immunization detailed schedule. Government of Prince Edward Island. Retrieved from: https://www.princeedwardisland.ca/sites/default/files/publications/ai_detailed_sch_jan2018.pdf

[335] Department of Health and Wellness Chief Public Health Office. (2018). Prince Edward Island adult immunization detailed schedule. Government of Prince Edward Island. Retrieved from: https://www.princeedwardisland.ca/sites/default/files/publications/ai_detailed_sch_jan2018.pdf

[336] Department of Health and Wellness Chief Public Health Office. (2018). Prince Edward Island adult immunization detailed schedule. Government of Prince Edward Island. Retrieved from: https://www.princeedwardisland.ca/sites/default/files/publications/ai_detailed_sch_jan2018.pdf

[337] Government of Newfoundland and Labrador. (2019). Section 5: Immunization programs for high risk groups. Retrieved from: https://www.gov.nl.ca/hcs/files/publichealth-cdc-im-section5.pdf

[338] Newfoundland and Labrador Pharmacy Board. (2022). Standards of practice: Prescribing by pharmacists. Retrieved from: https://nlpb.ca/media/SOPP-Prescribing-by-Pharmacists-May2022.pdf

[339] Newfoundland and Labrador Pharmacy Board. (2022). Standards of practice: Prescribing by pharmacists. Retrieved from: https://nlpb.ca/media/SOPP-Prescribing-by-Pharmacists-May2022.pdf

[340] Government of Newfoundland and Labrador. (2019). Section 5: Immunization programs for high risk groups. Retrieved from: https://www.gov.nl.ca/hcs/files/publichealth-cdc-im-section5.pdf

[341] Government of Newfoundland and Labrador. (2019). Section 5: Immunization programs for high risk groups. Retrieved from: https://www.gov.nl.ca/hcs/files/publichealth-cdc-im-section5.pdf

[342] Government of Yukon. (2018). Immunize information. Yukon Immunize. Retrieved from: https://yukonimmunization.ca/diseases-vaccines/immunizationinfo

[343] Government of Yukon. (2019). Pneumococcal infection. Yukon HealthGuide. Retrieved from: https://ykhealthguide.org/downloads/pneumococcal.pdf

[344] Government of Yukon. (2020). BULLETIN vaccine scheduling in Yukon. Retrieved from: https://yukon.ca/sites/yukon.ca/files/cs/cs-pharmacists-vaccine-bulletin.pdf

[345] Government of Yukon. (2019). Pneumococcal infection. Yukon HealthGuide. Retrieved from: https://ykhealthguide.org/downloads/pneumococcal.pdf

[346] Government of Yukon. (2020). BULLETIN vaccine scheduling in Yukon. Retrieved from: https://yukon.ca/sites/yukon.ca/files/cs/cs-pharmacists-vaccine-bulletin.pdf

[347] Government of Yukon. (2018). Yukon immunization program manual: Section 8 – Biological products. Retrieved from: https://yukon.ca/sites/yukon.ca/files/hss/hss-section-8-pneumococcal-vaccines.pdf

[348] Government of Yukon. (2018). Yukon immunization program manual: Section 8 – Biological products. Retrieved from: https://yukon.ca/sites/yukon.ca/files/hss/hss-section-8-pneumococcal-vaccines.pdf

[349] The Government of Nunavut. (n.d.). Immunization programs. Retrieved from: https://gov.nu.ca/health/information/immunization-programs

[350] The Government of Nunavut. (2014). Nunavut Immunization Manual (April 2014). Retrieved from: https://www.gov.nu.ca/sites/default/files/immunization_manual.pdf

[351] The Government of Nunavut. (2014). Nunavut Immunization Manual (April 2014). Retrieved from: https://www.gov.nu.ca/sites/default/files/immunization_manual.pdf

[352] The Government of Nunavut. (2014). Nunavut Immunization Manual (April 2014). Retrieved from: https://www.gov.nu.ca/sites/default/files/immunization_manual.pdf

[353] The Government of Nunavut. (2014). Nunavut Immunization Manual (April 2014). Retrieved from: https://www.gov.nu.ca/sites/default/files/immunization_manual.pdf

[354] Government of Northwest Territories. (2022). NWT immunization schedule: Publicly funded vaccines for infants and children. Retrieved from: https://www.hss.gov.nt.ca/sites/hss/files/immunization-schedule-general-public.pdf

[355] Government of Northwest Territories. (2022). NWT immunization schedule: Publicly funded vaccines for infants and children. Retrieved from: https://www.hss.gov.nt.ca/sites/hss/files/immunization-schedule-general-public.pdf

[356] Government of Northwest Territories. (2022). Vaccines publicly funded in the NWT: Northwest Territories immunization schedule. Retrieved from: https://www.hss.gov.nt.ca/professionals/sites/professionals/files/resources/nwt-immunization-schedule-health-care-professionals.pdf

[357] Government of Northwest Territories. (2022). Vaccines publicly funded in the NWT: Northwest Territories immunization schedule. Retrieved from: https://www.hss.gov.nt.ca/professionals/sites/professionals/files/resources/nwt-immunization-schedule-health-care-professionals.pdf

[358] Precision Vaccinations. (2021). Pneumosil pneumococcal vaccine. Retrieved from: https://www.precisionvaccinations.com/vaccines/pneumosil-pneumococcal-vaccine

[359] Precision Vaccinations. (2021). Sinovac PPV23 pneumococcal vaccine. Retrieved from: https://www.precisionvaccinations.com/vaccines/sinovac-ppv23-pneumococcal-vaccine

[360] World Health Organization. (2019). Pneumococcal conjugate vaccines in infants and children under 5 years of age: WHO position paper – February 2019. Weekly Epidemiological Record, 94(8), 85-104. Retrieved from: https://apps.who.int/iris/rest/bitstreams/1209121/retrieve

[361] World Health Organization. (2012). Pneumococcal vaccines: WHO position paper – 2012. Weekly Epidemiological Record, 87(14), 129-144. Retrieved from: https://apps.who.int/iris/bitstream/handle/10665/241905/WER8714.PDF?sequence=1&isAllowed=y

[362] World Health Organization. (2021). Implementing the Immunization Agenda 2030: A framework for action through coordinated planning, monitoring & evaluation, ownership & accountability, and communications & advocacy. Retrieved from: https://cdn.who.int/media/docs/default-source/immunization/strategy/ia2030/ia2030_frameworkforactionv04.pdf?sfvrsn=e5374082_1&download=true

[363] World Health Organization. (2021). Annex 1: IA2030 Monitoring and Evaluation Framework. Retrieved from: https://cdn.who.int/media/docs/default-source/immunization/ia2030_annex_frameworkforactionv04.pdf?sfvrsn=8fd85d98_4

[364] World Health Organization. (2012). Pneumococcal vaccines: WHO position paper – 2012. Weekly Epidemiological Record, 87(14), 129-144. Retrieved from: https://apps.who.int/iris/bitstream/handle/10665/241905/WER8714.PDF?sequence=1&isAllowed=y

[365] European Centre for Disease Prevention and Control. (2022). Pneumococcal disease: Recommended vaccinations. Vaccine scheduler. Retrieved from: https://vaccine-schedule.ecdc.europa.eu/Scheduler/ByDisease?SelectedDiseaseId=25&SelectedCountryIdByDisease=-1

[366] European Centre for Disease Prevention and Control. (2022). Pneumococcal disease: Recommended vaccinations. Vaccine scheduler. Retrieved from: https://vaccine-schedule.ecdc.europa.eu/Scheduler/ByDisease?SelectedDiseaseId=25&SelectedCountryIdByDisease=-1

[367] European Centre for Disease Prevention and Control. (2022). Pneumococcal disease: Recommended vaccinations. Vaccine scheduler. Retrieved from: https://vaccine-schedule.ecdc.europa.eu/Scheduler/ByDisease?SelectedDiseaseId=25&SelectedCountryIdByDisease=-1

[368] European Centre for Disease Prevention and Control. (2022). Pneumococcal disease: Recommended vaccinations. Vaccine scheduler. Retrieved from: https://vaccine-schedule.ecdc.europa.eu/Scheduler/ByDisease?SelectedDiseaseId=25&SelectedCountryIdByDisease=-1

[369] Kobayashi, M., Farrar, J. L., Gierke, R., Britton, A., Childs, L., Leidner, A. J., Campos-Outcalt, D., Morgan, R. L., Long, S. S., Talbot, H. K., Poehling, K. A., & Pilishvili, T. (2022). Use of 15-Valent Pneumococcal Conjugate Vaccine and 20-Valent Pneumococcal Conjugate Vaccine Among U.S. Adults: Updated Recommendations of the Advisory Committee on Immunization Practices - United States, 2022. MMWR. Morbidity and mortality weekly report, 71(4), 109–117. https://doi.org/10.15585/mmwr.mm7104a1

[370] Kobayashi, M., Farrar, J. L., Gierke, R., Britton, A., Childs, L., Leidner, A. J., Campos-Outcalt, D., Morgan, R. L., Long, S. S., Talbot, H. K., Poehling, K. A., & Pilishvili, T. (2022). Use of 15-Valent Pneumococcal Conjugate Vaccine and 20-Valent Pneumococcal Conjugate Vaccine Among U.S. Adults: Updated Recommendations of the Advisory Committee on Immunization Practices - United States, 2022. MMWR. Morbidity and mortality weekly report, 71(4), 109–117. https://doi.org/10.15585/mmwr.mm7104a1

[371] Kobayashi, M., Farrar, J. L., Gierke, R., Britton, A., Childs, L., Leidner, A. J., Campos-Outcalt, D., Morgan, R. L., Long, S. S., Talbot, H. K., Poehling, K. A., & Pilishvili, T. (2022). Use of 15-Valent Pneumococcal Conjugate Vaccine and 20-Valent Pneumococcal Conjugate Vaccine Among U.S. Adults: Updated Recommendations of the Advisory Committee on Immunization Practices - United States, 2022. MMWR. Morbidity and mortality weekly report, 71(4), 109–117. https://doi.org/10.15585/mmwr.mm7104a1

[372] Kobayashi, M., Farrar, J. L., Gierke, R., Britton, A., Childs, L., Leidner, A. J., Campos-Outcalt, D., Morgan, R. L., Long, S. S., Talbot, H. K., Poehling, K. A., & Pilishvili, T. (2022). Use of 15-Valent Pneumococcal Conjugate Vaccine and 20-Valent Pneumococcal Conjugate Vaccine Among U.S. Adults: Updated Recommendations of the Advisory Committee on Immunization Practices - United States, 2022. MMWR. Morbidity and mortality weekly report, 71(4), 109–117. https://doi.org/10.15585/mmwr.mm7104a1

[373] U.S. Centers for Medicare and Medicaid Services. (n.d.). Step 1: What does Medicare cost? Medicare.gov. Retrieved from: https://www.medicare.gov/basics/get-started-with-medicare/medicare-basics/what-does-medicare-cost

[374] U.S. Centers for Medicare and Medicaid Services. (n.d.). Pneumococcal shots. Medicare.gov. Retrieved from: https://www.medicare.gov/coverage/pneumococcal-shots

[375] The Lung Association. (2014). Pneumonia. Retrieved from: https://www.lung.ca/lung-health/lung-disease/pneumonia

[376] Centers for Disease Control and Prevention. (2022). Prevention. Retrieved from: https://www.cdc.gov/pneumonia/prevention.html

[377] Public Health Agency of Canada. (2022). Vaccine uptake in Canadian adults 2021. Government of Canada. Retrieved from: https://www.canada.ca/content/dam/phac-aspc/documents/services/immunization-vaccines/vaccination-coverage/highlights-2020-2021-seasonal-influenza-survey/full-report/highlights-2020-2021-seasonal-influenza-survey.pdf

[378] Public Health Agency of Canada. (2022). Highlights from the 2019 childhood National Immunization Coverage Survey (cNICS). Government of Canada. Retrieved from: https://www.canada.ca/en/public-health/services/publications/vaccines-immunization/2019-highlights-childhood-national-immunization-coverage-survey.html

[379] National Institute on Ageing. (2021). The underappreciated burden of influenza among Canada's older population. And what we need to do about it. Retrieved from: https://static1.squarespace.com/static/5c2fa7b03917eed9b5a436d8/t/63fd20a0bdda7910d3fe50b8/1677533345259/Shingles+Report+-+Final3.pdf

[380] National Institute on Ageing. (2022). The Overlooked Issue of Shingles Infections in Older Canadians And How to Address It! Retrieved from: https://static1.squarespace.com/static/5c2fa7b03917eed9b5a436d8/t/63fd20a0bdda7910d3fe50b8/1677533345259/Shingles+Report+-+Final3.pdf

[381] National Institute on Ageing. (2021). The underappreciated burden of influenza among Canada's older population. And what we need to do about it. Retrieved from: https://static1.squarespace.com/static/5c2fa7b03917eed9b5a436d8/t/63fd20a0bdda7910d3fe50b8/1677533345259/Shingles+Report+-+Final3.pdf

[382] National Institute on Ageing. (2022). The Overlooked Issue of Shingles Infections in Older Canadians And How to Address It! Retrieved from: https://static1.squarespace.com/static/5c2fa7b03917eed9b5a436d8/t/63fd20a0bdda7910d3fe50b8/1677533345259/Shingles+Report+-+Final3.pdf

[383] Public Health Agency of Canada. (2022). Vaccine uptake in Canadian adults 2019. Government of Canada. Retrieved from: https://www.canada.ca/en/public-health/services/publications/healthy-living/2018-2019-influenza-flu-vaccine-coverage-survey-results.html

[384] Public Health Agency of Canada. (2022). Vaccine uptake in Canadian adults 2021. Government of Canada. Retrieved from: https://www.canada.ca/content/dam/phac-aspc/documents/services/immunization-vaccines/vaccination-coverage/highlights-2020-2021-seasonal-influenza-survey/full-report/highlights-2020-2021-seasonal-influenza-survey.pdf

[385] MacDougall, D. M., Halperin, B. A., MacKinnon-Cameron, D., Li, L., McNeil, S. A., Langley, J. M., & Halperin, S. A. (2015). The challenge of vaccinating adults: attitudes and beliefs of the Canadian public and healthcare providers. BMJ open, 5(9), e009062. https://doi.org/10.1136/bmjopen-2015-009062

[386] MacDougall, D. M., Halperin, B. A., MacKinnon-Cameron, D., Li, L., McNeil, S. A., Langley, J. M., & Halperin, S. A. (2015). The challenge of vaccinating adults: attitudes and beliefs of the Canadian public and healthcare providers. BMJ open, 5(9), e009062. https://doi.org/10.1136/bmjopen-2015-009062

[387] Public Health Agency of Canada. (2018, July). Vaccine uptake in Canadian adults: Results from the 2016 adult National Immunization Coverage Survey (aNICS). Government of Canada. Retrieved from: https://publications.gc.ca/collections/collection_2018/aspc-phac/HP40-222-2018-eng.pdf

[388] Schneeberg, A., Bettinger, J. A., McNeil, S., Ward, B. J., Dionne, M., Cooper, C., Coleman, B., Loeb, M., Rubinstein, E., McElhaney, J., Scheifele, D. W., & Halperin, S. A. (2014). Knowledge, attitudes, beliefs and behaviours of older adults about pneumococcal immunization, a Public Health Agency of Canada/Canadian Institutes of Health Research Influenza Research Network (PCIRN) investigation. BMC public health, 14, 442. https://doi.org/10.1186/1471-2458-14-442

[389] MacDougall, D. M., Halperin, B. A., MacKinnon-Cameron, D., Li, L., McNeil, S. A., Langley, J. M., & Halperin, S. A. (2015). The challenge of vaccinating adults: attitudes and beliefs of the Canadian public and healthcare providers. BMJ open, 5(9), e009062. https://doi.org/10.1136/bmjopen-2015-009062

[390] Ipsos. (2016). PneuVUE – Adult Pneumonia Vaccine Understanding in Europe: A new view into pneumonia among older adults. Retrieved from: https://www.ipsos.com/sites/default/files/publication/1970-01/ipsos-healthcare-pneu-vue-report.pdf

[391] Ipsos. (2016). PneuVUE – Adult Pneumonia Vaccine Understanding in Europe: A new view into pneumonia among older adults. Retrieved from: https://www.ipsos.com/sites/default/files/publication/1970-01/ipsos-healthcare-pneu-vue-report.pdf

[392] Ipsos. (2016). PneuVUE – Adult Pneumonia Vaccine Understanding in Europe: A new view into pneumonia among older adults. Retrieved from: https://www.ipsos.com/sites/default/files/publication/1970-01/ipsos-healthcare-pneu-vue-report.pdf

[393] Gates, A., Gates, M., Rahman, S., Guitard, S., MacGregor, T., Pillay, J., Ismail, S. J., Tunis, M. C., Young, K., Hardy, K., Featherstone, R., & Hartling, L. (2021). A systematic review of factors that influence the acceptability of vaccines among Canadians. Vaccine, 39(2), 222–236. https://doi.org/10.1016/j.vaccine.2020.10.038

[394] Gates, A., Gates, M., Rahman, S., Guitard, S., MacGregor, T., Pillay, J., Ismail, S. J., Tunis, M. C., Young, K., Hardy, K., Featherstone, R., & Hartling, L. (2021). A systematic review of factors that influence the acceptability of vaccines among Canadians. Vaccine, 39(2), 222–236. https://doi.org/10.1016/j.vaccine.2020.10.038

[395] Government of Canada. (2016). Vaccine uptake in Canadian adults: Results from the 2014 adult National Immunization Coverage Survey. Retrieved from: https://www.canada.ca/en/public-health/services/publications/healthy-living/vaccine-uptake-canadian-adults-results-2014-adult-national-immunization-coverage-survey.html

[396] Public Health Agency of Canada. (2022). Vaccine uptake in Canadian adults 2021. Government of Canada. Retrieved from: https://www.canada.ca/content/dam/phac-aspc/documents/services/immunization-vaccines/vaccination-coverage/highlights-2020-2021-seasonal-influenza-survey/full-report/highlights-2020-2021-seasonal-influenza-survey.pdf

[397] Schneeberg, A., Bettinger, J. A., McNeil, S., Ward, B. J., Dionne, M., Cooper, C., Coleman, B., Loeb, M., Rubinstein, E., McElhaney, J., Scheifele, D. W., & Halperin, S. A. (2014). Knowledge, attitudes, beliefs and behaviours of older adults about pneumococcal immunization, a Public Health Agency of Canada/Canadian Institutes of Health Research Influenza Research Network (PCIRN) investigation. BMC public health, 14, 442. https://doi.org/10.1186/1471-2458-14-442

[398] Gilani, F., Majumdar, S. R., Johnson, J. A., Simpson, S. H., & ABCD Cohort Investigators (2020). Factors associated with pneumococcal vaccination in 2040 people with type 2 diabetes: A cross-sectional study. Diabetes & metabolism, 46(2), 137–143. https://doi.org/10.1016/j.diabet.2019.06.003

[399] Krueger, P., St Amant, O., & Loeb, M. (2010). Predictors of pneumococcal vaccination among older adults with pneumonia: findings from the Community Acquired Pneumonia Impact Study. BMC geriatrics, 10, 44. https://doi.org/10.1186/1471-2318-10-44

[400] Schneeberg, A., Bettinger, J. A., McNeil, S., Ward, B. J., Dionne, M., Cooper, C., Coleman, B., Loeb, M., Rubinstein, E., McElhaney, J., Scheifele, D. W., & Halperin, S. A. (2014). Knowledge, attitudes, beliefs and behaviours of older adults about pneumococcal immunization, a Public Health Agency of Canada/Canadian Institutes of Health Research Influenza Research Network (PCIRN) investigation. BMC public health, 14, 442. https://doi.org/10.1186/1471-2458-14-442

[401] Schneeberg, A., Bettinger, J. A., McNeil, S., Ward, B. J., Dionne, M., Cooper, C., Coleman, B., Loeb, M., Rubinstein, E., McElhaney, J., Scheifele, D. W., & Halperin, S. A. (2014). Knowledge, attitudes, beliefs and behaviours of older adults about pneumococcal immunization, a Public Health Agency of Canada/Canadian Institutes of Health Research Influenza Research Network (PCIRN) investigation. BMC public health, 14, 442. https://doi.org/10.1186/1471-2458-14-442

[402] Ipsos. (2016). PneuVUE – Adult Pneumonia Vaccine Understanding in Europe: A new view into pneumonia among older adults. Retrieved from: https://www.ipsos.com/sites/default/files/publication/1970-01/ipsos-healthcare-pneu-vue-report.pdf

[403] Ipsos. (2016). PneuVUE – Adult Pneumonia Vaccine Understanding in Europe: A new view into pneumonia among older adults. Retrieved from: https://www.ipsos.com/sites/default/files/publication/1970-01/ipsos-healthcare-pneu-vue-report.pdf

[404] Nasreen, S., Gebretekle, G. B., Lynch, M., Kurdina, A., Thomas, M., Fadel, S., Houle, S., Waite, N. M., Crowcroft, N. S., & Allin, S. (2022). Understanding predictors of pneumococcal vaccine uptake in older adults aged 65 years and older in high-income countries across the globe: A scoping review. Vaccine, 40(32), 4380–4393. https://doi.org/10.1016/j.vaccine.2022.06.056

[405] Gates, A., Gates, M., Rahman, S., Guitard, S., MacGregor, T., Pillay, J., Ismail, S. J., Tunis, M. C., Young, K., Hardy, K., Featherstone, R., & Hartling, L. (2021). A systematic review of factors that influence the acceptability of vaccines among Canadians. Vaccine, 39(2), 222–236. https://doi.org/10.1016/j.vaccine.2020.10.038

[406] Qendro, T., de la Torre, M. L., Panopalis, P., Hazel, E., Ward, B. J., Colmegna, I., & Hudson, M. (2020). Suboptimal Immunization Coverage among Canadian Rheumatology Patients in Routine Clinical Care. The Journal of rheumatology, 47(5), 770–778. https://doi.org/10.3899/jrheum.181376

[407] Public Health Agency of Canada. (2022). Vaccine uptake in Canadian adults 2021. Government of Canada. Retrieved from: https://www.canada.ca/content/dam/phac-aspc/documents/services/immunization-vaccines/vaccination-coverage/highlights-2020-2021-seasonal-influenza-survey/full-report/highlights-2020-2021-seasonal-influenza-survey.pdf

[408] MacDougall, D. M., Halperin, B. A., MacKinnon-Cameron, D., Li, L., McNeil, S. A., Langley, J. M., & Halperin, S. A. (2015). The challenge of vaccinating adults: attitudes and beliefs of the Canadian public and healthcare providers. BMJ open, 5(9), e009062. https://doi.org/10.1136/bmjopen-2015-009062

[409] MacDougall, D. M., Halperin, B. A., MacKinnon-Cameron, D., Li, L., McNeil, S. A., Langley, J. M., & Halperin, S. A. (2015). The challenge of vaccinating adults: attitudes and beliefs of the Canadian public and healthcare providers. BMJ open, 5(9), e009062. https://doi.org/10.1136/bmjopen-2015-009062

[410] Schneeberg, A., Bettinger, J. A., McNeil, S., Ward, B. J., Dionne, M., Cooper, C., Coleman, B., Loeb, M., Rubinstein, E., McElhaney, J., Scheifele, D. W., & Halperin, S. A. (2014). Knowledge, attitudes, beliefs and behaviours of older adults about pneumococcal immunization, a Public Health Agency of Canada/Canadian Institutes of Health Research Influenza Research Network (PCIRN) investigation. BMC public health, 14, 442. https://doi.org/10.1186/1471-2458-14-442

[411] Lau, D., Hu, J., Majumdar, S. R., Storie, D. A., Rees, S. E., & Johnson, J. A. (2012). Interventions to improve influenza and pneumococcal vaccination rates among community-dwelling adults: a systematic review and meta-analysis. Annals of family medicine, 10(6), 538–546. https://doi.org/10.1370/afm.1405

[412] Gates, A., Gates, M., Rahman, S., Guitard, S., MacGregor, T., Pillay, J., Ismail, S. J., Tunis, M. C., Young, K., Hardy, K., Featherstone, R., & Hartling, L. (2021). A systematic review of factors that influence the acceptability of vaccines among Canadians. Vaccine, 39(2), 222–236. https://doi.org/10.1016/j.vaccine.2020.10.038

[413] Nasreen, S., Gebretekle, G. B., Lynch, M., Kurdina, A., Thomas, M., Fadel, S., Houle, S., Waite, N. M., Crowcroft, N. S., & Allin, S. (2022). Understanding predictors of pneumococcal vaccine uptake in older adults aged 65 years and older in high-income countries across the globe: A scoping review. Vaccine, 40(32), 4380–4393. https://doi.org/10.1016/j.vaccine.2022.06.056

[414] Lau, D., Hu, J., Majumdar, S. R., Storie, D. A., Rees, S. E., & Johnson, J. A. (2012). Interventions to improve influenza and pneumococcal vaccination rates among community-dwelling adults: a systematic review and meta-analysis. Annals of family medicine, 10(6), 538–546. https://doi.org/10.1370/afm.1405

[415] Kawczak, S., Mooney, M., Mitchner, N., Senatore, V., & Stoller, J. K. (2020). The impact of a quality improvement continuing medical education intervention on physicians' vaccination practice: a controlled study. Human vaccines & immunotherapeutics, 16(11), 2809–2815. https://doi.org/10.1080/21645515.2020.1737457

[416] Ho, H. J., Tan, Y. R., Cook, A. R., Koh, G., Tham, T. Y., Anwar, E., Hui Chiang, G. S., Lwin, M. O., & Chen, M. I. (2019). Increasing Influenza and Pneumococcal Vaccination Uptake in Seniors Using Point-of-Care Informational Interventions in Primary Care in Singapore: A Pragmatic, Cluster-Randomized Crossover Trial. American journal of public health, 109(12), 1776–1783. https://doi.org/10.2105/AJPH.2019.305328

[417] De Wals, P., Boulianne, N., Sévin, E., Ouakki, M., Deceuninck, G., & Guay, M. (2009). Uptake of pneumococcal conjugate vaccine: methodological issues in measurement and impact of publicly funded programs. Canadian journal of public health = Revue canadienne de sante publique, 100(6), 413–416. https://doi.org/10.1007/BF03404335

[418] Public Health Agency of Canada. (2022). Canadian COVID-19 vaccination coverage report. Government of Canada. Retrieved from: https://health-infobase.canada.ca/covid-19/vaccination-coverage/

[419] Government of Canada. (2019). Immunization and vaccine priorities in Canada. Retrieved from: https://www.canada.ca/en/public-health/services/immunization-vaccine-priorities.html

[420] Government of Canada. (2022). National Immunization Strategy. Retrieved from: https://www.canada.ca/en/public-health/services/immunization-vaccine-priorities/national-immunization-strategy.html

[421] Government of Canada. (2016). Chapter 5 - An inclusive and fair Canada. Retrieved from: https://www.budget.gc.ca/2016/docs/plan/ch5-en.html

[422] Government of Canada. (2017). National Immunization Strategy: Objectives 2016 – 2021. Retrieved from: https://www.canada.ca/en/public-health/services/publications/healthy-living/national-immunization-strategy-objectives-2016-2021.html

[423] Government of Canada. (2022). National Immunization Strategy. Retrieved from: https://www.canada.ca/en/public-health/services/immunization-vaccine-priorities/national-immunization-strategy.html

[424] Government of Canada. (2022). Vaccination coverage goals and vaccine preventable disease reduction targets by 2025. Retrieved from: https://www.canada.ca/en/public-health/services/immunization-vaccine-priorities/national-immunization-strategy/vaccination-coverage-goals-vaccine-preventable-diseases-reduction-targets-2025.html

[425] Government of Canada. (2022). National Immunization Strategy. Retrieved from: https://www.canada.ca/en/public-health/services/immunization-vaccine-priorities/national-immunization-strategy.html

[426] Government of Canada. (2022). National Immunization Strategy. Retrieved from: https://www.canada.ca/en/public-health/services/immunization-vaccine-priorities/national-immunization-strategy.html

[427] Canadian Immunization Research Network. (2022). About us: CIRN 2017-2022. Retrieved from: https://cirnetwork.ca/about-us/

[428] Government of Canada. (2022). National Immunization Strategy. Retrieved from: https://www.canada.ca/en/public-health/services/immunization-vaccine-priorities/national-immunization-strategy.html

[429] Government of Canada. (2022). Immunization Partnership Fund. Retrieved from: https://www.canada.ca/en/public-health/services/immunization-vaccine-priorities/immunization-partnership-fund.html

[430] Government of Canada. (2022). National Immunization Strategy. Retrieved from: https://www.canada.ca/en/public-health/services/immunization-vaccine-priorities/national-immunization-strategy.html

[431] Public Health Agency of Canada. (2022). Public Health Agency Of Canada 2022–23 departmental plan. Government of Canada. Retrieved from: https://publications.gc.ca/collections/collection_2022/aspc-phac/HP2-26-2022-eng.pdf

[432] Public Health Agency of Canada. (2022). Government of Canada invests in community-based projects to support COVID-19 vaccine uptake. Government of Canada. Retrieved from: https://www.canada.ca/en/public-health/news/2022/01/government-of-canada-invests-in-community-based-projects-to-support-covid-19-vaccine-uptake.html

[433] Government of Canada. (2021). Canadian Immunization Registry Functional Standards (IRFS) 2020-2024 - Recommendations from the Canadian Immunization Registry and Coverage Network (CIRC). Government of Canada. Retrieved from: https://www.canada.ca/en/public-health/services/publications/vaccines-immunization/canadian-immunization-registry-functional-standards-2020-2024.html

[434] Government of Canada. (2021). Canadian Immunization Registry Functional Standards (IRFS) 2020-2024 - Recommendations from the Canadian Immunization Registry and Coverage Network (CIRC). Government of Canada. Retrieved from: https://www.canada.ca/en/public-health/services/publications/vaccines-immunization/canadian-immunization-registry-functional-standards-2020-2024.html

[435] Wilson, S. E., Quach, S., MacDonald, S. E., Naus, M., Deeks, S. L., Crowcroft, N. S., Mahmud, S. M., Tran, D., Kwong, J. C., Tu, K., Johnson, C., & Desai, S. (2017). Immunization information systems in Canada: Attributes, functionality, strengths and challenges. A Canadian Immunization Research Network study. Canadian journal of public health = Revue canadienne de sante publique, 107(6), e575–e582. https://doi.org/10.17269/cjph.107.5679

[436] Ling, J. (2021). Provinces are working with outdated vaccine tracking systems, hindering national data. The Globe and Mail Inc. Retrieved from: https://www.theglobeandmail.com/canada/article-provinces-working-with-outdated-vaccine-tracking-systems/

[437] HealthLink BC. (2017). Pneumonia. Retrieved from: https://www.healthlinkbc.ca/health-topics/hw63868

[438] HealthLink BC. (2017). Pneumonia. Retrieved from: https://www.healthlinkbc.ca/health-topics/hw63868

[439] Mandell, L. A., Marrie, T. J., Grossman, R. F., Chow, A. W., & Hyland, R. H. (2000). Canadian guidelines for the initial management of community-acquired pneumonia: an evidence-based update by the Canadian Infectious Diseases Society and the Canadian Thoracic Society. The Canadian Community-Acquired Pneumonia Working Group. Clinical infectious diseases : an official publication of the Infectious Diseases Society of America, 31(2), 383–421. https://doi.org/10.1086/313959

[440] Mandell, L. A., Marrie, T. J., Grossman, R. F., Chow, A. W., & Hyland, R. H. (2000). Canadian guidelines for the initial management of community-acquired pneumonia: an evidence-based update by the Canadian Infectious Diseases Society and the Canadian Thoracic Society. The Canadian Community-Acquired Pneumonia Working Group. Clinical infectious diseases : an official publication of the Infectious Diseases Society of America, 31(2), 383–421. https://doi.org/10.1086/313959

[441] Mandell, L. A., Marrie, T. J., Grossman, R. F., Chow, A. W., & Hyland, R. H. (2000). Canadian guidelines for the initial management of community-acquired pneumonia: an evidence-based update by the Canadian Infectious Diseases Society and the Canadian Thoracic Society. The Canadian Community-Acquired Pneumonia Working Group. Clinical infectious diseases : an official publication of the Infectious Diseases Society of America, 31(2), 383–421. https://doi.org/10.1086/313959

[442] Mandell, L. A., Marrie, T. J., Grossman, R. F., Chow, A. W., & Hyland, R. H. (2000). Canadian guidelines for the initial management of community-acquired pneumonia: an evidence-based update by the Canadian Infectious Diseases Society and the Canadian Thoracic Society. The Canadian Community-Acquired Pneumonia Working Group. Clinical infectious diseases : an official publication of the Infectious Diseases Society of America, 31(2), 383–421. https://doi.org/10.1086/313959

[443] Ludwig, E., Bonanni, P., Rohde, G., Sayiner, A., & Torres, A. (2012). The remaining challenges of pneumococcal disease in adults. European respiratory review : an official journal of the European Respiratory Society, 21(123), 57–65. https://doi.org/10.1183/09059180.00008911

[444] Ludwig, E., Bonanni, P., Rohde, G., Sayiner, A., & Torres, A. (2012). The remaining challenges of pneumococcal disease in adults. European respiratory review : an official journal of the European Respiratory Society, 21(123), 57–65. https://doi.org/10.1183/09059180.00008911

[445] Ludwig, E., Bonanni, P., Rohde, G., Sayiner, A., & Torres, A. (2012). The remaining challenges of pneumococcal disease in adults. European respiratory review : an official journal of the European Respiratory Society, 21(123), 57–65. https://doi.org/10.1183/09059180.00008911

[446] Ludwig, E., Bonanni, P., Rohde, G., Sayiner, A., & Torres, A. (2012). The remaining challenges of pneumococcal disease in adults. European respiratory review : an official journal of the European Respiratory Society, 21(123), 57–65. https://doi.org/10.1183/09059180.00008911

[447] Ludwig, E., Bonanni, P., Rohde, G., Sayiner, A., & Torres, A. (2012). The remaining challenges of pneumococcal disease in adults. European respiratory review : an official journal of the European Respiratory Society, 21(123), 57–65. https://doi.org/10.1183/09059180.00008911

[448] Song, J. Y., Eun, B. W., & Nahm, M. H. (2013). Diagnosis of pneumococcal pneumonia: current pitfalls and the way forward. Infection & chemotherapy, 45(4), 351–366. https://doi.org/10.3947/ic.2013.45.4.351

[449] Vernet, G., Saha, S., Satzke, C., Burgess, D. H., Alderson, M., Maisonneuve, J. F., Beall, B. W., Steinhoff, M. C., & Klugman, K. P. (2011). Laboratory-based diagnosis of pneumococcal pneumonia: state of the art and unmet needs. Clinical microbiology and infection : the official publication of the European Society of Clinical Microbiology and Infectious Diseases, 17 Suppl 3, 1–13. https://doi.org/10.1111/j.1469-0691.2011.03496.x

[450] Song, J. Y., Eun, B. W., & Nahm, M. H. (2013). Diagnosis of pneumococcal pneumonia: current pitfalls and the way forward. Infection & chemotherapy, 45(4), 351–366. https://doi.org/10.3947/ic.2013.45.4.351

[451] Vernet, G., Saha, S., Satzke, C., Burgess, D. H., Alderson, M., Maisonneuve, J. F., Beall, B. W., Steinhoff, M. C., & Klugman, K. P. (2011). Laboratory-based diagnosis of pneumococcal pneumonia: state of the art and unmet needs. Clinical microbiology and infection : the official publication of the European Society of Clinical Microbiology and Infectious Diseases, 17 Suppl 3, 1–13. https://doi.org/10.1111/j.1469-0691.2011.03496.x

[452] Pride, M. W., Huijts, S. M., Wu, K., Souza, V., Passador, S., Tinder, C., Song, E., Elfassy, A., McNeil, L., Menton, R., French, R., Callahan, J., Webber, C., Gruber, W. C., Bonten, M. J., & Jansen, K. U. (2012). Validation of an immunodiagnostic assay for detection of 13 Streptococcus pneumoniae serotype-specific polysaccharides in human urine. Clinical and vaccine immunology : CVI, 19(8), 1131–1141. https://doi.org/10.1128/CVI.00064-12

[452a] Wunderink, R. G., Self, W. H., Waterer, G. W., Anderson, E., Balk, R., Fakhran, S., Courtner, D., Qi, C., Williams, D., Zhu, Y., Hicks, L., Whitney, C. G., Moore, M. R., Carvalho, M. D. G., Bramley, A., Jain, S., Edwards, K., & Grijalva, C. G. (2014). Occult pneumococcal community-acquired pneumonia (cap) in the Cdc Etiology of Pneumonia in the Community (epic) Study detected by serotype-specific urinary antigen detection (ssuad). American Journal of Respiratory and Critical Care Medicine, 189, 1. Retrieved from: https://www.atsjournals.org/doi/abs/10.1164/ajrccm-conference.2014.189.1_MeetingAbstracts.A4639

[453] Pride, M. W., Huijts, S. M., Wu, K., Souza, V., Passador, S., Tinder, C., Song, E., Elfassy, A., McNeil, L., Menton, R., French, R., Callahan, J., Webber, C., Gruber, W. C., Bonten, M. J., & Jansen, K. U. (2012). Validation of an immunodiagnostic assay for detection of 13 Streptococcus pneumoniae serotype-specific polysaccharides in human urine. Clinical and vaccine immunology : CVI, 19(8), 1131–1141. https://doi.org/10.1128/CVI.00064-12

[454] Song, J. Y., Eun, B. W., & Nahm, M. H. (2013). Diagnosis of pneumococcal pneumonia: current pitfalls and the way forward. Infection & chemotherapy, 45(4), 351–366. https://doi.org/10.3947/ic.2013.45.4.351

[455] Pride, M. W., Huijts, S. M., Wu, K., Souza, V., Passador, S., Tinder, C., Song, E., Elfassy, A., McNeil, L., Menton, R., French, R., Callahan, J., Webber, C., Gruber, W. C., Bonten, M. J., & Jansen, K. U. (2012). Validation of an immunodiagnostic assay for detection of 13 Streptococcus pneumoniae serotype-specific polysaccharides in human urine. Clinical and vaccine immunology : CVI, 19(8), 1131–1141. https://doi.org/10.1128/CVI.00064-12

[456] Song, J. Y., Eun, B. W., & Nahm, M. H. (2013). Diagnosis of pneumococcal pneumonia: current pitfalls and the way forward. Infection & chemotherapy, 45(4), 351–366. https://doi.org/10.3947/ic.2013.45.4.351

[456a] Eletu, S. D., Sheppard, C. L., Thomas, E., Smith, K., Daniel, P., Litt, D. J., Lim, W. S., & Fry, N. K. (2017). Development of an extended-specificity multiplex immunoassay for detection of Streptococcus pneumoniae serotype-specific antigen in urine by use of human monoclonal antibodies. Clinical and vaccine immunology : CVI, 24(12), e00262-17. https://doi.org/10.1128/CVI.00262-17

[456b] Pick, H., Daniel, P., Rodrigo, C., Bewick, T., Ashton, D., Lawrence, H., Baskaran, V., Edwards-Pritchard, R. C., Sheppard, C., Eletu, S. D., Rose, S., Litt, D., Fry, N. K., Ladhani, S., Chand, M., Trotter, C., McKeever, T. M., & Lim, W. S. (2020). Pneumococcal serotype trends, surveillance and risk factors in UK adult pneumonia, 2013-18. Thorax, 75(1), 38–49. https://doi.org/10.1136/thoraxjnl-2019-213725

[457] Vernet, G., Saha, S., Satzke, C., Burgess, D. H., Alderson, M., Maisonneuve, J. F., Beall, B. W., Steinhoff, M. C., & Klugman, K. P. (2011). Laboratory-based diagnosis of pneumococcal pneumonia: state of the art and unmet needs. Clinical microbiology and infection : the official publication of the European Society of Clinical Microbiology and Infectious Diseases, 17 Suppl 3, 1–13. https://doi.org/10.1111/j.1469-0691.2011.03496.x

[458] Song, J. Y., Eun, B. W., & Nahm, M. H. (2013). Diagnosis of pneumococcal pneumonia: current pitfalls and the way forward. Infection & chemotherapy, 45(4), 351–366. https://doi.org/10.3947/ic.2013.45.4.351

[459] Vernet, G., Saha, S., Satzke, C., Burgess, D. H., Alderson, M., Maisonneuve, J. F., Beall, B. W., Steinhoff, M. C., & Klugman, K. P. (2011). Laboratory-based diagnosis of pneumococcal pneumonia: state of the art and unmet needs. Clinical microbiology and infection : the official publication of the European Society of Clinical Microbiology and Infectious Diseases, 17 Suppl 3, 1–13. https://doi.org/10.1111/j.1469-0691.2011.03496.x

[460] LeBlanc, J. J., ElSherif, M., Ye, L., MacKinnon-Cameron, D., Li, L., Ambrose, A., Hatchette, T. F., Lang, A. L., Gillis, H., Martin, I., Andrew, M. K., Boivin, G., Bowie, W., Green, K., Johnstone, J., Loeb, M., McCarthy, A., McGeer, A., Moraca, S., Semret, M., … Serious Outcomes Surveillance (SOS) Network of the Canadian Immunization Research Network (CIRN) (2017). Burden of vaccine-preventable pneumococcal disease in hospitalized adults: A Canadian Immunization Research Network (CIRN) Serious Outcomes Surveillance (SOS) network study. Vaccine, 35(29), 3647–3654. https://doi.org/10.1016/j.vaccine.2017.05.049

[461] Public Health Agency of Canada. (2022). Vaccine uptake in Canadian adults 2021. Government of Canada. Retrieved from: https://www.canada.ca/content/dam/phac-aspc/documents/services/immunization-vaccines/vaccination-coverage/highlights-2020-2021-seasonal-influenza-survey/full-report/highlights-2020-2021-seasonal-influenza-survey.pdf

[462] Public Health Agency of Canada. (2022). Vaccine uptake in Canadian adults 2021. Government of Canada. Retrieved from: https://www.canada.ca/content/dam/phac-aspc/documents/services/immunization-vaccines/vaccination-coverage/highlights-2020-2021-seasonal-influenza-survey/full-report/highlights-2020-2021-seasonal-influenza-survey.pdf

[463] Statistics Canada. (2021). Health characteristics of seniors aged 65 and over, Canadian Health Survey on Seniors (Table 13-10-0789-01) [Data table]. Retrieved from: https://doi.org/10.25318/1310078901-eng

[464] Statistics Canada. (2021). Health characteristics of seniors aged 65 and over, Canadian Health Survey on Seniors (Table 13-10-0789-01) [Data table]. Retrieved from: https://doi.org/10.25318/1310078901-eng

[465] Leger. (2021). Seasonal influenza vaccination coverage survey, 2020–2021: Final report. Public Health Agency of Canada. Retrieved from: https://publications.gc.ca/collections/collection_2021/aspc-phac/H14-315-2021-eng.pdf

[466] Statistics Canada. (2019). Canadian Health Survey on Seniors. Retrieved from: https://www23.statcan.gc.ca/imdb/p3Instr.pl?Function=assembleInstr&lang=en&Item_Id=1261582

[467] Statistics Canada. (2021). Health characteristics of seniors aged 65 and over, Canadian Health Survey on Seniors (Table 13-10-0789-01) [Data table]. Retrieved from: https://doi.org/10.25318/1310078901-eng

[468] Government of Canada. (2022). Pneumococcal vaccine: Canadian Immunization Guide. Retrieved from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-16-pneumococcal-vaccine.html

[469] Statistics Canada. (2019). Canadian Health Survey on Seniors. Retrieved from: https://www23.statcan.gc.ca/imdb/p3Instr.pl?Function=assembleInstr&lang=en&Item_Id=1261582

[470] Leger. (2021). Seasonal influenza vaccination coverage survey, 2020–2021: Final report. Public Health Agency of Canada. Retrieved from: https://publications.gc.ca/collections/collection_2021/aspc-phac/H14-315-2021-eng.pdf

[471] Government of Canada. (2022). Pneumococcal vaccine: Canadian Immunization Guide. Retrieved from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-16-pneumococcal-vaccine.html

[472] Statistics Canada. (2021). Canadian Health Survey on Seniors (CHSS). Retrieved from: https://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=5267

[473] Huang, G., Martin, I., Tsang, R. S., Demczuk, W. H., Tyrrell, G. J., Li, Y. A., Dickson, C., Reyes-Domingo, F., & Squires, S. G. (2021). Invasive bacterial diseases in northern Canada, 1999 to 2018. Canada communicable disease report = Releve des maladies transmissibles au Canada, 47(11), 491–499. https://doi.org/10.14745/ccdr.v47i11a09

[474] Government of Ontario. (2016). Schedule of Benefits – Physician Services Under the Health Insurance Act. Retrieved from: http://www.health.gov.on.ca/en/pro/programs/ohip/sob/physserv/sob_master20160401.pdf

[475] Government of Canada. (2021). Invasive pneumococcal disease. Retrieved from: https://www.canada.ca/en/public-health/services/immunization/vaccine-preventable-diseases/invasive-pneumococcal-disease/health-professionals.html

[476] Government of Canada. (2018). Notifiable diseases online. Retrieved from: http://diseases.canada.ca/notifiable/

[477] Public Health Agency of Canada. (2021). Notifiable diseases online. Government of Canada. Retrieved from: https://dsol-smed.phac-aspc.gc.ca/notifiable/

[478] The Communicable and Infectious Disease Steering Committee Antimicrobial Resistance Surveillance Task Group. (2016). Antimicrobial resistance surveillance data requirements for priority organisms. Pan-Canadian Public Health Network. Retrieved from: https://www.phn-rsp.ca/en/docs/antimicrobial-resistance-surveillance-data-requirements-priority-organisms.pdf

[479] Government of Canada. (2021). Invasive pneumococcal disease. Retrieved from: https://www.canada.ca/en/public-health/services/immunization/vaccine-preventable-diseases/invasive-pneumococcal-disease/health-professionals.html

[480] The Communicable and Infectious Disease Steering Committee Antimicrobial Resistance Surveillance Task Group. (2016). Antimicrobial resistance surveillance data requirements for priority organisms. Pan-Canadian Public Health Network. Retrieved from: https://www.phn-rsp.ca/en/docs/antimicrobial-resistance-surveillance-data-requirements-priority-organisms.pdf

[481] Public Health Agency of Canada. (2021). Government of Canada. National laboratory surveillance of invasive streptococcal disease in Canada - Annual summary 2019. Retrieved from: https://www.canada.ca/en/public-health/services/publications/drugs-health-products/national-laboratory-surveillance-invasive-streptococcal-disease-canada-annual-summary-2019.html

[482] Government of Canada. (2021). Invasive pneumococcal disease. Retrieved from: https://www.canada.ca/en/public-health/services/immunization/vaccine-preventable-diseases/invasive-pneumococcal-disease/health-professionals.html

483. The Communicable and Infectious Disease Steering Committee Antimicrobial Resistance Surveillance Task Group. (2016). Antimicrobial resistance surveillance data requirements for priority organisms. Pan-Canadian Public Health Network. Retrieved from: https://www.phn-rsp.ca/en/docs/antimicrobial-resistance-surveillance-data-requirements-priority-organisms.pdf

[484] Canadian Paediatric Society. (2022). Surveillance. Retrieved from: https://cps.ca/en/impact

[485] The Communicable and Infectious Disease Steering Committee Antimicrobial Resistance Surveillance Task Group. (2016, April). Antimicrobial resistance surveillance data requirements for priority organisms. Pan-Canadian Public Health Network. Retrieved from: https://www.phn-rsp.ca/en/docs/antimicrobial-resistance-surveillance-data-requirements-priority-organisms.pdf

[486] The Communicable and Infectious Disease Steering Committee Antimicrobial Resistance Surveillance Task Group. (2016). Antimicrobial resistance surveillance data requirements for priority organisms. Pan-Canadian Public Health Network. Retrieved from: https://www.phn-rsp.ca/en/docs/antimicrobial-resistance-surveillance-data-requirements-priority-organisms.pdf

[487] The Communicable and Infectious Disease Steering Committee Antimicrobial Resistance Surveillance Task Group. (2016). Antimicrobial resistance surveillance data requirements for priority organisms. Pan-Canadian Public Health Network. Retrieved from: https://www.phn-rsp.ca/en/docs/antimicrobial-resistance-surveillance-data-requirements-priority-organisms.pdf

[488] Canadian Institute for Health Information, Canadian Lung Association, Health Canada, & Statistics Canada. (2001). Respiratory disease in Canada. Government of Canada. Retrieved from: https://secure.cihi.ca/free_products/RespiratoryComplete.pdf

[489] The Communicable and Infectious Disease Steering Committee Antimicrobial Resistance Surveillance Task Group. (2016). Antimicrobial resistance surveillance data requirements for priority organisms. Pan-Canadian Public Health Network. Retrieved from: https://www.phn-rsp.ca/en/docs/antimicrobial-resistance-surveillance-data-requirements-priority-organisms.pdf

[490] The Communicable and Infectious Disease Steering Committee Antimicrobial Resistance Surveillance Task Group. (2016). Antimicrobial resistance surveillance data requirements for priority organisms. Pan-Canadian Public Health Network. Retrieved from: https://www.phn-rsp.ca/en/docs/antimicrobial-resistance-surveillance-data-requirements-priority-organisms.pdf

[491] The Communicable and Infectious Disease Steering Committee Antimicrobial Resistance Surveillance Task Group. (2016). Antimicrobial resistance surveillance data requirements for priority organisms. Pan-Canadian Public Health Network. Retrieved from: https://www.phn-rsp.ca/en/docs/antimicrobial-resistance-surveillance-data-requirements-priority-organisms.pdf

[492] I. Martin, personal communication, October 3, 2022

[493] Public Health Agency of Canada. (2022). Enhanced National Invasive Pneumococcal Disease Surveillance System (eIPD) pilot. Government of Canada. Retrieved from: https://www.canada.ca/en/public-health/services/surveillance.html#a10

[494] Canadian Immunization Research Network. (2018). Serious Outcomes Surveillance (SOS) Network. Retrieved from: http://cirnetwork.ca/network/serious-outcomes/

[495] Canadian Immunization Research Network. (n.d.). Annual report 2018-19. Retrieved from: https://cirnetwork.ca/wp-content/uploads/2020/01/CIRN-annual-report-2019-jan4.pdf

[496] Canadian Immunization Research Network. (n.d.). Annual report 2019-2020. Retrieved from: https://cirnetwork.ca/wp-content/uploads/2021/08/AR.2019-20.Final_.pdf

[497] Canadian Immunization Research Network. (2018). Serious Outcomes Surveillance (SOS) Network. Retrieved from: http://cirnetwork.ca/network/serious-outcomes/

[498] A. McGeer, personal communication, March 2, 2023

[499] Canadian Immunization Research Network. (2018). Serious Outcomes Surveillance (SOS) Network. Retrieved from: http://cirnetwork.ca/network/serious-outcomes/

[500] LeBlanc, J. J., ElSherif, M., Ye, L., MacKinnon-Cameron, D., Li, L., Ambrose, A., Hatchette, T. F., Lang, A. L., Gillis, H., Martin, I., Andrew, M. K., Boivin, G., Bowie, W., Green, K., Johnstone, J., Loeb, M., McCarthy, A., McGeer, A., Moraca, S., Semret, M., … Serious Outcomes Surveillance (SOS) Network of the Canadian Immunization Research Network (CIRN) (2017). Burden of vaccine-preventable pneumococcal disease in hospitalized adults: A Canadian Immunization Research Network (CIRN) Serious Outcomes Surveillance (SOS) network study. Vaccine, 35(29), 3647–3654. https://doi.org/10.1016/j.vaccine.2017.05.049

[501] Canadian Lung Association. (2021). Prevention. Retrieved from: https://www.lung.ca/prevention-12

[502] Ludwig, E., Bonanni, P., Rohde, G., Sayiner, A., & Torres, A. (2012). The remaining challenges of pneumococcal disease in adults. European respiratory review : an official journal of the European Respiratory Society, 21(123), 57–65. https://doi.org/10.1183/09059180.00008911

[503] LeBlanc, J. J., ElSherif, M., Ye, L., MacKinnon-Cameron, D., Li, L., Ambrose, A., Hatchette, T. F., Lang, A. L., Gillis, H., Martin, I., Andrew, M. K., Boivin, G., Bowie, W., Green, K., Johnstone, J., Loeb, M., McCarthy, A., McGeer, A., Moraca, S., Semret, M., … Serious Outcomes Surveillance (SOS) Network of the Canadian Immunization Research Network (CIRN) (2017). Burden of vaccine-preventable pneumococcal disease in hospitalized adults: A Canadian Immunization Research Network (CIRN) Serious Outcomes Surveillance (SOS) network study. Vaccine, 35(29), 3647–3654. https://doi.org/10.1016/j.vaccine.2017.05.049

[504] LeBlanc, J. J., ElSherif, M., Ye, L., MacKinnon-Cameron, D., Li, L., Ambrose, A., Hatchette, T. F., Lang, A. L., Gillis, H., Martin, I., Andrew, M. K., Boivin, G., Bowie, W., Green, K., Johnstone, J., Loeb, M., McCarthy, A., McGeer, A., Moraca, S., Semret, M., … Serious Outcomes Surveillance (SOS) Network of the Canadian Immunization Research Network (CIRN) (2017). Burden of vaccine-preventable pneumococcal disease in hospitalized adults: A Canadian Immunization Research Network (CIRN) Serious Outcomes Surveillance (SOS) network study. Vaccine, 35(29), 3647–3654. https://doi.org/10.1016/j.vaccine.2017.05.049

[505] LeBlanc, J. J., ElSherif, M., Ye, L., MacKinnon-Cameron, D., Li, L., Ambrose, A., Hatchette, T. F., Lang, A. L., Gillis, H., Martin, I., Andrew, M. K., Boivin, G., Bowie, W., Green, K., Johnstone, J., Loeb, M., McCarthy, A., McGeer, A., Moraca, S., Semret, M., … Serious Outcomes Surveillance (SOS) Network of the Canadian Immunization Research Network (CIRN) (2017). Burden of vaccine-preventable pneumococcal disease in hospitalized adults: A Canadian Immunization Research Network (CIRN) Serious Outcomes Surveillance (SOS) network study. Vaccine, 35(29), 3647–3654. https://doi.org/10.1016/j.vaccine.2017.05.049

[506] Statistics Canada. (2021). Health characteristics of seniors aged 65 and over, Canadian Health Survey on Seniors (Table 13-10-0789-01) [Data table]. Retrieved from: https://doi.org/10.25318/1310078901-eng

[507] Public Health Agency of Canada. (2022). Vaccine uptake in Canadian adults 2021. Government of Canada. Retrieved from: https://www.canada.ca/content/dam/phac-aspc/documents/services/immunization-vaccines/vaccination-coverage/highlights-2020-2021-seasonal-influenza-survey/full-report/highlights-2020-2021-seasonal-influenza-survey.pdf

[508] Public Health Agency of Canada. (2022). Vaccine uptake in Canadian adults 2021. Government of Canada. Retrieved from: https://www.canada.ca/content/dam/phac-aspc/documents/services/immunization-vaccines/vaccination-coverage/highlights-2020-2021-seasonal-influenza-survey/full-report/highlights-2020-2021-seasonal-influenza-survey.pdf

[509] Public Health Agency of Canada. (2022). Vaccine uptake in Canadian adults 2021. Government of Canada. Retrieved from: https://www.canada.ca/content/dam/phac-aspc/documents/services/immunization-vaccines/vaccination-coverage/highlights-2020-2021-seasonal-influenza-survey/full-report/highlights-2020-2021-seasonal-influenza-survey.pdf

[510] Statistics Canada. (2019). Canadian Health Survey on Seniors. Retrieved from: https://www23.statcan.gc.ca/imdb/p3Instr.pl?Function=assembleInstr&lang=en&Item_Id=1261582

[511] Leger. (2021). Seasonal influenza vaccination coverage survey, 2020–2021: Final report. Public Health Agency of Canada. Retrieved from: https://publications.gc.ca/collections/collection_2021/aspc-phac/H14-315-2021-eng.pdf

[512] Statistics Canada. (2021). Canadian Health Survey on Seniors (CHSS). Retrieved from: https://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=5267

[513] Ling, J. (2021). Provinces are working with outdated vaccine tracking systems, hindering national data. The Globe and Mail Inc. Retrieved from: https://www.theglobeandmail.com/canada/article-provinces-working-with-outdated-vaccine-tracking-systems/

[514] Stall, N. M., Nakamachi, Y., Chang, M., Isaacksz, S., Mills, C. S., Niedra, E., Lemieux, C., Brown, K. A., Costa, A. P., Hodges, B., Huynh, T., Ikura, S., Jones, A., Lapointe-Shaw, L., Maltsev, A., McGeer, A., Rochon, P. A., Siddiqi, A., Thurston, A., … Sinha, S. K. (2021). Mobile in-home COVID-19 vaccination of Ontario homebound older adults by neighbourhood risk. Science Briefs of the Ontario COVID-19 Science Advisory Table, 1(19). https://doi.org/10.47326/ocsat.2021.02.19.1.0

[515] Berical, A. C., Harris, D., Dela Cruz, C. S., & Possick, J. D. (2016). Pneumococcal Vaccination Strategies. An Update and Perspective. Annals of the American Thoracic Society, 13(6), 933–944. https://doi.org/10.1513/AnnalsATS.201511-778FR

[516] Berical, A. C., Harris, D., Dela Cruz, C. S., & Possick, J. D. (2016). Pneumococcal Vaccination Strategies. An Update and Perspective. Annals of the American Thoracic Society, 13(6), 933–944. https://doi.org/10.1513/AnnalsATS.201511-778FR

[517] Berical, A. C., Harris, D., Dela Cruz, C. S., & Possick, J. D. (2016). Pneumococcal Vaccination Strategies. An Update and Perspective. Annals of the American Thoracic Society, 13(6), 933–944. https://doi.org/10.1513/AnnalsATS.201511-778FR

[518] Berical, A. C., Harris, D., Dela Cruz, C. S., & Possick, J. D. (2016). Pneumococcal Vaccination Strategies. An Update and Perspective. Annals of the American Thoracic Society, 13(6), 933–944. https://doi.org/10.1513/AnnalsATS.201511-778FR

[519] World Health Organization. (2008, October 17). 23-valent pneumococcal polysaccharide vaccine: WHO position paper. Weekly Epidemiological Record, 83(42), 373-384. Retrieved from: https://apps.who.int/iris/rest/bitstreams/958394/retrieve

[520] Weinberger, B. (2021). Vaccination of older adults: Influenza, pneumococcal disease, herpes zoster, COVID-19 and beyond. Immunity & ageing : I & A, 18(1), 38. https://doi.org/10.1186/s12979-021-00249-6

[521] Oliveira, G. S., Oliveira, M., Miyaji, E. N., & Rodrigues, T. C. (2021). Pneumococcal Vaccines: Past Findings, Present Work, and Future Strategies. Vaccines, 9(11), 1338. https://doi.org/10.3390/vaccines9111338

[522] Weinberger, B. (2018). Vaccines for the elderly: current use and future challenges. Immunity & Ageing, 15(3), 1-8. https://doi.org/10.1186/s12979-017-0107-2

[523] Daniels, C. C., Rogers, P. D., & Shelton, C. M. (2016). A Review of Pneumococcal Vaccines: Current Polysaccharide Vaccine Recommendations and Future Protein Antigens. The journal of pediatric pharmacology and therapeutics : JPPT : the official journal of PPAG, 21(1), 27–35. https://doi.org/10.5863/1551-6776-21.1.27

[524] Weinberger, B. (2018). Vaccines for the elderly: current use and future challenges. Immunity & Ageing, 15(3), 1-8. https://doi.org/10.1186/s12979-017-0107-2

[525] Precision Vaccinations. (2022). Pneumococcal Vaccines 2022. Retrieved from: https://www.precisionvaccinations.com/vaccines/pneumococcal-vaccines-2022

[526] Oliveira, G. S., Oliveira, M., Miyaji, E. N., & Rodrigues, T. C. (2021). Pneumococcal Vaccines: Past Findings, Present Work, and Future Strategies. Vaccines, 9(11), 1338. https://doi.org/10.3390/vaccines9111338

[527] Merck Canada Inc. (2022). Product monograph including patient medication information: VAXNEUVANCE®. Government of Canada. Retrieved from: https://pdf.hres.ca/dpd_pm/00066824.PDF

[528] Pfizer Canada Inc. (n.d.). Product monograph: PREVNAR®. Government of Canada. Retrieved from: https://pdf.hres.ca/dpd_pm/00011596.PDF

[529] Public Health Agency of Canada. (2023). Public health level recommendations on the use of pneumococcal vaccines in adults, including the use of 15-valent and 20-valent conjugate vaccines. Government of Canada. Retrieved from: https://www.canada.ca/en/public-health/services/immunization/national-advisory-committee-on-immunization-naci/public-health-level-recommendations-use-pneumococcal-vaccines-adults-including-use-15-valent-20-valent-conjugate-vaccines.html

[530] 101 Pharmacy. (2022). Our services. Retrieved from: https://101pharmacy.ca/services/

[531] Ottawa West Travel Medicine. (2022). Fees. Retrieved from: https://www.ottawatravelmedicine.com/en/fees

[532] Assaad, U., El-Masri, I., Porhomayon, J., & El-Solh, A. A. (2012). Pneumonia immunization in older adults: review of vaccine effectiveness and strategies. Clinical interventions in aging, 7, 453–461. https://doi.org/10.2147/CIA.S29675

[533] Kawakami, K., Ohkusa, Y., Kuroki, R., Tanaka, T., Koyama, K., Harada, Y., Iwanaga, K., Yamaryo, T., & Oishi, K. (2010). Effectiveness of pneumococcal polysaccharide vaccine against pneumonia and cost analysis for the elderly who receive seasonal influenza vaccine in Japan. Vaccine, 28(43), 7063–7069. https://doi.org/10.1016/j.vaccine.2010.08.010

[534] Christenson, B., Hedlund, J., Lundbergh, P., & Ortqvist, A. (2004). Additive preventive effect of influenza and pneumococcal vaccines in elderly persons. The European respiratory journal, 23(3), 363–368. https://doi.org/10.1183/09031936.04.00063504

[535] Government of Canada. (2022). COVID-19 vaccine: Canadian Immunization Guide. Retrieved from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-26-covid-19-vaccine.html

[536] Government of Canada. (2022). COVID-19 vaccine: Canadian Immunization Guide. Retrieved from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-26-covid-19-vaccine.html

[537] Janssens, J. P., & Krause, K. H. (2004). Pneumonia in the very old. The Lancet. Infectious diseases, 4(2), 112–124. https://doi.org/10.1016/S1473-3099(04)00931-4

[538] Janssens, J. P., & Krause, K. H. (2004). Pneumonia in the very old. The Lancet. Infectious diseases, 4(2), 112–124. https://doi.org/10.1016/S1473-3099(04)00931-4

[539] Government of Canada. (2016). Page 6: Canadian Immunization Guide: Part 3 – Vaccination of Specific Populations. Retrieved from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-3-vaccination-specific-populations/page-6-immunization-patients-health-care-institutions.html

[540] Chan, T. C., Fan-Ngai Hung, I., Ka-Hay Luk, J., Chu, L. W., & Hon-Wai Chan, F. (2014). Effectiveness of influenza vaccination in institutionalized older adults: a systematic review. Journal of the American Medical Directors Association, 15(3), 226.e1–226.e6. https://doi.org/10.1016/j.jamda.2013.10.008

[541] Monto, A. S., Hornbuckle, K., & Ohmit, S. E. (2001). Influenza vaccine effectiveness among elderly nursing home residents: a cohort study. American journal of epidemiology, 154(2), 155–160. https://doi.org/10.1093/aje/154.2.155

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