

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



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NIA NATIONAL
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About the National Institute on Ageing

The National Institute on Ageing (NIA) is a policy and research centre based at Ryerson University in Toronto. 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 important perspectives, including those of financial, physical, psychological, and social wellness.

The NIA is also focused on leading cross-disciplinary research to better understand the issues that can lead to the development of evidence-informed actionable insights that can meaningfully contribute towards shaping the innovative policies, practices and products that will be needed to address the multiple challenges and opportunities presented by Canada's coming of age. The NIA is committed to providing national leadership in promoting a collaborative approach that also seeks to continually establish municipal, provincial,

federal and global partnerships with other academic centres, and ageing-related organizations.

The NIA further serves as the academic home for the National Seniors Strategy (NSS), an evolving evidence-based policy document co-authored by a group of leading researchers, policy experts and stakeholder organizations from across Canada and first published in October 2015. The NSS outlines four pillars that guide the NIA's work to advance knowledge and inform policies through evidence-based research around ageing in Canada that include Independent, Productive and Engaged Citizens; Healthy and Active Lives; Care Closer to Home; and Support for Caregivers.



National Institute on Ageing Immunization Series

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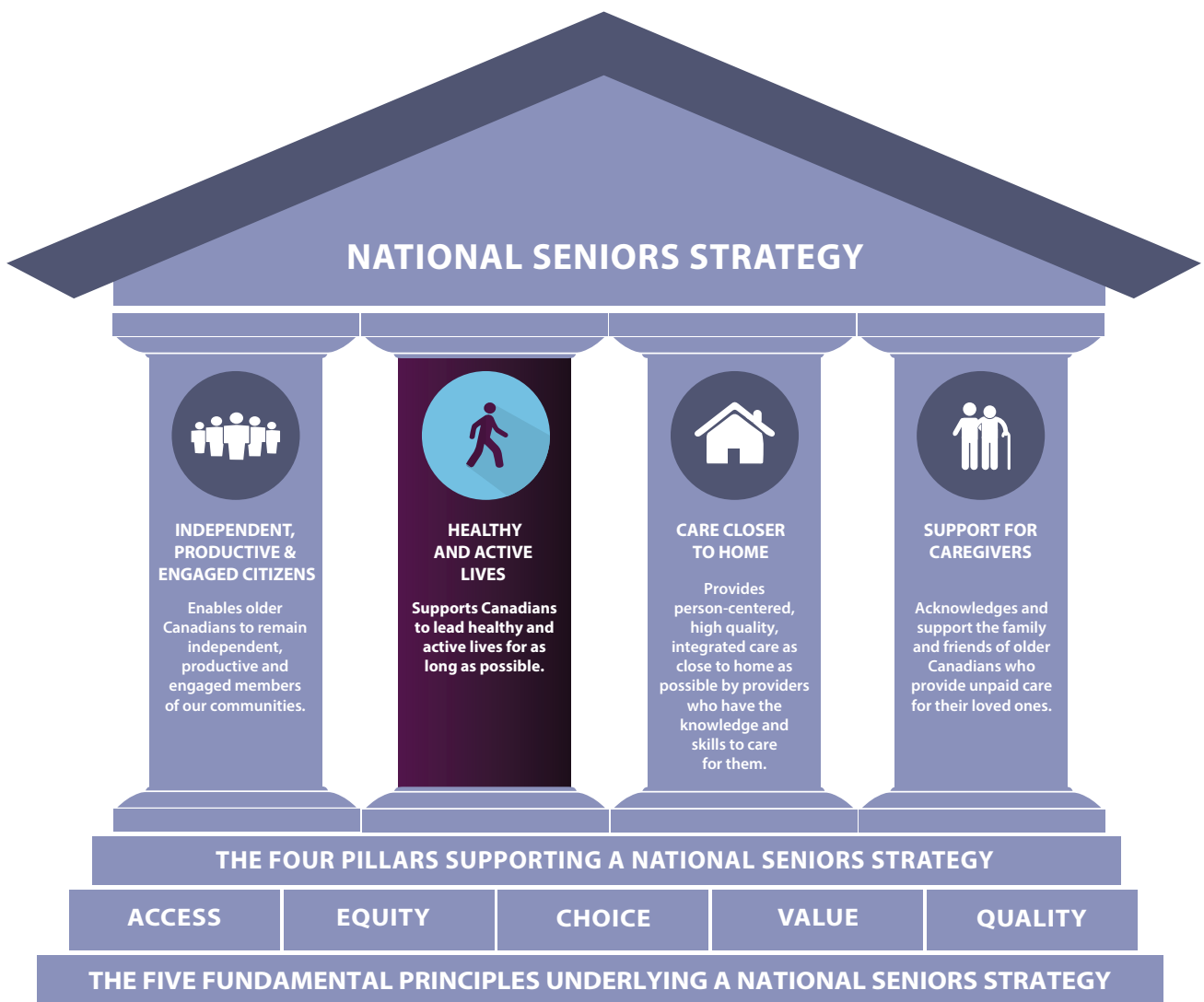
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In 2018, the NIA began looking at adult immunizations as a part of its 'Healthy and Active Lives' pillar of work, encouraging education and support so that Canadians, as well as

policy and decision-makers can better understand and promote policies and activities that better support wellness, prevention, and overall healthy ageing.



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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) set an 80% target vaccination coverage rate with the pneumococcal vaccine for those over the age of 65¹ – however, estimates suggest that as of 2016, only 42% of Canadians had received their pneumococcal vaccination.² At the same time the target vaccination coverage rate for children under the age of two was set at 95%¹, and research shows children are doing much better with conservative estimates suggesting 80% of Canadian children have been vaccinated against pneumococcal disease.³ 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 actually up-to-date according to Canadian recommended standards.²

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.⁴

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 actually up-to-date according to Canadian recommended standards²



It can be serious and sometimes fatal – especially for older adults, infants, and young children.⁵ Pneumonia can be caused by bacteria, viruses, and more rarely by fungal infections.⁶

The most common cause of bacterial pneumonia is a bacteria called *Streptococcus pneumoniae*.⁶ *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.⁷ This can result in meningitis and bacteremia.⁷

The incidence of pneumonia amongst adults is highest with older Canadians.⁸ There are increased rates of pneumonia in older adults when compared to those under age 65, with residents of long-term care homes having even higher rates.⁹ Pneumonia can be a consequence of influenza infection. Together with influenza, pneumonia was the 8th leading cause of death in Canada in 2016 – however, when looking at individuals 85-89 years of age it is the 7th leading cause of death and at 90 years of age it is the 6th leading cause of death.¹⁰

Pneumonia is among one of the top ten reasons that people went to Emergency Departments (ED) in Canada, with 135,000 pneumonia-related ED visits last year.¹¹

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Lack of availability of specific diagnostic tests means that the true burden of pneumonia across the country is likely underestimated.¹² 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 actually vaccinated. In Canada, the reality is that we do not actually know how many people have been vaccinated.

Vaccination is an effective way to protect against pneumococcal disease. Vaccines help the immune system develop antibodies which protect us from getting sick when infected with that particular bacteria or virus.¹³ There are two main types of vaccines for *S. pneumoniae* currently available – polysaccharide and conjugate vaccines.^{14,15} Polysaccharide vaccines are

recommended for healthy adults, as well as adults and children at high risk of invasive pneumococcal disease¹⁵, while conjugate vaccines were created to provide a stronger immune response for children and other immunocompromised populations.¹⁴

In Canada, it is recommended that adults over 65, children, and individuals at high-risk of developing invasive pneumococcal disease are vaccinated against pneumococcal disease.¹⁵

When children are vaccinated, the overall rates of pneumococcal disease decrease.¹⁶ This is why it is important that children are vaccinated to protect themselves, as well as the older adults in the population.¹⁶

Providers play a significant role in increasing vaccination rates. In order to improve vaccination rates there is a need to improve education both among 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, there is additional work to be done to improve the prevention of pneumonia and pneumococcal disease in Canada.

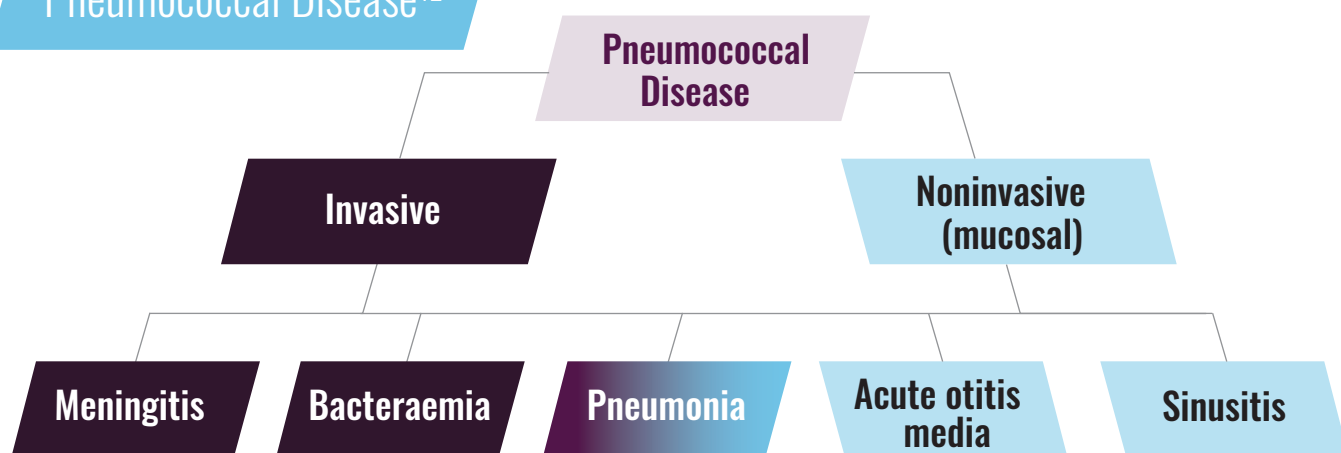
The following recommendations provide evidence-informed policy and practice approaches that can be used by health authorities and organizations to support vaccination and overall prevention across Canada.

- 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 Towards 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 Vaccination.
- 9.** Promote Following the Current National Advisory Committee on Immunization (NACI) Statement for Pneumococcal Vaccination
- 10.** Consider Mandating Pneumococcal Vaccination for Residents of Long-Term Care Homes

Background and Context

Figure 1:
Pneumococcal Disease¹²



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

Pneumonia versus Pneumococcal Disease

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.¹⁷ Pneumonia can also be serious for infants and young children.⁵ It is a common lung infection that can lead to difficulty breathing, coughing, fever or other symptoms.^{4,5} While pneumonia is the most common manifestation of *S. pneumoniae* infection, it is not the

only type of pneumococcal disease or infection. As depicted in the chart above, adapted from Ludwig et al. (2012), pneumococcal disease can cause a variety of disease manifestations, including pneumonia.¹² Pneumococcal disease can be broadly separated into invasive and non-invasive types of illnesses.¹² As depicted on the right-hand side of Figure 1 on page 9, pneumonia is typically caused by a non-invasive type of pneumococcal disease.

Pneumonia can be caused by bacteria, viruses, and more rarely by fungal infections.⁶ The most common cause of bacterial pneumonia is a bacteria called *Streptococcus pneumoniae* (also known as *S. pneumoniae*, Strep pneumo, or pneumococcus) that can live in the human nose and throat.⁶ It can be transmitted through direct mouth-to-mouth contact, coughing or sneezing, or through indirect contact

with someone who carries the bacteria asymptotically.⁷

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.⁴ 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.¹⁷

What is Community-Acquired Pneumonia (CAP)?

Types of pneumonia are often classified based on where the disease was contracted. A 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.^{4,20} Healthcare-associated or hospital-acquired pneumonia (HAP) refers to a pneumonia that was contracted while in the care of a hospital or long-term care home setting, and often refers to more serious cases of pneumonia with more severe symptoms because patients are already sick to begin with and may have acquired a more virulent strain of bacterial pneumonia as well²¹. Walking pneumonia refers to a pneumonia where the symptoms may be quite mild and generally people with this type of pneumonia are able to function regularly and may think that they only have a cold.²²

One study found that patients who had CAP had increased rates of hospitalizations and ED visits when compared to patients who never had CAP.²³ The rate of mortality for CAP is still found to be highest among those over age 65.²³

Other symptoms may include:

- Feeling very tired or weak
- Nausea and vomiting
- Chest pain – this may become more painful during coughing or taking a breath in
- Experiencing a faster than normal heartbeat
- Confusion or delirium in older adults
- Diarrhea⁴

As can be seen on the left-hand side of Figure 1 on page 9, 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)**.⁷ In children under the age of two, IPD typically manifests as bacteremia or meningitis.⁷ Meningitis occurs when the pneumococcal disease infects the tissue that covers the brain and the spinal cord that may cause symptoms, including, stiff neck, fever, headache, eye sensitivity to light, and confusion.¹⁸ Bacteremia is an infection of the blood, which leads to symptoms

that include fever, chills, and lack of alertness.¹⁸ In adults, IPD typically presents as something called 'bacteremic pneumococcal pneumonia', which can be a common complication of influenza.^{7,19} IPD is more common in the very young, older adults, and high-risk groups during winter/spring months in countries with temperate climates.^{7,15}

The Burden of Pneumonia in Canada

Older Canadians Are At Greatest Risk

Pneumonia incidence is highest amongst older Canadians and is expected to increase as the population ages.⁸ In 2010, there were 24,761 cases of community-acquired pneumonia in Canada that required hospitalization, this number is expected to double by 2025 with the largest increases being in adults over age 75.⁸ There are higher incidence rates for older adults over 65 living in the community when compared to those under age 65.⁹ The highest incidence rates, however exist amongst older adults living in long-term care homes.⁹

Estimates of the annual incidence of pneumonia among those over age 65 range from 2.5-4.4%.⁹ In comparison, estimates suggest that the incidence rate for those over 65 living in a long-term care home ranges from 3.3-11.4% annually,⁹ almost double the incidence rate of those living in the community.

In Canada, rates of hospitalization due to pneumonia in individuals aged 65 and over was 1,537 per 100,000 people in 2009-2010.²⁴ This

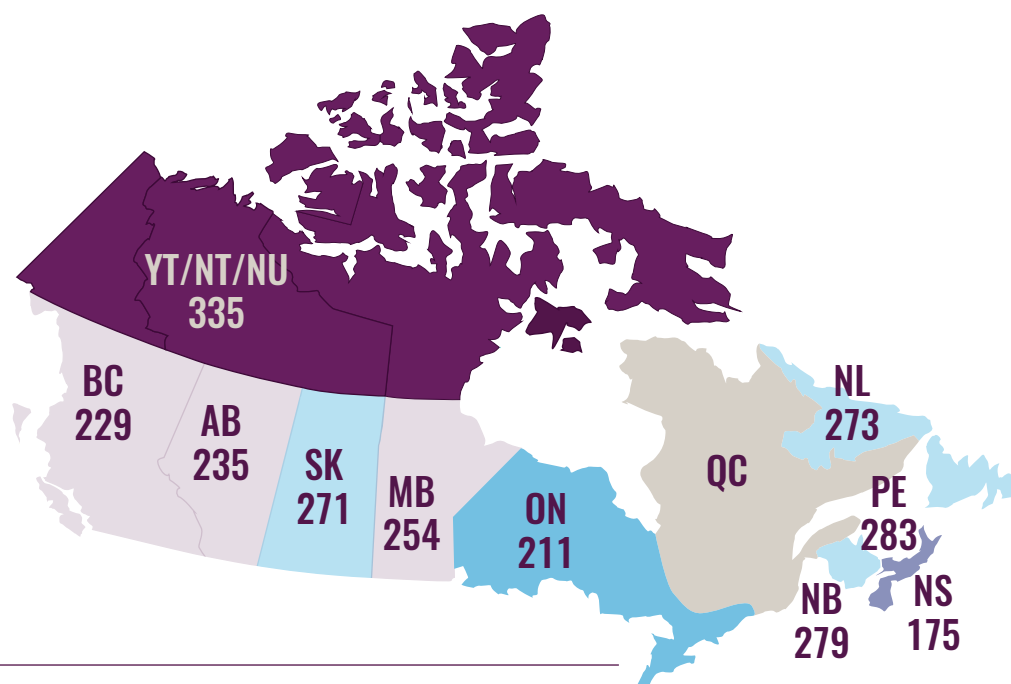
reflects a decline in the rate of hospitalization from 1,766 per 100,000 people in 2004-2005, due to the growing uptake of childhood pneumonia vaccination.²⁴ The associated length of stay in those 70 and over in 2009-2010 is 12.98 days.²⁴

More specifically, hospitalization rates for pneumonia in individuals over the age of 75 (1,303 per 100,000 for males and 1,003 per 100,000 for females), is almost five times higher than for 65-69

Figure 2: Rates of Hospitalization Due to Pneumonia - Age and Sex Standardized Incidence Rate, by Province, 2015⁸

(cases per 100,000)

- 300-340
- 260-299
- 220-259
- 180-219
- <180



Note: Data from Quebec are not available.

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

year-olds (280 per 100,000 for males and 226 per 100,000 for females) demonstrating the greater burden of pneumonia amongst the oldest members of our society.⁸ There are limitations to this data as it only includes hospitalized cases where pneumonia was listed as the primary diagnosis.

Hospitalization rates of Pneumonia - Over 75 Years Old⁸

Females	1,003 per 100,000
Males	1,303 per 100,000

Hospitalization rates of Pneumonia - 70-74 Years Old⁸

Females	331 per 100,000
Males	450 per 100,000

Hospitalization rates of Pneumonia - 65-69 Years Old⁸

Females	226 per 100,000
Males	280 per 100,000

Together with influenza, pneumonia was the 8th leading cause of death in Canada in 2016.¹⁰

This likely underestimates the number of cases because pneumonia may have been listed as secondary to another diagnosis and then those cases would be excluded from the rates.⁸

One study testing for CAP and IPD in nine hospitals across five provinces (BC, ON, QC, NB, and NS) found that mortality was the highest for those over age 50 in comparison to younger age groups.²⁵ As age increased, so did the hospital length of stay.²⁵ Pneumococcal CAP and IPD, when compared to all-cause CAP, led to more severe outcomes, including being admitted to an Intensive Care Unit (ICU), needing a ventilator, developing additional complications when in the hospital, and an increased 30-day mortality rate.²⁵

In Canada, IPD is most common among the very young and those over age 65.⁷ The incidence rate for IPD cases has remained relatively stable between 2009-2014, with an average of 9.6 cases per 100,000 persons per year, with ranges between 8.9 and 9.8.²⁶

The incidence of IPD has been declining for children, but the rates among older adults have generally remained stable between 2009-2014.²⁶ In 2014 in Canada, the highest incidence rates were in adults over 60 years with rates of 21.5 cases per 100,000 persons.²⁶ This is compared to a rate of 16.9 per 100,000 for infants under the age of one.²⁶

Together with influenza, pneumonia was the 8th leading cause of death in Canada in 2016.¹⁰ However, influenza and pneumonia are the 7th leading cause of death for Canadians aged 85-89, and the 6th leading cause of death for Canadians aged 90 and older.¹⁰ In 2016, influenza and pneumonia caused 6,235 deaths, 88% (5,491) of which, were Canadians over the age of 65.¹⁰

A new report from the Canadian Institute for Health Information (CIHI) found that pneumonia was one of the top ten reasons that Canadians reported going to the ED in 2017.¹¹ Estimates from CIHI suggest that there were approximately 135,000 pneumonia-related ED visits for 2017-2018, a 13% increase over the previous year.¹¹

Estimates from CIHI suggest that there were approximately 135,000 pneumonia-related ED visits last year, a 13% increase over the previous year.¹¹

More than 25% of the ED visits for pneumonia led to a hospital admission for at least one night.¹¹

Pneumonia is of particular concern because it is consistently among the leading causes of in-hospital deaths in Canada.¹¹ Older adults accounted for approximately 65% of pneumonia-related admission.¹¹

Incidence Rates of Invasive Pneumococcal Disease²⁶

Average IPD cases between 2009-2014	9.6 cases per 100,000 (ranging from 8.9-9.8)
Adults over 60, 2014	21.5 cases per 100,000
Infants (under age 1), 2014	16.9 per 100,000

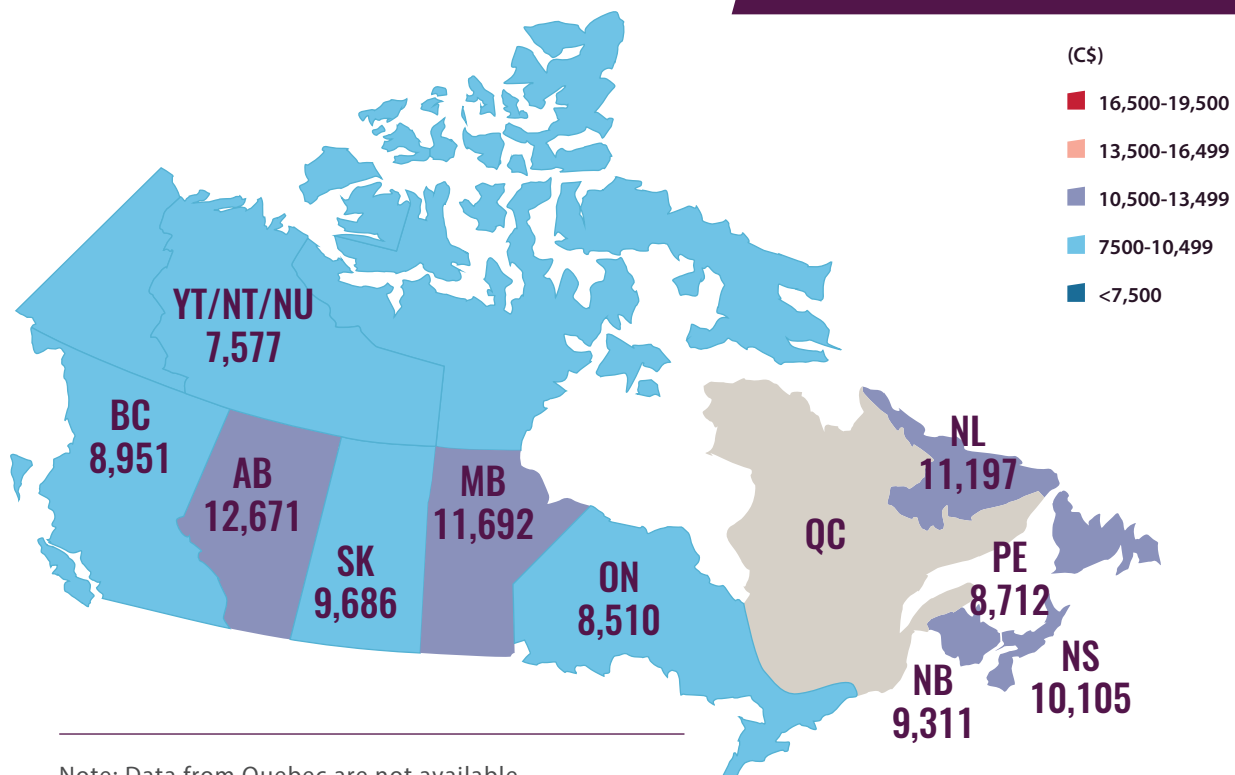
In Ontario, *S. pneumoniae* remains among the top ten most burdensome infectious diseases across the province, along with influenza, HIV/AIDS, hepatitis C and B, and others.²⁷ Most of the burden associated with *S. pneumoniae* is related to premature mortality and living for additional years with reduced functioning.²⁷

The Cost of Pneumonia in Canada

Pneumonia is a costly disease, due to its associated costs of hospitalizations and other treatments.⁸ According to

the Public Health Agency of Canada, respiratory infections (including pneumonia, influenza and other infections) have a total indirect cost of \$2.8 billion.²⁸ In this case, indirect costs refer to the cost of lost productivity due to illness, injury, or premature death.²⁸ For this particular analysis, it did not include activities such as the cost of unpaid caregiving to support those caring for people with respiratory infections.²⁸

Figure 3: Pneumonia Average Cost per Case by Province, 2015⁸



Note: Data from Quebec are not available.

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

In 2012, a study from the United States compared the costs per year after a person was admitted to hospital for pneumonia versus an admission without pneumonia and found approximately \$15,000 increase in costs over a year for those with an index-pneumonia admission.²⁹ 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.⁸ 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.⁸ This difference in costs is likely due to regional differences in the cost of services, for example, Alberta has a higher average cost but they also have a higher average length of stay.⁸ This is in comparison to the territories which have a lower cost per case, but also report a lower length of stay.⁸

Glossary

Non-invasive pneumococcal infections: "these occur outside the major organs or the blood and tend to be less serious" (NHS, 2018)³⁰

Invasive pneumococcal infections: "these occur inside a major organ or the blood and tend to be more serious" (NHS, 2018)³⁰

Bacteremic pneumococcal pneumonia: A type of invasive pneumococcal infection more common among older adults and often times is a complication of influenza⁷

Serotype: "Name given to a strain of bacteria, or other pathogen, that can be distinguished from other strains of the same species by specific antibodies."³¹

Polysaccharide vaccine: this vaccine is made by using a capsule that surrounds the pneumococcal bacteria.¹³

Conjugate vaccine: this vaccine is made by taking a capsule that surrounds the pneumococcal bacteria and linking it to a protein carrier.¹³

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.^{15,32} These groups are also at an increased risk of complications and death.³²

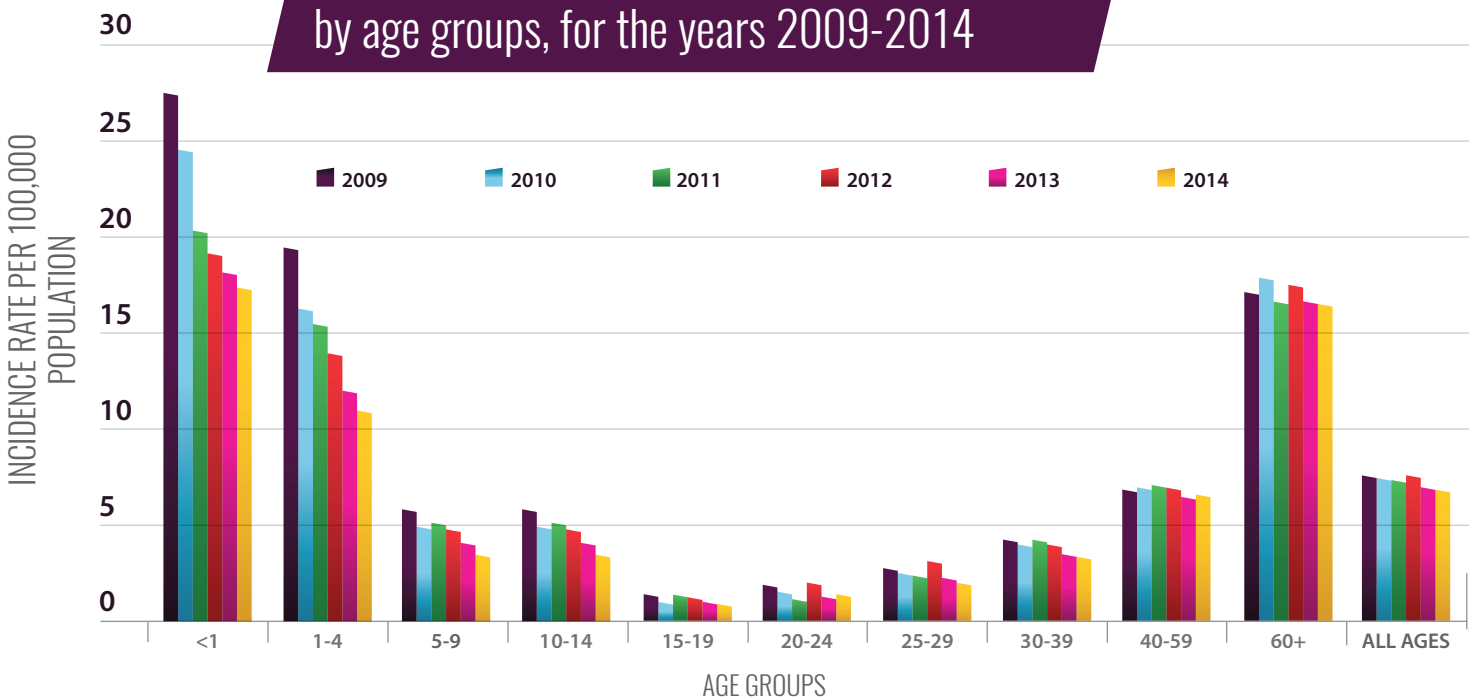
Children, particularly those under the age of 1, are also at increased risk as their immune systems have not fully matured.¹⁵

Older Adults:

With ageing, the effectiveness of the human immune system declines, commonly referred to as **immunosenescence**.³³

Immunosenescence causes older adults to be more likely to contract pneumonia and other infections and less likely to respond to vaccines.³³ There have been attempts to better address the lack of vaccine-efficacy in adults over 65, including using new vaccines that have been developed to address the changes in immune function.³³ Please see "The History of Pneumococcal Vaccine" box on page 24.

Figure 4: Annual Incidence of IPD cases in Canada, by age groups, for the years 2009-2014

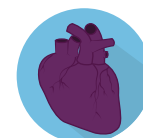


Source: Demczuk, W.H.B., Griffith, A., Singh, R., Montes, K., Sawatzky, P., Martin, I., & Mulvey, M. (2015). National Laboratory Surveillance of Invasive Streptococcal Disease in Canada – Annual Summary 2014. Retrieved from: <http://www.healthycanadians.gc.ca/publications/drugs-products-medicaments-produits/2014-streptococcus/alt/surveillance-streptococca-eng.pdf>

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.⁹ 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.³⁴

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, are at a 12% increased risk of developing heart failure when compared to people who did not have pneumonia.³⁵ Eurich et al.(2017) studied patients admitted to hospital for CAP and followed them after discharge and found that those

According to Canada's National Advisory Committee on Immunization (NACI) the following conditions put people at increased risk of both becoming infected and experiencing worse outcomes:

1. chronic heart, kidney or lung disease
2. chronic liver disease, including cirrhosis
3. diabetes mellitus
4. conditions that affect the immune system, such as HIV
5. having your spleen removed or a spleen that does not work properly
6. sickle cell disease
7. organ or stem cell transplant
8. cochlear implants
9. neurologic conditions that may impair clearance of oral secretions¹⁵



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.³⁵

In one study, it was found that the excess risk of developing CAP amongst older adults was highly related to having underlying congestive heart failure, when compared to those with heart diseases other than congestive heart failure.³⁴

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.³⁶ Due to its strong connection with heart failure, there is 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 cardiovascular conditions.³⁵

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.³² Age matters as well, with one UK study demonstrating that people living with COPD older than 65 were at increased risk of developing CAP versus younger people living with COPD.³⁷ 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.³⁴ In addition, being previously hospitalized for COPD complications was associated with a greater chance of developing CAP.³⁷



Adults living with asthma have been found to be more likely to have IPD when compared to adults without asthma.³⁸ The severity of the asthma is important, with the risk of IPD becoming greater as the asthma severity increases.³⁸ As such in 2014, NACI added asthma as a high-risk condition.³⁸ Individuals who require medical attention for asthma should

be given the appropriate vaccine for their age group.³⁸

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.³⁹ Cognitive impairment was found in both older and younger adults, many of whom were completely healthy prior to their episode of CAP.³⁹

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.⁴⁰ Similar to other studies, it was also found that these associations are present in individuals who were only hospitalized once and without comorbidities.⁴⁰ These results are not limited to older adults who require the most critical care.⁴⁰

Other Chronic Conditions



Individuals living with diabetes also have an increased risk of developing CAP.³² Diabetes has the largest impact on the development of IPD and CAP in people under the age of 64.³² Additionally, individuals previously hospitalized with diabetes had an increased risk of developing different types of pneumonia and meningitis.⁴¹ 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 60.⁴¹

Obesity, defined as having a Body Mass Index (BMI) over 30, was found to be associated with an increased risk of being hospitalized for respiratory diseases (including pneumonia) during periods of seasonal influenza.⁴²

Finally, it has been found that a hospitalization for pneumonia increases the risk of developing depressive symptoms by 1.6 times.⁴⁰

Special Populations:

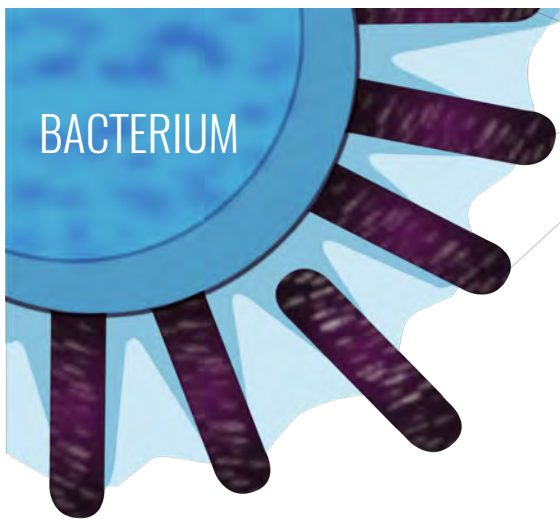
Canada has an International Circumpolar Surveillance (ICS) data collection system that collects data about IPD in the North.⁴³ This system has shown that IPD remains a significant cause of morbidity in Northern Canada.⁴³ In one particular study, Indigenous populations were found to have rates 2-16 times higher than those of non-Indigenous people.⁴³ In Manitoba, communities that are socio-economically disadvantaged and predominantly Indigenous have increased rates of IPD.⁴⁴ It has been suggested that higher rates of respiratory problems may be related to housing conditions including crowding, needing repairs, and compromised air quality, however, additional factors must also be considered.⁴⁵

Children:

S. pneumoniae is the leading cause of invasive bacterial infections in children, which includes meningitis, bacteremia, sepsis, and pneumonia.⁴⁶ The average age-specific incidence rates for IPD from 2000-2011 for

infants (less than one year) was 34.6 per 100,000 compared to 19.0 per 100,000 adults.⁷ The ICS found that in the North the results were similar to Canadian national data, where infants and those over 65 have higher rates, however the overall rates in the North were much higher than national rates.⁴³

In individuals under 5 and between the ages of 5-17 with high-risk conditions, (including prematurity, asthma, chronic heart disease, and chronic lung disease), an increased risk of pneumonia has been demonstrated.⁴⁷ For children between the ages of 5-17 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.⁴⁷ 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.⁴⁷



Polysaccharide Coating¹³

are created against the specific serotype or strain.⁴⁸ Both of the existing pneumococcal vaccines are inactivated, which means that they do not contain a live organism so they cannot cause the disease that they are preventing against.^{14,48}

How Do Pneumococcal Vaccines Protect Us?

Vaccines are used to “show” the immune system a bacteria or virus before the body encounters it naturally.^{13,14} This allows the body to develop antibodies, which protects and prevents us from getting sick.^{13,14} There are two ways of developing anti-bodies, the first being naturally when an individual gets sick and survives the infection.¹⁴ Vaccines are the other way to help create antibodies, which are protein molecules that help to kill and get rid of the bacteria.^{13,14}

S. pneumoniae has a coating called a ‘polysaccharide capsule’.⁴⁸ It is this capsule, or covering, that prevents it from being killed by immune cells.⁴⁸ *S. pneumoniae* has 92 serotypes (or strains).⁷ The invasive disease caused by 24 of these serotypes can be prevented by vaccinating against these specific types.⁷ The vaccines

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

After the implementation of immunization programs for children, “serotype replacement” may occur.⁵⁰ This is when there is an increase in cases caused by serotypes that are not covered in the vaccine.⁵⁰ 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 PCV7.⁵¹ There was an increase in a specific serotype 19A⁵¹, which is included in the PCV13 vaccine now.¹⁵ Since PCV13 has been introduced in children, there have been reductions in these serotypes in people over age 65.⁵²

Different Types of Pneumococcal Vaccines



Pneumococcal Polysaccharide

23-Valent Vaccine (PPV23):

Polysaccharide vaccines are made up of long chains of sugar molecules that make up the surface 'polysaccharide' capsule of certain bacteria.¹⁴ In Canada, this vaccine goes by the name of "Pneumovax23" and protects against 23 serotypes.¹⁵ Young children under age 2 do not respond very well to polysaccharide vaccinations.¹⁴ This is because their immune systems are not properly developed to adequately respond to them.¹⁴

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.¹⁴ 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.¹⁴ Thus, it is able to provide a 'booster' effect that the polysaccharide vaccines lack.¹⁴ This 'booster' effect occurs when a person is given repeated dosages which causes the antibody levels to go higher and higher.¹⁴

Conjugated vaccines are used routinely in Canada for the infant immunization programs. Currently Quebec is the only province that uses the pneumococcal 10-valent conjugate vaccine (PCV10), also known as "Synflorix".⁴⁹ PCV10 protects against 10 serotypes of pneumococcal disease.⁴⁹

All other provinces and territories administer the pneumococcal 13-valent conjugate vaccines (PCV13), also known as "Prenar-13", which protects against 13 serotypes of pneumococcal disease.¹⁵ This vaccine is funded for children and high-risk adult groups.

The History of the Pneumococcal Vaccine

Development of the first pneumococcal vaccine began with gold miners in South Africa by Sir Almorth Wright.⁵³

In 1886, gold was discovered in Johannesburg, South Africa, and large numbers of people were being brought in to work in the mines.⁵³ The rate of pneumonia was as high as 100 cases per 1000 persons per year, with a fatality rate of 25%.⁵³

Due to these numbers, pneumonia was seen as one of the greatest threats to the South African mining industry.⁵³

Sir Almorth Wright, and three colleagues, arrived in 1911 to begin trying to develop an effective pneumococcal vaccine.⁵³ Sir Almorth Wright worked to develop an effective vaccine that could help protect against pneumonia.⁵³ 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.⁵³

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 antibiotics⁵⁴
- This led to the development of polysaccharide vaccines⁵⁴
- However, polysaccharide vaccines were less effective in children, who were getting pneumococcal disease at very high rates⁵⁴

Development of conjugating vaccines in the 2000s

- The realization that polysaccharide vaccines could be linked, or 'conjugated', led the development of pneumococcal conjugate vaccines (PCVs) that are widely used now.⁵⁴
- The first ones became available in 2000 and were found to be more effective for children affected by this disease.⁵⁴

The Current State of the Pneumococcal Vaccine:

- PCV7 was one of the first conjugate vaccinations funded for children under the age of two between 2002-2006.⁷
- This vaccine was replaced by the PCV10 in 2009; then these were replaced by PCV13 in 2010.⁷ Quebec used PCV13 in 2011, but then switched back to PCV10 in 2018.⁴⁹

S.pneumoniae has 92 serotypes (or strains).⁷ The invasive disease caused by 24 of these serotypes can be prevented by vaccinating against these specific types.⁷

Although expanding the amounts of serotypes in the vaccines seems logical, there must also be comprehensive measures to improve current vaccination adherence.⁵⁶ Due to difficulties in adding serotypes

into the vaccines, there are current limits on how many serotypes can be included.⁵⁷ New vaccines with more coverage that are also affordable and that have longer-lasting immunity (particularly for older adults) are also needed.⁵⁶

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.⁵⁴ This needs to be further understood.

Who Should Get Vaccinated?

Current NACI Recommendations for Pneumococcal Vaccination in Older Canadians:

NACI recommends the routine administration of the PPV23 vaccination to all adults over age 65 and all residents of long-term care homes.¹⁵ This includes recommending the vaccine for all of those adults, even if they have no current risk factors.¹⁵ This recommendation is due to IPD being more common amongst older adults.¹⁵

For older adults who wish to seek additional protection, NACI says that PCV13 can be considered for those who are 65 and over and who have never received a pneumococcal vaccine.¹⁵ Please refer to the diagram on page 27 for additional information. These recommendations are the most current at the time of publication. The next version of the NACI statements will be released within the next few years with any additional changes or updates that have been made.

What is NACI?



The National Advisory Committee on Immunization (NACI) is a national committee consisting of many experts in the fields of pediatrics, infectious diseases, immunology, nursing, pharmacy, and public health among other specialties.⁵⁸ NACI makes recommendations around the use of vaccines to the Public Health Agency of Canada (PHAC).⁵⁸ The main populations that they recommend the use of the pneumococcal vaccine is for older adults, children, and individuals defined as high-risk – including those living with chronic conditions.¹⁵

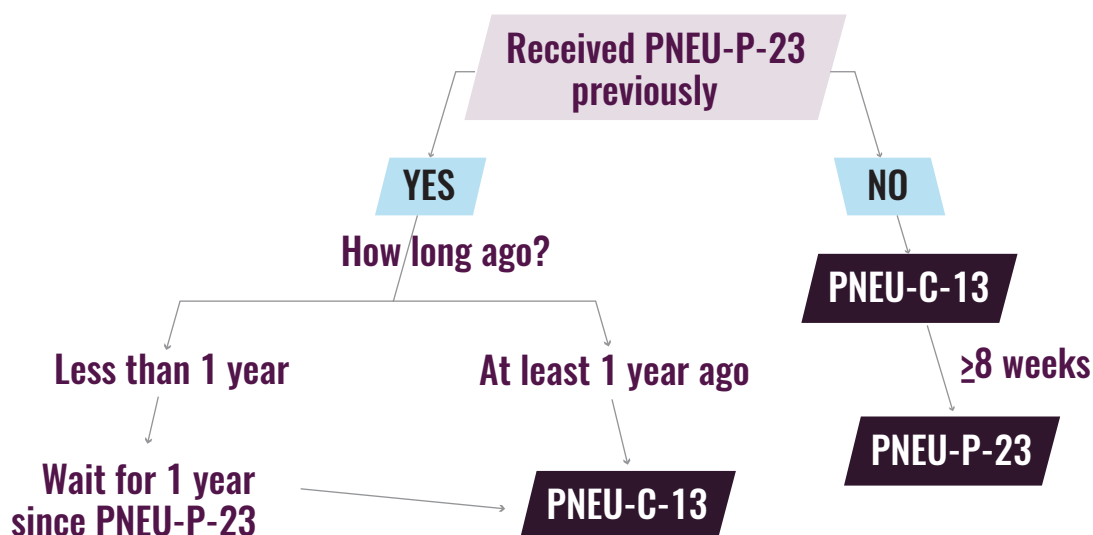
The chart below summarizes the current recommended and funded schedules for Canadians. The next updates to this NACI statement are expected to be published within the upcoming years.

Summary of Funded Recommended Schedules for Canadians¹⁵

AGE/CONDITION	Pneu-P-23	Pneu-C-13
Healthy Children (2 months - 5 years)		✓
Children at high risk of IPD (2 months - less than 18 years)	✓	✓
Adults 18-64 with chronic health conditions	✓	
Adults 18-64 in long-term care homes, or who are smokers, living with alcoholism, or homeless persons	✓	
All adults over age 65- with or without risk factors	✓	
Adults with a compromised immune system	✓	✓

¹⁵Please note: there may be exceptions to the above table, please refer to <https://www.canada.ca/en/public-health/services/immunization/national-advisory-committee-on-immunization-naci.html> for all up-to-date recommendations from NACI

Figure 5: Recommended two-step vaccination process for individuals who need or wish to protect themselves against the 13 serotypes in PNEU-C-13



Source: Public Health Agency of Canada. (2016). An Advisory Committee Statement (ACS) National Advisory Committee on Immunization (NACI) - Update on the use of 13-valent pneumococcal conjugate vaccine (PNEU-C-13) in addition to 23-valent pneumococcal polysaccharide vaccine (Pneu-P-23) in immunocompetent adults 65 years of age and older - Interim Recommendation. Retrieved from: <https://www.canada.ca/content/dam/phac-aspc/documents/services/publications/healthy-living/update-use-of-13-valent-pneumococcal-conjugate-vaccine-pneu-c-13-in-addition-to-23-valent-pneumococcal-polysaccharide-vaccine-pneu-p-23-immunocompetent-adults-65-years-and-older-interim-recommendation/update-pneu-c-13-and-pneu-p-23-mise-a-jour-2016-eng.pdf>

Current NACI Recommendations for Pneumococcal Vaccination in Younger Canadians:

Vaccinating Children Helps Everyone

The Public Health Agency of Canada calls for the routine immunization of all infants (2 months to less than 12 months of age) with PCV13, as well as additional doses and vaccination with PPV23 for children who are at high-risk of pneumococcal disease.¹⁵ In addition, any child under the age of 18 who is at high-risk of pneumococcal disease should receive PCV13 if they did not receive it as a child.¹⁵ IPD is more common amongst very young children.¹⁵ Increasing the number of children vaccinated protects individuals over 65 indirectly through the principle of herd immunity (i.e. vaccinating those around others who are at greater risk).

In 2010, a study in Manitoba found that switching to the PCV13 vaccine for infants versus the previous PCV7 version, significantly decreases the rates of disease among children.⁴⁴ Studies have found that the PCV7 vaccine was protective for children 3-59 months against disease caused by all of the seven serotypes covered in the vaccine, it was also effective against antibiotic-resistant strains and all IPD

because the most resistant serotypes were in the PCV7.⁵⁹ In children under the age of 5, the effectiveness of the conjugate vaccine has been found to be in the range of 86% to 97% against the IPD serotypes which are covered in the vaccine.¹⁵

Studies have further suggested that publicly funded immunization programs for PCV7, PCV10 and PCV13 have been associated with decreases in hospitalizations and the related costs of pneumococcal disease for younger children in Ontario.⁵⁵ Benefits were also extended to older children and older adults who did not receive the vaccine.⁵⁵ The achievement of significant decreases in hospitalizations for pneumonia after the introduction of PCV10 and PCV13, further suggest that the strains covered in these vaccines were likely responsible for a significant proportion of the remaining burden of pneumococcal disease after the introduction of the PCV7 vaccine.⁵⁵ Indeed, publicly-funded pneumococcal vaccinations with increasing serotype coverage has led to decreases in hospitalizations, and health care costs along with other costs in Ontario and elsewhere.⁵⁵ Furthermore, the benefits of vaccination have likely extended beyond those vaccinated which has implications for parents, grandparents, and caregivers.⁵⁵

Between 2010-2011, PCV13 became the conjugate vaccine used for the routine immunization of Canadian infants.⁷ One study looked at data three years after it was universally introduced and found approximately 15% of adult hospitalizations for community-acquired pneumonia were caused by PCV13 and PPV23 serotypes.²⁵ This suggests that hospitalizations for the PCV13 and PPV23 serotypes decreased in adults, even when children were the ones principally being vaccinated.²⁵ Herd immunity can occur through childhood vaccination programs, however, there will still be morbidity and mortality for adults because there are still different serotypes that can cause disease and illness.¹⁶ Vaccinating children will not completely eliminate the risk of pneumococcal disease for adults, as such there remains a strong need to vaccinate adults as well.¹⁶

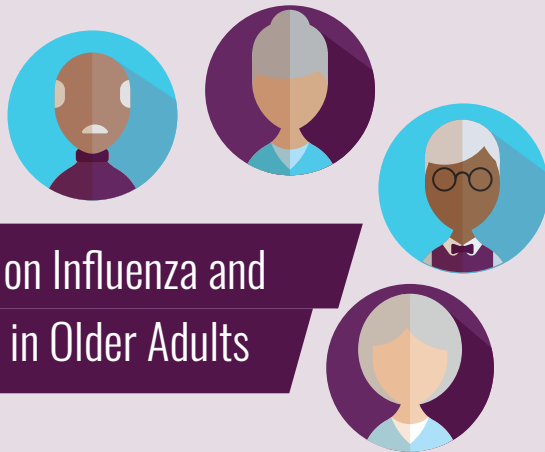
PCV7 and PCV13 serotypes have been declining among all age groups from 2010 to 2014.²⁶ However, PPV23 serotypes have increased when looking at all age groups between the 2010-2014 years.²⁶

Historically, there have been spikes in pneumococcal incidence during

the same one to two week period each year.⁶⁰ These patterns were the same whether there were differences in weather, and colder temperatures did not appear to drive higher rates.⁶⁰ The spike occurs during the weeks of December 24th to January 7th when families typically gather for the holidays, which tends to be a time when older adults are exposed to new serotypes that young children may have.⁶⁰ However, this spike in older adults has been eliminated in the United States following the introduction of PCV7.⁶¹

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.⁶² Vaccines may not elicit as strong of a response in certain populations and conditions, this is why PHAC has created specific recommendations for additional doses or higher doses for certain populations or conditions.⁶² Please see Recommendation 9 for the full recommended schedules for all populations.



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.^{63,64}

Due to the combined effects of pneumonia and influenza, it is recommended that individuals over age 65 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.⁶⁴ Furthermore, for individuals who were hospitalized for either pneumonia or influenza, shorter hospital stays were achieved if they were immunized against influenza and pneumonia.⁶⁴ One study from Japan also showed reductions in medical costs for those over age 75 who were vaccinated against influenza in the first year after receiving their

pneumococcal vaccinations.⁶⁵

In one study, the influenza vaccination was associated with a reduction in the risk of hospitalization with community-acquired pneumonia, and it reduced risk of death during the influenza season.⁶⁶ Although it did not have an effect on the occurrence of outpatient pneumonia or pneumococcal bacteremia.⁶⁶

The Ministry of Health and Long-Term Care (MOHLTC) in Ontario currently recommends that all long-term care residents, people visiting long-term care homes, and caregivers of these individuals, be vaccinated against influenza.⁶⁷ Studies have found that influenza vaccination for long-term care residents may reduce pneumonia among residents and death related to both pneumonia and influenza.^{68,69}

Vaccination Policies and Their Outcomes in Canada

Each province and territory controls what is covered for residents. All of the provinces and territories cover the polysaccharide (PPV23) vaccine for adults over 65. Similarly, all provinces and territories have coverage for the conjugate (PCV) vaccines for children, although the ages of eligibility for coverage vary. Similarly, all provinces and territories have some type of coverage for those living with chronic conditions, however, the recommendations and the conditions covered vary. The table below (page 33) shows that most Canadians receive their vaccinations through their primary care provider, however, in some provinces pharmacists are also licensed to administer pneumococcal vaccines. Below is a table (page 33) that describes the funding and availability of the various pneumococcal vaccines across Canada's provinces and territories.

In Ontario, it is currently recommended that all adults age 65 and over receive a free single dose of

PPV23. However, despite this longstanding recommendation, in 2016, only an estimated 42% of those over age 65 had received their pneumococcal vaccination², while in 2014 only 17% of those 18-64 living with a chronic condition had received theirs.⁷⁰

Similar to influenza target rates, PHAC set an 80% target vaccination coverage rate for the pneumococcal vaccine for age 65 and over by 2010⁷¹ and has now revised its target to 2025.¹ Although the vaccine is available for free to both populations, those over 65 have reported receiving the vaccine at a greater rate in comparison to the younger population with chronic conditions.⁷⁰ Research also concludes that Canadians do not know enough about vaccines. 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 actually up-to-date according to Canadian recommended standards.²

At the same time, PHAC has established a 95% vaccination target for children under the age of two for the pneumococcal vaccine.¹ In general, Canadian children are doing far better at getting vaccinated, with some data showing that 80% of children under the age of two had been vaccinated against pneumococcal disease in 2015.³ In 2015, 97% of the parents surveyed believe that childhood vaccinations are safe and effective.³ From 2011 to 2015, the amount of parents that were concerned about side effects of the pneumococcal vaccine also reportedly decreased from 74% to 66%.³

Pneumococcal Vaccination Policies by Province (2018-2019)

Pneumococcal vaccines are provided at public health clinics, physician's offices, travel clinics, or pharmacies in certain provinces.

Province/ Territory	Where can you get it?	Funding for PPV 23	Funding for PCV13
British Columbia	Health care providers in the community Pharmacy ⁷²	Adults over 65 Adults in care facilities Funded for high-risk conditions* ⁷³	Children 2-12 months Children 5-18 months without a spleen Adults and children 5+ with HIV or stem cell transplant ⁷⁴
Alberta	Health care providers in the community, public health units, and doctors. As of January 2019 pharmacists may be able to administer the vaccine. ⁷⁵	Adults over 65 Adults in care facilities Funded for high-risk conditions* ⁷⁶	Children 2 months + Individuals over age 2 at high-risk for IPD Offered to adults over age 65 (but they must pay) ⁷⁷
Saskatchewan	Public health clinics Physicians and nurse practitioners ⁷⁸ Pharmacists in certain situations ⁷⁹	Adults over 65 Residents of care facilities High-Risk conditions* ⁸⁰	Children 2 months-59 months Individuals over age 5 that are high-risk * ⁸¹
Manitoba	Physicians, public health nurses, pharmacists (only for PPV23), physician assistants, nurses and nurse practitioners can administer vaccines. ⁸²	Adults over 65 Residents of care facilities High-Risk Conditions* ⁸³	Children 2 months- less than 5 years Individuals 5 years and over with HIV or who have had a stem cell or organ transplant. ⁸³

Pneumococcal Vaccination Policies by Province (2018-2019)

Pneumococcal vaccines are provided at public health clinics, physician's offices, travel clinics, or pharmacies in certain provinces.

Province/ Territory	Where can you get it?	Funding for PPV 23	Funding for PCV13
Ontario	<p>Health care professionals or public health units⁸⁴</p> <p>Pharmacists are able to administer the vaccine, but there may be a fee for administering the vaccine⁸⁵</p>	<p>Adults over 65</p> <p>Residents of care facilities</p> <p>High-Risk Conditions ^{*86}</p>	<p>Children 6 weeks – 4 years</p> <p>High-Risk for adults over 50^{** 86}</p>
Quebec	<p>Have to contact the Centre Local de Services Communautaires (CLSCs – local community service centre) or doctor to determine more information as the procedure to get vaccinated varies depending on the region in Quebec.⁸⁷</p>	<p>Adults over 65</p> <p>Limited high-risk conditions^{***88}</p>	<p>Asplenia or weakened immune system⁸⁸</p> <p>Since 2011, Prevnar 13 has been the vaccine used for children – however in May 2018 Synflorix (PCV10) replaced Prevnar 13</p> <p>Quebec is the only province in Canada to use Synflorix in children.</p> <p>Prevnar 13 is still recommended for:</p> <p>People 5-17 at increased risk of serious pneumococcal infection due to a medical condition; and adults without a spleen and those with a weakened immune system ⁴⁹</p>

Pneumococcal Vaccination Policies by Province (2018-2019)

Pneumococcal vaccines are provided at public health clinics, physician's offices, travel clinics, or pharmacies in certain provinces.

Province/ Territory	Where can you get it?	Funding for PPV 23	Funding for PCV13
Nova Scotia	<p>Health care providers and public health offices⁸⁹</p> <p>Pharmacists can administer both pneumococcal vaccinations to at-risk adults⁹⁰</p>	<p>Adults over 65</p> <p>Residents of care facilities</p> <p>High-Risk Conditions^{*91}</p>	<p>Children 2 months and older⁸⁹</p> <p>High-Risk Groups^{**91}</p>
New Brunswick	<p>Primary care providers including family doctors, nurse practitioners and Public Health.⁹²</p>	<p>Adults over 65</p> <p>Residents of care facilities (including those newly admitted to long-term care homes)</p> <p>High-Risk Conditions^{*93}</p>	<p>Children under 5</p> <p>Children and adults with HIV or immunosuppressive conditions and hematopoietic stem cell transplant⁹³</p>
Prince Edward Island	<p>Physicians and nurse practitioners are able to provide PPV23 in their offices or adults can make appointments at the local Health PEI Public Health nursing office.</p> <p>Residents in long-term care facilities are immunized by the staff in the home.⁹⁴</p>	<p>Adults over 65</p> <p>Residents of care facilities</p> <p>High-Risk Conditions^{*94}</p>	<p>Children 2 months and up⁹⁵</p> <p>Certain high-risk conditions^{**}</p> <p>PCV3 is recommended for all adults over age 65 but is not funded for this population.⁹⁴</p>

Pneumococcal Vaccination Policies by Province (2018-2019)

Pneumococcal vaccines are provided at public health clinics, physician's offices, travel clinics, or pharmacies in certain provinces.

Province/ Territory	Where can you get it?	Funding for PPV 23	Funding for PCV13
Newfoundland and Labrador	Available through local Health and Community Service offices in Newfoundland and Labrador. ⁹⁶	Adults over 65 Residents of care facilities Indigenous Populations High-risk conditions* ⁹⁶	Children 2 months – less than 5 years ⁹⁷ Funded for those with cochlear implants, asplenia, sickle-cell disease, and immunosuppression ⁹⁷
Yukon	Community health centres offer immunizations. ⁹⁸	Adults over 65 Residents of care facilities High-risk conditions* ⁹⁹	Children 2 months – less than 5 years ⁹⁹ High-risk conditions** ⁹⁹
Nunavut	Health care providers and local health care centres ¹⁰⁰	Children over 2 years who have not had this vaccine prior (but who have received the complete pneumococcal conjugate 13 series) Adults over 50 High-risk conditions* ¹⁰⁰	Children 2 months to less than 5 years. ¹⁰⁰
Northwest Territories	Local health centres or public health clinics ¹⁰¹	Adults 65 and over High-risk conditions (not specified) ¹⁰¹	Children 2 months to less than 5 years For those over age 5 with certain health conditions (not specified). ¹⁰¹

* High-risk conditions include: asplenia; sickle-cell disease; weakened immune system (due to disease and/or treatment – including HIV); chronic liver disease; chronic kidney disease; chronic heart disease; chronic lung disease; cell, organ, or stem cell transplant; cochlear implant; diabetes; cystic fibrosis; malignant neoplasms; chronic cerebrospinal fluid leak; chronic neurological conditions that may impair clearing of oral secretions; hemoglobinopathies(MB); alcoholism/alcohol dependency; homelessness; and users of illicit drugs.

** Asplenia, congenital immunodeficiencies, HIV, hematopoietic stem cell transplant, immunocompromising therapy, malignant neoplasms, sickle cell disease, and solid organ or cell transplant.

*** Heart disease; lung disease (e.g. emphysema, chronic bronchitis); asthma requiring regular medical follow-up for people aged 50 and older; kidney disease; diabetes; poor spleen function or no spleen; liver disease (e.g. hepatitis, cirrhosis, alcoholism); immune system deficiency (e.g. cancer, HIV infection).

Pneumococcal Vaccination Around the World

The majority of European countries have developed schedules similar to the existing Canadian schedule.¹⁰² Most recommend that the conjugate vaccine be used for children – while the specifics of funding, the number of doses, and age at which it should be administered differs.¹⁰² The recommendations for adults, however, are not as uniform. Countries such as Finland, Italy, Luxembourg, Austria, Denmark, and Belgium recommend a combination of conjugate and polysaccharide vaccines for adults over age 65.¹⁰² Sweden, Spain, Slovenia, Ireland, Germany, and Cyprus recommend PCV for children and PPV23 for adults.¹⁰² Iceland and Finland specifically recommends PCV10 for children.¹⁰² Hungary and Norway specifically recommend PCV13 for children and PPV23 for adults.¹⁰² The Netherlands and France

recommend PCV for children, however do not recommend any routine pneumococcal vaccination for adults.¹⁰²

In the United States, the Centers for Disease Control and Prevention (CDC), recommends a PCV13 vaccination for those younger than 2 years of age and recommends both the PCV13 and PPV23 for those over age 65.¹⁰³ However, the recommendation about the routine use of PCV13 in adults was to be reevaluated and revised as needed.¹⁰⁴ For those with high-risk conditions^a it is generally recommended that they receive both vaccines with appropriate timing between vaccinations.¹⁰⁵

The World Health Organization (WHO) recommends that PCVs be included in childhood immunization programmes globally.¹⁰⁶ The WHO

^a High-risk conditions: chronic heart disease, chronic lung disease, chronic liver disease, diabetes, cerebrospinal fluid leaks, cochlear implants, sickle cell disease or other hemoglobinopathies, asplenia, HIV, chronic kidney failure, immunosuppression, alcoholism, cigarette smoking, cancer, and transplants

considers PCVs to be safe for those in target groups, including immunocompromised individuals.¹⁰⁶ The WHO considers PCV10 and PCV13 to be comparable in safety and suggest that the choice of which vaccine depends on additional factors including the vaccine serotypes typical in the location, the supply of vaccines in the region, and cost considerations.¹⁰⁶ Additionally, in high-or middle-income countries the WHO recommends PPV23 to high-risk populations including those over age 65 and also as a supplement to the PCV13 vaccine for some populations.¹⁰⁶

Improving Vaccination Rates

Pneumonia is a serious, potentially fatal disease and is in many cases preventable with vaccination. Despite this, vaccination rates for both children and older Canadians in particular remain below national targets. Factors that influence the low rate of vaccinations include a lack of awareness about which vaccines are needed, when they are needed, and the role of health care providers in recommending vaccines.

Education

Although Canadians are generally receptive to receiving vaccines, there is still a significant lack of awareness about which vaccines they need and how they work. In one study, just under 60% of respondents agreed or strongly agreed with the statement, 'it is important for adults to receive all recommended vaccinations'.¹⁰⁷ Studies show that the public and health care providers generally accept the concept of vaccination and understand that prevention is a better option than treatment.¹⁰⁷

The public also understands that vaccinations are helpful and consider the side effects less severe than the condition the vaccine is preventing - in this case, pneumonia and related respiratory diseases. However, only 21.7% strongly agreed or agreed that they knew what vaccines they should have received according to public health recommendations.¹⁰⁷

One study found participants had higher coverage rates than the Canadian national survey found, however, 20% of individuals surveyed who were eligible to receive the vaccination for free said that they had never heard of the pneumococcal vaccine.¹⁰⁸ 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.¹⁰⁷ The PneuVUE study found that only 44% of Europeans thought pneumonia was contagious, and less than 30% were aware of the vaccine.¹⁰⁹ Only 13% of people

considered themselves 'very much at risk' of developing pneumonia, while approximately 70% of the people had at least one risk factor for developing pneumonia.¹⁰⁹

Approximately 59% of older adults considered themselves to be only slightly at risk, followed by 21% who thought they were at no risk.¹⁰⁹

People over 65 tend to achieve higher vaccination rates.⁷⁰

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".¹⁰⁸ Similar small studies have found that adults with comorbidities were more likely to report receiving a pneumococcal vaccination.¹¹⁰ 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.¹⁰⁸ Generally, the older population should be

educated consistently emphasizing the importance of vaccination as a way to maintain overall good health.¹⁰⁸

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.¹⁰⁹ Only 55% of respondents over 65 years old were offered the vaccine by their doctor, despite all qualifying for it.¹⁰⁹ Providing education for clinicians and reminders for clinicians was associated with achieving a greater pneumococcal vaccination rate.^{108,111}

If a health care professional recommends a pneumonia vaccination it significantly increases the probability of immunization. However, 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.¹⁰⁷ In the same study, 59.7% of those respondents reported that if a health care provider recommended it they would have received the vaccination.¹⁰⁷ Another study with veterans in the United States identified barriers for patients including not having the vaccine offered to them or being given incorrect information that they could not receive the pneumococcal and zoster vaccination at the same time.¹¹²

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.¹¹¹ Additionally, having vaccines available free of charge, increases uptake and reduces both social and health inequities.¹¹³

What Are Our Governments Doing to Improve Vaccination Rates?

The current National Immunization Strategy in Canada aims to reduce the incidence of vaccine preventable diseases and to increase the number of Canadians receiving their vaccinations.¹¹⁴ One of its objectives was to create goals and vaccination rate targets, including an 80% vaccination coverage rate for pneumococcal vaccination among adults over age 65.¹

Canada is working to find better ways to conduct national vaccination coverage surveys and try to better understand the determinants of vaccination acceptance and uptake, including asking questions about knowledge, attitudes, and behaviours of people.¹¹⁴ The Canadian Institutes of Health Research (CIHR) have funded studies to better understand why people are not vaccinated and where people who are receiving vaccines are getting vaccinated.¹¹⁴

The Canadian Immunization Research Network (CIRN) further supports research projects on vaccination issues and out of the \$10 million of funding allocated for 2017-2021, \$2 million will be used for research around vaccination acceptance.¹¹⁴ CANImmunize is 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.¹¹⁴

Not Enough Data Exists to Fully Understand Pneumococcal Disease in Canada

More Data is 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.⁴ Additional or more specific tests may be ordered in certain cases, such as in older adults or those with chronic conditions.⁴

Diagnostic testing for patients presenting with CAP has been debated amongst experts in this field including respirologists and infectious disease specialists.¹¹⁵ 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.¹¹⁵ 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.¹¹⁵ 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 obtaining a specimen.¹¹⁵

It is also noted that correctly diagnosing CAP can be difficult.¹² In practice, CAP is generally diagnosed based on clinical symptoms and a physical exam.¹² There are some difficulties with the tests that currently exist including low sensitivity and a delay in receiving lab results.¹² 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.¹² There is a need to develop new tests that are more specific and better able to diagnose CAP.¹²

Urinary tests are sometimes used for diagnosis of pneumococcal pneumonia because they are easy to use and non-invasive.^{116,117} However, they lack specificity in children and may give false positive results for children.^{116,117} Pfizer has developed a non-commercial serotype-specific urinary antigen detection (SSUAD) assay that is more sensitive and was developed to determine vaccine efficacy.¹¹⁸ This test is not commercially available yet and is only able to identify the serotypes covered in the PCV13 vaccine.^{117,119} However, if this test was used in combination with the current urinary tests, it would be able to identify the specific serotype causing CAP.^{117,119}

Non-invasive accurate diagnostic tests would also allow treatment to be targeted more appropriately and ensure that the treatment used is necessary.¹¹⁶ 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.^{116, 117} 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 which 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.²⁵ There are, however, several existing and emerging surveillance systems and networks that are aiming to address this gap (see box on page 46). 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 Snapshot of Pneumonia Surveillance Systems in Canada



Since 2000, invasive pneumococcal disease (IPD) has been identified as a nationally notifiable condition through the Canadian Notifiable Disease Surveillance System (CNDSS).⁷ IPD is considered a priority for monitoring as it can lead to many serious outcomes.¹²⁰ Once a disease is notifiable, the provinces and territories must submit disease data to estimate disease rates.¹²⁰ This system collects epidemiological trends and reports on the rates and cases of IPD, it also collects basic demographic information including age and sex.¹²¹

Additionally, limited data on IPD is collected through the National Microbiology Laboratory (NML) Streptococcus Surveillance, which began in 2010.⁷ This laboratory data includes serotype data¹²¹, but it is not nationally representative and is limited by reporting differences between jurisdictions.⁷ 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.¹²¹

Two specialized pneumonia surveillance programs exist for specific populations, the Immunization Monitoring Program, ACTive (IMPACT) and International Circumpolar Surveillance (ICS). IMPACT is surveillance for children and ICS is surveillance for the three territories, Labrador and northern Quebec.¹²¹ Both of these link epidemiologic and laboratory data (i.e. demographic information and serotypes).¹²¹ These are good data collection systems, but because they are collecting results specific to children and northern populations their results cannot be generalized.¹²¹

There is a need for a more enhanced 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.^{121,122} The Enhanced National Invasive Pneumococcal Disease Surveillance System (eIPDSS) pilot was launched in 2011.¹²¹ It is being piloted in New Brunswick to



determine the feasibility of conducting timely data collection and linking epidemiologic and laboratory data.¹²¹ If this system were expanded it would create better understanding of IPD trends across Canada, specifically looking at serotype distribution.¹²¹ This would allow better estimates of the rates of IPD across the country and identify variations across the country.

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.¹²³ SOS provides real-time surveillance data for both influenza and CAP.¹²³ Currently the network has participating hospitals from British Columbia, Ontario, Quebec, New Brunswick, and Nova Scotia that provide data.¹²³

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.²⁵ 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.

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.

To estimate vaccination rates for common vaccines in Canada, the Public Health Agency of Canada (PHAC) collects survey data approximately every two years though the adult National Immunization Coverage Survey (aNICS).⁷⁰ However, there are significant limitations to this data, including both the survey's low response rate and the fact that the data is all self-reported.⁷⁰

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.¹²⁴

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 of Prevention For Lung Disease More Generally¹²⁵

- Wash your hands
- Cover your coughs
- Avoid those individuals around you who may be sick
- Stop smoking
- Avoid second hand or third hand smoke
- Keep the air in the home clean (or example, try to reduce mould, pet dander, or air fresheners)
- Wear a mask against harmful exposures



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 vaccination rates.^{107,109}

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 and does not allow the doctor 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.¹² In Canada, national surveillance data of IPD is available, but there is little available data on the actual burden of CAP.²⁵ 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.²⁵ 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.²⁵

4. Improve Reporting and Surveillance of Pneumococcal Vaccination

Currently, Canadians estimate vaccination rates based on a self-reported survey, the aNICS, which has a low response rate and therefore cannot be largely generalized to the population.⁷⁰ Better data on who has received a vaccination is needed in order to determine how far Canada actually 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.

The administration of vaccinations could also be monitored through provincial billing data. The federal government can help by setting a national standard which will keep the data collection consistent across the country.

5. Continue Working towards 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.⁵⁶ Implementation is difficult as there are two different vaccines available that need to be administered using a specific schedule.⁵⁶

New vaccines developed will need to be affordable and will need to cover against more or better strains.⁵⁶ Additionally, there is a need to focus on longer-lasting immunity effects for more strains, which will particularly benefit our ageing population.⁵⁶ The World Health Organization (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.¹²⁶

Ideally, universal pneumococcal vaccines would be useful for older populations.¹²⁷ 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.^{127,128}

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

As can be seen from the table presented above (pages 33-37), there are many differences among the provinces and territories on who can administer the vaccination, which vaccinations are recommended, and which populations are funded to receive the vaccine. This can lead to confusion for the general population about whether they should be vaccinated, which will be funded for them, and where they can get it. Pharmacists should be able to administer 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, all provinces and territories provide the polysaccharide vaccine for adults over 65 and most provide some coverage for adults in care institutions. All provinces and territories provide funding for the conjugate vaccine for children, but the ages for which the vaccine are funded differ across the provinces and territories. Also, the funding for high-risk conditions varies across the provinces. Therefore, there is a need to harmonize the funding and coverage policies for those with high-risk conditions and children so that there is a common message being given to all Canadians and their care providers regarding pneumococcal vaccination.

8. Recommend the Administration of Pneumococcal Vaccine in Conjunction with the Influenza 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.⁶³ Studies have found reductions in death and lesser hospital stays and costs when older adults are vaccinated against both diseases.^{64,65}

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.

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 over 65, 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. Consider Mandating Pneumococcal Vaccination for Residents of Long-Term Care Homes

The estimated incidence of pneumonia is higher for people living in long-term care settings.⁹ It has been estimated that people over 65 in long-term care homes have an annual incidence of pneumonia up to 7% higher than those over 65 in the community (3.3-11.4% in long term care versus 2.5-4.4%).⁹

PHAC currently recommends that residents of long-term care homes should consider the influenza, pneumococcal and herpes zoster (shingles) vaccination.¹²⁹ The NIA has

previously recommended that mandatory influenza vaccination should be considered for those living in long-term care homes. Studies have shown that influenza vaccination can reduce pneumonia among residents in long-term care facilities and death due to pneumonia and influenza.^{68,69} The NIA therefore recommends making pneumococcal vaccination mandatory for all long-term care residents.

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