evohealth

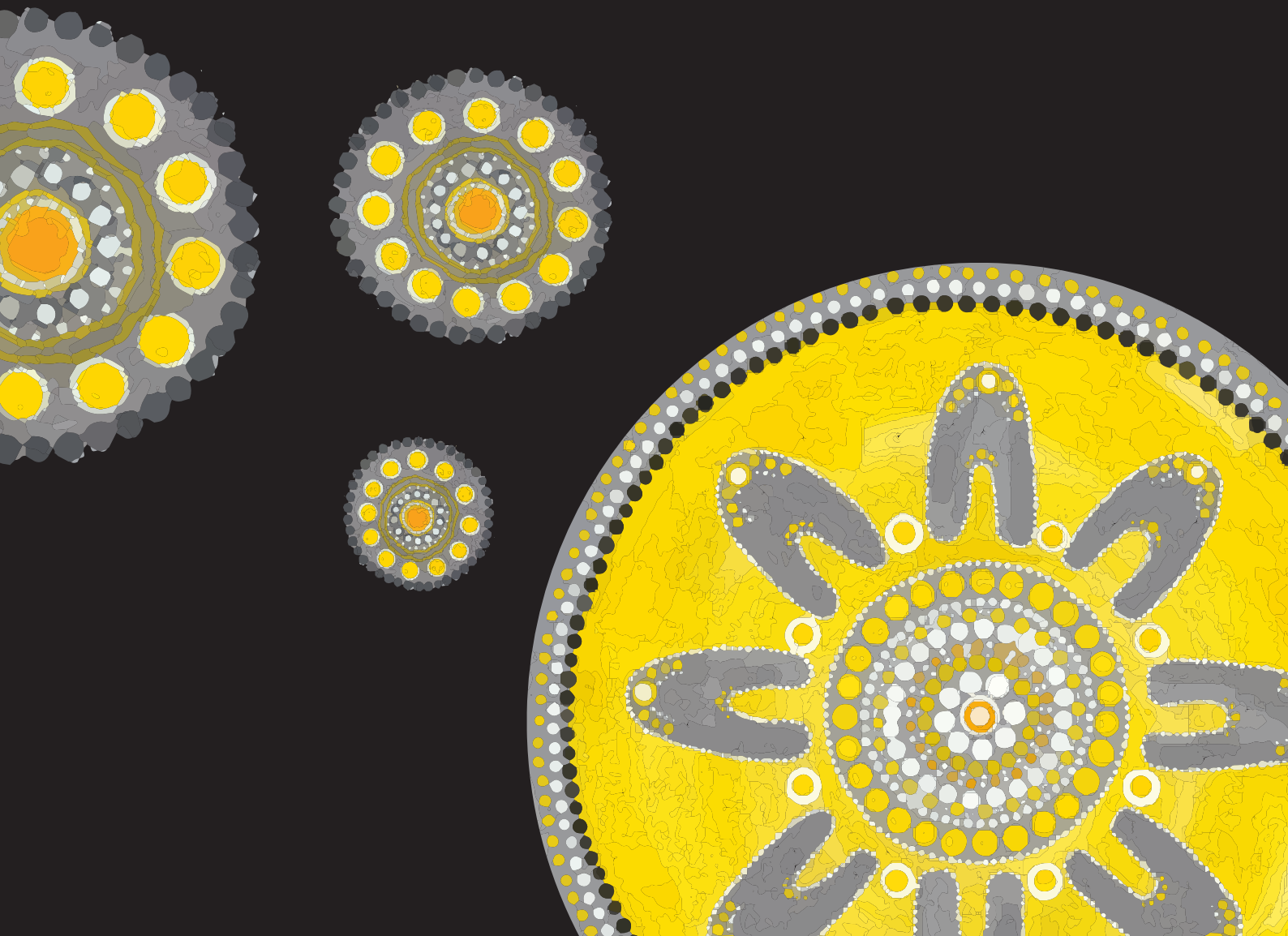
February 2024

Prioritising prevention

Addressing the burden of pneumococcal disease in Australia

Evohealth acknowledges that we work on the traditional lands of many Aboriginal clans, tribes, and nations.

We commit to working in collaboration with Aboriginal and Torres Strait Islander communities and peoples to improve health, emotional and social well-being outcomes in the spirit of partnership.



About Evohealth

The delivery of healthcare is complex.
Our focus is not.

Better health for all Australians.

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About this report

Background

Prioritising prevention: Addressing the burden of pneumococcal disease in Australia is an evidence-based report analysing the burden of pneumococcal disease (PD) (non-invasive and invasive) in the Australian population. Specifically, it considers the burden among children, elderly, Aboriginal and Torres Strait Islander people and patients with pre-existing co-morbidities, as well as impacts on the healthcare system and economy. This report makes recommendations to address this burden and was independently authored by Evohealth, in partnership with an independent Advisory Committee comprising of leaders in clinical management and research of PD.

Approach

This report has been informed by:

- A comprehensive review of published academic and grey Australian and global literature;
- Interviews with Australian clinicians, researchers, public health experts and patient advocacy groups;
- An epidemiological analysis of the burden of invasive PD in children, older Australians, Aboriginal and Torres Strait Islander people and people with co-morbidities (see Appendix A for methodology); and
- The contributions of our expert Project Advisory Committee members.

This project received funding from MSD Australia. However, MSD representatives did not participate in the development of the report to ensure the independence of Evohealth and the Advisory Committee.

Acknowledgements

Evohealth wishes to acknowledge the ongoing support from the individuals and organisations who contributed to this project.

We would like to acknowledge the Advisory Committee who provided critical oversight and input to the development of this report. The Advisory Committee comprised the following members:

Mr Mark Brooke

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We also extend our sincere thanks to our patient representative Carly Goya, for sharing her family's experience with pneumococcal disease.

National Notifiable Diseases Surveillance System data on invasive pneumococcal disease were provided by the Office of Health Protection, Department of Health and Aged Care, on behalf of the Communicable Diseases Network Australia.

Executive Summary

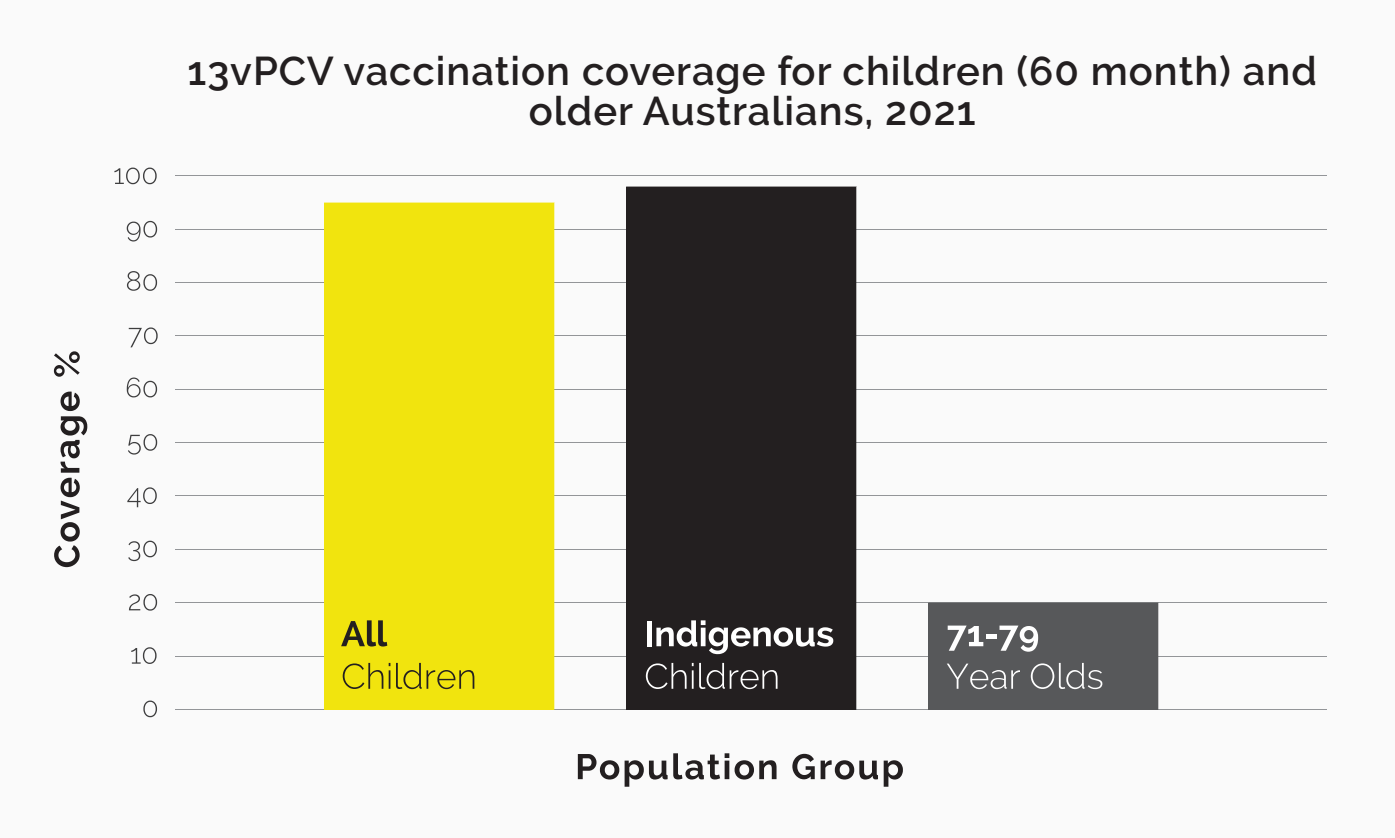
Despite the longstanding availability of vaccines, pneumococcal disease (PD) continues to place significant burden on the Australian community and healthcare system. It is a leading cause of serious illness in the young, elderly, and Aboriginal and Torres Strait Islander populations and individuals with co-morbidities. [1] PD is seldom part of public conversation, with greater attention paid to other infectious diseases such as influenza or more recently, coronavirus disease (COVID-19). Much can, and should, be done to raise awareness of PD in our community. The impact of this disease in Australia, especially amongst high-risk populations, needs to be urgently addressed to prevent disabilities, avoid unnecessary hospitalisations, and save lives.

PD is an infectious disease caused by the bacterium Streptococcus pneumoniae (*S. pneumoniae)*. PD can progress to a range of infections throughout the body. These infections can remain non-invasive, staying in a localised area such as the middle ear or sinuses, or become invasive if *S. pneumoniae* infects normally sterile sites of the body. Invasive pneumococcal disease (IPD) can cause severe disease such as meningitis, with accompanying high rates of mortality. [2]

Overall, PD causes the second highest burden of all vaccine preventable disease in Australia. [3]

Some of our most vulnerable populations are at greatest risk of IPD and its potentially severe outcomes, with the highest incidence occurring amongst children under five, adults 65 years and older, and the Aboriginal and Torres Strait Islander population. As a means of prevention, Australia provides free access to a range of vaccines through the National Immunisation Program (NIP). Currently, there are two PD vaccines available on the NIP, Prevenar 13 (13vPCV) and Pneumovax 23 (23vPPV). These vaccines are available to key groups; infants and children, adults 70 years and older, Aboriginal and Torres Strait Islander adults 50 years and older, and Australians with certain risk conditions. [4] Children in Australia have good PD vaccine coverage rates with around 95 per cent fully vaccinated. However, only 20 per cent of those aged 71-79 years old are vaccinated. Clearly more work must be done to ensure our adult population are also meeting vaccination targets. (Figure 1). [5]

Figure 1: *13vPCV vaccination coverage for children (60 months) and older Australians, 2021 [5]*



*Source: NCRIS**

** Published AIR adult vaccination coverage data are only available for 70 year and 71-79 year age cohorts*

Approximately 100 serotypes of *S. pneumoniae* have been identified, which vary by polysaccharide capsule. [6] Amongst others, serotype 3 is known to be particularly problematic. [6, 7]

Australia collects data on IPD through the National Notifiable Diseases Surveillance System (NNDSS). This surveillance is critical to ensure that the performance of current and future vaccines is monitored so that we can target the IPD serotypes that cause the most severe outcomes in Australia.

With many Australians still bearing the burden of non-invasive PD and IPD, we need a system wide, holistic approach to reduce and address the impact of this disease.

In 2022, 44 per cent of IPD cases were attributed to serotypes that are included in vaccines available in Australia. [7]

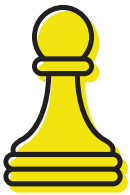
All five of the most prevalent serotypes causing infection between 2009 and 2022 are covered in the vaccines funded under the NIP in Australia. [7]

Pneumococcal disease is one of the highest vaccine preventable diseases. It is a significant cause of morbidity. We need better vaccines, better coverage, better data.

- Professor Paul Van Buynder

Recommendations

To address the impact of this disease we must quantify the burden and invest in targeted preventative strategies. With the support of our Advisory Committee, we have identified six targeted and tangible recommendations for change. To ensure we prevent PD and reduce its burden in Australia, we need to:



RECOMMENDATION 1

Develop a national PD strategy to reduce the burden of disease, including invasive and non-invasive disease.

RECOMMENDATION 2

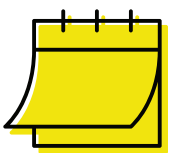
Enhance surveillance and testing practices for PD to ensure better data are available to quantify the true burden of disease.

RECOMMENDATION 3

Provide funded PD vaccines through the NIP for all people identified with at-risk conditions.

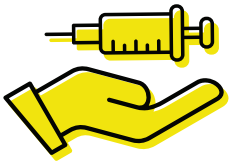
RECOMMENDATION 4

Through a targeted PD awareness campaign, provide information to empower and enable patients and healthcare professionals to make informed decisions about PD prevention.



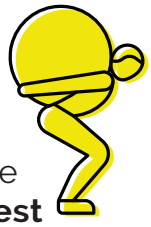
RECOMMENDATION 5

Incorporate NIP vaccination schedule into prescribing and practice software.

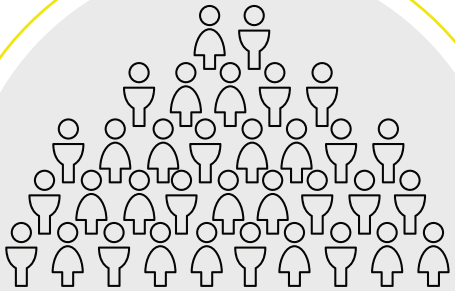


RECOMMENDATION 6

Implement opportunistic vaccination programs and wrap around services to enhance vaccination delivery.



PD causes the **second highest burden** of all vaccine preventable disease in Australia. [3]



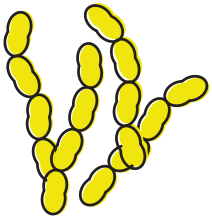
Globally, approximately **one million children** die of PD every year. [8]

PD causes more than **one-third** of all community acquired pneumonia and **up to half** of hospitalised pneumonia in adults. [4]

5.8 X
more likely

Aboriginal and **Torres Strait Islander** people report **5.8 times** more cases of IPD than non-Indigenous people in Australia [3]

Almost all adults who contract IPD have at least **one risk factor or co-morbidity**. [9]



Serotypes 3, 19A and **22F** were the top three serotypes associated with IPD in Australia between 2009 and 2022. [7]

up to $200

The **cost** to privately access the current vaccines can be between **$125 to $200** for people who are not eligible for the funded PD vaccines. [10-12]

41%

In 2022, **41 per cent of IPD cases** were due to **serotypes covered by vaccines** currently available in Australia. [7]

95%

95 per cent of children were fully vaccinated against PD in 2021 [5]

Between 1997 and 2006, **622 Australians** have died from pneumonia, meningitis, or sepsis caused by *S. pneumoniae*. [13]

20.1%

20.1 per cent of people aged between 71-79 years were vaccinated against PD in 2021 [5]

IPD caused by serotype 3 has an approximate **30 per cent mortality rate**, this increases to 47 per cent if a person has **multiple co-morbidities**. [6]

Understanding pneumococcal disease

Of all the vaccine preventable diseases, PD (non-invasive PD and IPD) causes the second largest burden of vaccine preventable disease in Australia, accounting for 24 per cent in 2015. [3]

PD can lead to severe disease and even death, and this is primarily borne by younger, older, and Aboriginal and Torres Strait Islander populations in Australia as well as those with co-morbidities. Yet PD is often overshadowed by other infectious diseases such as influenza and COVID-19.

PD is an infectious disease caused by the bacterium *S. pneumoniae* - a gram-positive facultative anaerobic organism. [2, 14] Many people, particularly children, can be carriers of *S. pneumoniae* and will show no signs or symptoms of disease. [2] When infection does occur, often the symptoms are mild. In some patients, the disease can progress to more severe infection requiring hospitalisation or may even be fatal.

PD is spread through infected droplets of saliva or mucus, direct contact with secretions, or when bacteria survive and are transmitted on objects. [15] Pneumococcal infections can occur at any time of the year but are most common during winter and spring. [1]

S. pneumoniae bacteria can multiply and overwhelm a person's immune system and cause significant infection with a wide range of symptoms and clinical manifestations. [16] PD infections present as either non-invasive PD or IPD (Table 1) and range from localised to life threatening infections.

- **non-invasive PD** is the most common form of PD. It causes localised infections such as otitis media and pneumonia without bacteraemia (pneumonia that has not spread into the blood stream). [16] The clinical manifestations of non-invasive PD are less likely to cause serious outcomes compared to IPD. [16]

- **IPD** is less common but substantially more serious and in some cases life threatening. Serious IPD infections occur when *S. pneumoniae* move beyond the nasopharynx and spread throughout the body. That is, IPD caused by the infection of a normally sterile site such as the blood stream or cerebrospinal fluid (CSF). [9] Clinical manifestations of IPD can include pneumonia, meningitis, bacteraemia and sepsis. [2]

Non-invasive pneumococcal disease (non-IPD)

Middle ear infection (Otitis media)

Inflammation of the middle ear, most common in young children [17]

Inflammation of lungs (Pneumonia without bacteraemia)

Infection within the lungs that has not spread into the blood stream [16]

Invasive pneumococcal disease (IPD)

Bacteraemic pneumonia

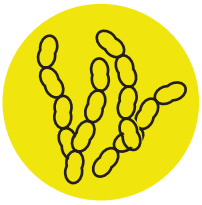
Pneumonia that has spread to the pleural fluid. It may be accompanied by local or systemic complications such as empyema [18]

Infection of the lining of the brain and spinal cord (Meningitis)

Infection of the membranes surrounding the brain and spinal cord [19]

Blood infection (Bacteraemia)

Bacteria or infection present in the bloodstream, can progress to septicaemia or sepsis [20]



Sepsis

As a response to infection, the body damages its own tissues and organs [21]

Table 1: *Clinical manifestations of PD*
Source: Evohealth

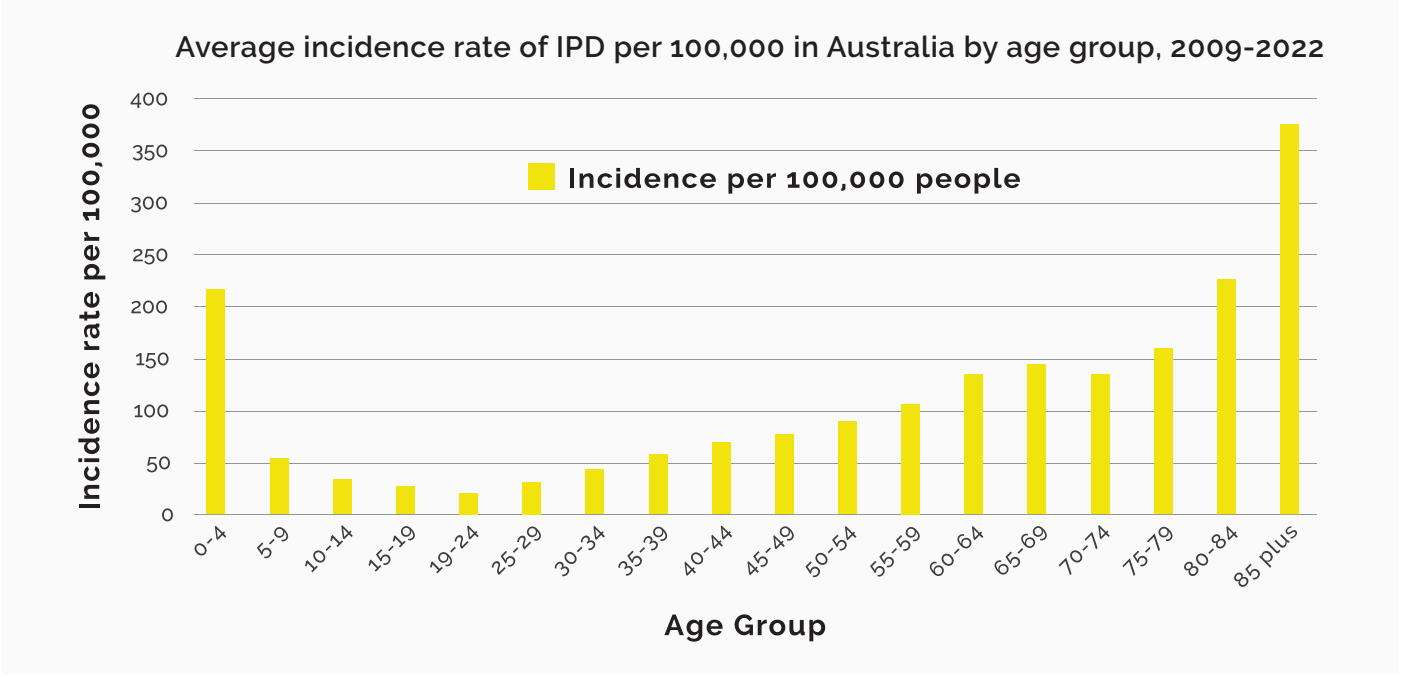
Our most vulnerable need protection

Australian surveillance data reveal that the greatest burden of PD is borne by our most vulnerable populations, namely children less than 5 years of age, elderly Australians over 70 years, Aboriginal and Torres Strait Islander populations and people with co-morbidities (Figure 2), [1, 7]

Figure 2: *Patient groups with greatest burden of PD* *Source: Evohealth*

Despite funded pneumococcal vaccines being available in Australia for almost twenty years, there were 1,859 confirmed cases of IPD in 2022. [4, 7] Our youngest and oldest citizens shoulder most of the burden, as can be seen in our analysis of IPD incidence rates across the total Australian population (Figure 3). This is discussed in detail below.

Figure 3: *Average incidence rate of IPD per 100,000 in Australia by age group, 2009-2022 [7]*



Source: NNDSS & ABS data

While these high-risk groups all have access to vaccines, we are falling short.

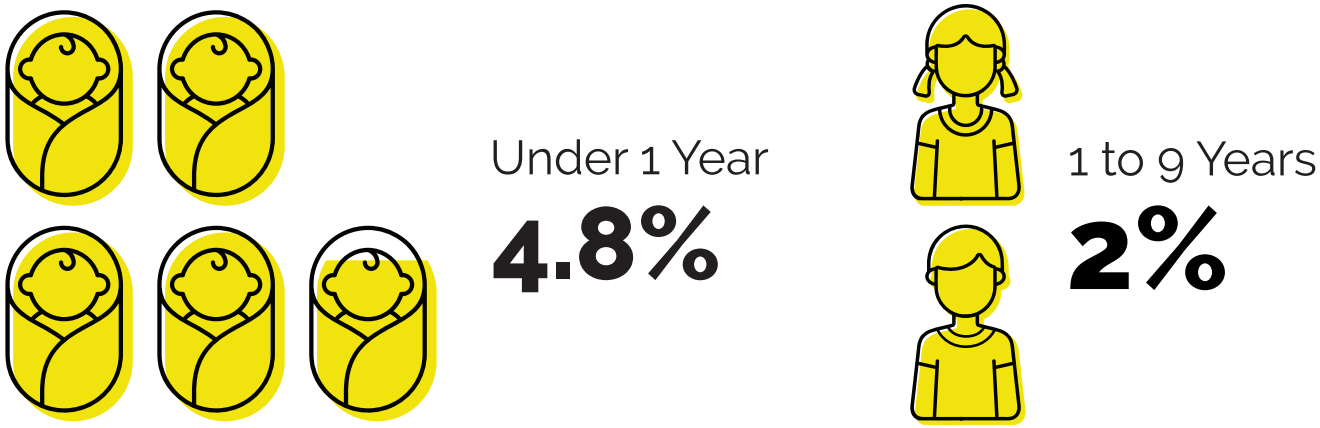
1. Infants and children

Our youngest population, particularly those under 5 years old, have an increased risk of non-invasive and invasive PD. The most common clinical presentation of non-invasive PD in children is acute otitis media with 28-55 per cent of cases caused by *S. pneumoniae*. [4] If left untreated, otitis media can cause permanent hearing loss as well as behavioural and learning difficulties which can impede cognitive development. These cognitive delays can impact education performance and impact children and their families and carers for life. [4]

Historically, the most common manifestation of IPD in children was bacteraemia. However, recent research and targeted molecular surveillance reveals that since 2011 there has been an increase in pneumonia, complicated pneumonia, and empyema, including greater prevalence of serotype 3 IPD [22] This change can partly be attributed to changes in diagnostic practices, which includes an increase in diagnosis using pleural fluids. More research is required to understand the burden of disease resulting from serotype 3 PD, which remains high despite access to vaccines. [6]

The younger a child, the higher the risk of death from IPD. For children under 1 year, there was a 4.8 per cent case fatality rate in 2015 compared with 2 per cent for children aged 1 to 9 years old in the same period (Figure 4). [3]

Figure 4: *Child IPD mortality rates in 2015 [3]*



Source: Australian Institute of Health and Welfare 2019

Risk factors such as immunosuppression, sickle cell disease, asplenia or breach in the CSF barrier, increase the likelihood of the disease becoming invasive. In one in five cases of IPD in children, the child has at least one of these risk factors present. [23] Despite high vaccine coverage rates amongst this group, cases of IPD and non-invasive PD are still occurring and increasing in fully vaccinated children, signalling that we need to do more. [24]

Patient story – Baby Mabel

Mabel was just six and a half months old when she passed away in the arms of her parents. She was a happy, joyful infant and was fully vaccinated and healthy. She died from PD that progressed to meningitis.

Carly Goya, Mabel's mum, was unaware of PD and did not understand the potential severity of disease, or how PD can progress into more severe, invasive disease such as meningitis.

Carly explained that she doesn't understand that "if you can receive consumer information for COVID-19 why is it not the same for other vaccines and infectious diseases". She stressed that awareness is key so that other families do not have to bear the loss of their beautiful babies and children.

1 in 5 children with reported IPD has one or more risk factors. [23]

2. Older Australians

For adults, the risk of PD and progression to severe disease increases with age as immune function declines. [25] Australians aged 65 and over make up 16 per cent of our population, which is an estimated 4.2 million people. [26] This older age group experiences high rates of pneumococcal pneumonia which has the potential to progress to complicated or invasive pneumonia. [27]

IPD in adults weighs heavily on our health care system. In the 2011-2012 financial year, the rate of pneumococcal pneumonia hospitalisations was 274 per 100,000 for adults aged at or over 65 years. [27] From 2008 to 2013 there was an average of 455 per 100,000 pneumococcal pneumonia related visits to general practitioners (GPs) by this same group. [27]

Approximately **20 per cent** of annual pneumonia hospitalisations are due to pneumococci in people over 65 years. [27]

Not only can IPD cause severe disease and hospitalisation, but it can also result in devastating outcomes for older Australians. Between 1997 and 2006, 622 Australians died from pneumonia, meningitis, or sepsis caused by *S. pneumoniae*. [13] Even more worryingly, one in five Australians aged 85 and over who contract IPD will die from the disease, further emphasising the urgent need to act to reduce this burden. [3]

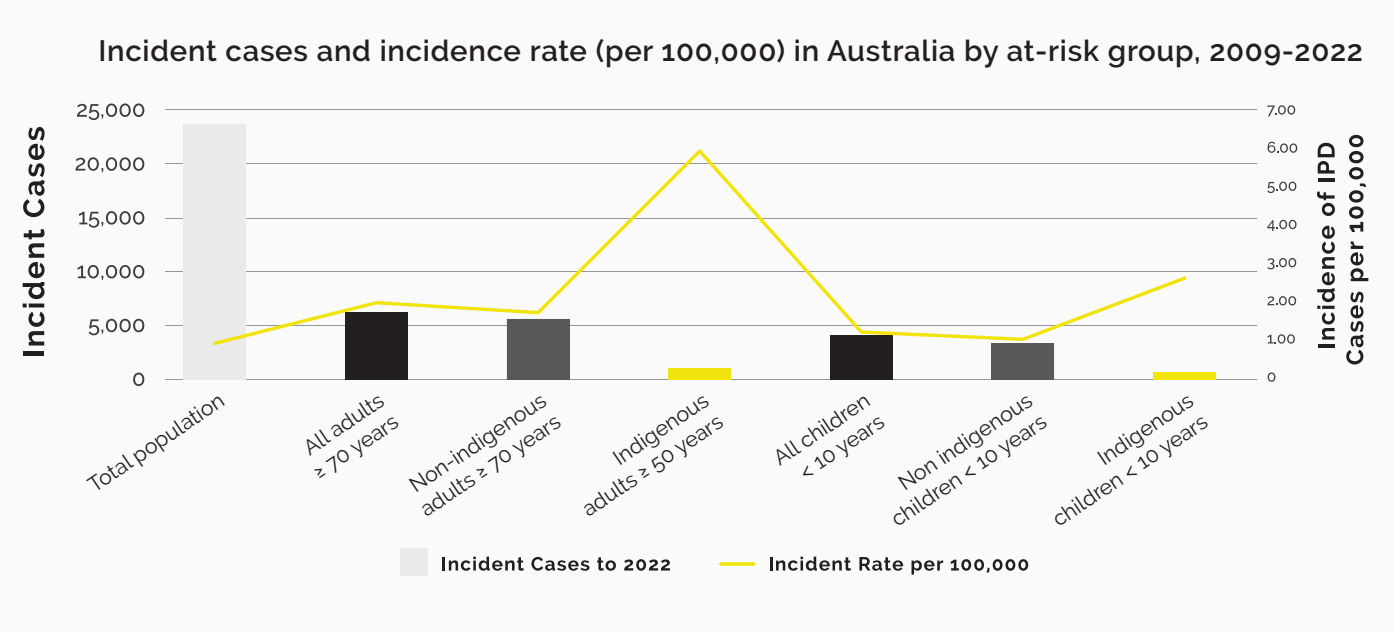
A recent change to the NIP in 2020 which aimed to simplify vaccination advice, removed access to PD vaccination for people 65 to 69 years old. It is this age group that has some of the highest rates of IPD in Australia (Figure 3) and is at greatest risk of severe disease and long-term complications, and therefore in need of access to free vaccines. [7, 28]

3. Aboriginal and Torres Strait Islander people

IPD disproportionately affects Aboriginal and Torres Strait Islander people at a rate of 5.8 times higher than the non-Indigenous population. [3] This difference is even more pronounced amongst younger adults (25-49 years old), who are 11 times more likely to acquire IPD than non-Indigenous Australians of the same age. [29]

This difference is illustrated further by the incidence rates of confirmed IPD in Australia from 2009 to 2022. [7] In this period, Indigenous adults 50 years and over experienced the highest incidence rate of IPD at 5.92 per 100,000 (Figure 5).

Figure 5: *Incident cases and incidence rate (per 100,000) in Australia by at-risk group, 2009-2022*



Source: NNDSS data, ABS data

The higher rates of IPD exist in parallel with higher rates of chronic disease present in this population. This only further increases the risk of severe IPD and can be linked to social and cultural determinants of health such as overcrowded housing, less access to health services in remote settings, and language barriers. [30]

Indigenous children are five times more likely than non-Indigenous children to be diagnosed with otitis media and experience severe disease earlier in life and more frequently. [4, 31] The flow-on effects of otitis media include ear pain and aches, hearing loss, disrupted sleep, loss of appetite, and behavioural issues. [32]

Rates of IPD are **11 times higher** in Aboriginal and Torres Strait Islander people (25-49 years). [29]

These significant and disproportionate impacts of PD on this population highlight the need to act to ensure Aboriginal and Torres Strait Islander people are a focus for future prevention strategies.

4. People with co-morbidities

Currently, the NIP lists several conditions that make a person eligible for free vaccination against PD such as sickle cell disease, haematological malignancies. CSF leak and Human Immunodeficiency Virus (HIV) infection. However, there are also several at-risk conditions not eligible such as diabetes and chronic obstructive pulmonary disease (COPD). Australia currently lacks data on IPD outcomes for people with co-morbidities and their access to vaccines, but a number of international studies have shown that some co-morbidities increase the risk of IPD and mortality due to progressive disease. [33]

A Japanese study alarmingly showed 47.7 per cent of patients less than 65 years old who have multiple co-morbidities are at a greater risk of death due to IPD. [33] It also revealed that serotype 3 is the most common IPD serotype isolated in these adults. [33] Another international study noted, in the older population in France, 36 per cent of IPD cases are in patients with two or more co-morbidities. [34] Consequently, access to and availability of vaccines for these and other high-risk groups must be a priority in Australia given that evidence shows they are at most risk of severe disease and mortality.

IPD can lead to long lasting illness and disability

The potential long-term complications of IPD, particularly pneumonia, can be devastating for some vulnerable patients. This can include functional and cognitive impairment, as well as endocarditis and other cardiovascular dysfunction. In adults, IPD manifests most commonly as pneumonia accounting for approximately 55 per cent of all IPD cases. [7]

In one study undertaken across 13 countries approximately 12 per cent of patients hospitalised due to community acquired pneumonia (CAP) experienced at least one cardiac event upon or during hospital admission. [27] These complications can impact the patient, their carers and families, potentially for the remainder of their life.

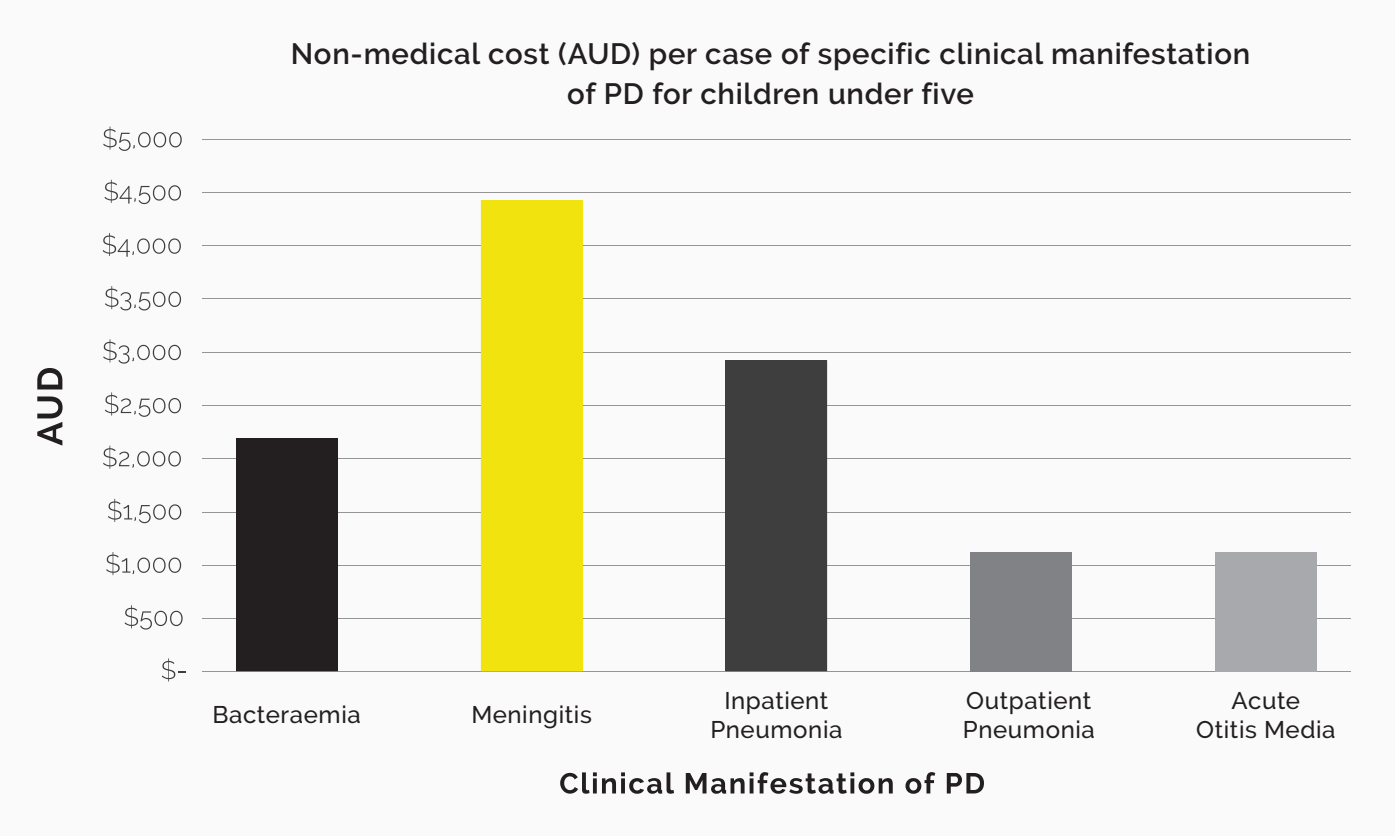
Non-invasive PD and IPD are costing Australians and our health care system

The economic burden of PD in high-risk populations in Australia is substantial. The non-medical indirect costs alone for IPD are significant for carers and parents of children. These costs include missed days of work and loss of wages, which vary dependent on the length of the child's stay in hospital if inpatient care is required.

For IPD, the non-medical indirect costs per case in children less than five years of age is AUD $2,169 for bacteraemia and AUD $4,427 for meningitis. Treating inpatient pneumonia costs AUD $2,898 per case. Outpatient pneumonia and acute otitis media each cost AUD$1,116 in non-medical indirect costs per case (Figure 6). [35] This economic burden, in addition to the direct medical costs of care, contributes to the significant economic impact of PD.

The economic burden of IPD in Australia for people over 65 years is also substantial, yet recognition for the disease is lacking compared to other infectious diseases such as influenza. [27] In 2012, the costs associated with pneumococcal pneumonia hospitalisations in this group were estimated at AUD $55,722,136. The estimated costs for GP visits alone due to pneumococcal pneumonia was AUD $1,604,189, with an incredible 51,000 GP visits annually for people over 75 years of age [27]. From primary care visits to hospitalisations and indirect costs of care, there is a significant economic burden borne by patients, families and those that care for them, as well as adding pressure to an already overstretched healthcare system.

Figure 6: *Non-medical cost (AUD) per case of specific clinical manifestation of PD for children under five*



*Source: [35] *Converted from USD to AUD*

There are almost **51,000** annual GP visits for pneumonia in Australians aged over 75 years. [27]

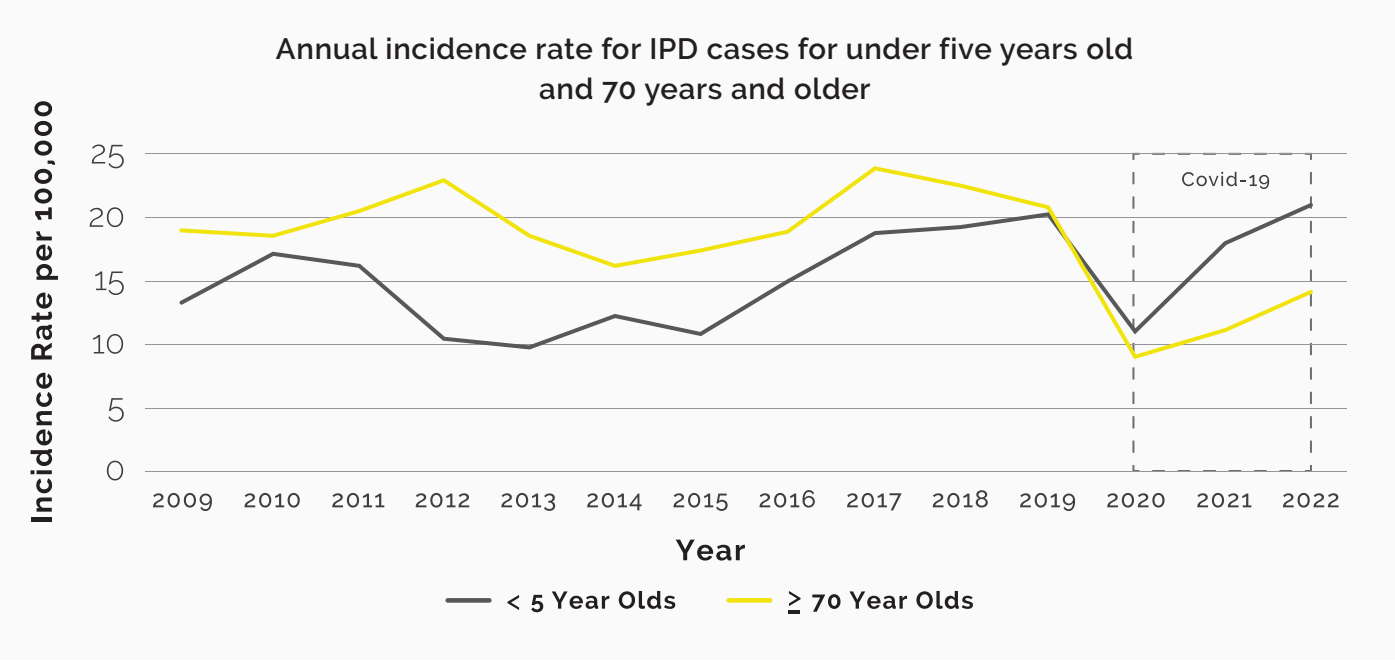
Impact of COVID-19 pandemic

When assessing two key populations, children under five years old and adults 70 years and over, the incidence rate of IPD has remained relatively steady from 2009 until 2020, before decreasing due to the infection control measures of the COVID-19 pandemic (Figure 7).

In children less than five years old, the annual incidence rate of IPD ranged from 10 per 100,000 at its lowest in 2013 to 21 per 100,000 in 2022. It is important to note that IPD has returned to a higher rate following the pandemic in this group, as reported in the 2022 data. [7] However, incidence rates amongst older Australians aged 70 years and older were 9 per 100,000 in 2022, remaining lower than pre COVID-19 pandemic levels.

These numbers are reflective of the consistent burden of IPD in Australia and the need for an adaptive strategy for addressing the disease and ensuring better health outcomes for our vulnerable populations.

Figure 7: *Annual incidence rate for IPD cases for under five years old and 70 years and older*



Source: NNDSS data, ABS data

How are we preventing pneumococcal disease

Currently, vaccines are the best prevention we have against PD. [2] Treatment of PD infection using antimicrobials, especially broad spectrum, are not an effective long-term strategy. The inappropriate and broad use of antibiotics can lead to antimicrobial resistance (AMR), more severe illness and more deaths. [36] We cannot depend on the antibiotics, and need to continue our focus on prevention.

Across the board, the development and implementation of PD vaccines has benefited society; improving health outcomes, reducing costs of healthcare for individuals and government, minimising impacts on parents, carers and families, and contributing to healthcare equity. [37, 38] Since the introduction of PD vaccines in 2001, there has also been a decrease in the prevalence of antimicrobial resistant pneumococcal infections. [2] This is highlighted by the 10 per cent reduction of IPD cases resistant to penicillin in 2012 following the introduction of 13vPCV vaccine. [39] With costly inpatient and outpatient care for IPD and non-invasive PD, prevention is the best approach to reduce costs and improve health outcomes.

> *Prevention is better than disease.*
>
> **- Nurse Practitioner and Immunisation Hub Coordinator**

Vaccines available on the National Immunisation Program

The NIP supports free access to vaccines whilst raising awareness of vaccine preventable disease amongst clinicians and those most at risk of disease. The NIP was first introduced in Australia in 1997 and aims to reduce the burden of vaccine preventable diseases by providing free vaccines to vulnerable populations. [40] In Australia, there are two vaccines available through the NIP for eligible individuals: [4]

VACCINE 1

Prevenar 13 (13vPCV) vaccine: is a pneumococcal conjugate vaccine which evokes an immune response and immunological memory in infants and adults. Immunological memory means the immune system will remember the pathogens and respond effectively when exposed to them again. [41]

VACCINE 2

Pneumovax 23 (23vPPV): is a pneumococcal polysaccharide vaccine which despite covering a greater number of serotypes, does not induce immunological memory and does not induce an immune response for the majority of serotypes for infants. [4]

Availability of vaccines for vulnerable populations in Australia

Under the NIP, identified high-risk groups are eligible for free vaccination. The current vaccine schedule for PD (Figure 8) in Australia provides guidance to health care professionals. The Australian Technical Advisory Group on Immunisation (ATAGI) advises the Pharmaceutical Benefits Advisory Committee (PBAC) on current, new, and emerging vaccines, including technical advice on their effectiveness and use in Australia. The PBAC uses this advice to make recommendations for vaccines and scheduling to the Federal Minister for Health. [4, 42] Australia's current NIP vaccination schedule for PD is in Figure 8 below.

Figure 8: *Current Australian vaccine schedule for PD. [4]*

PD vaccination schedule in Australia

Children under five years old should receive three doses of 13vPCV at ages two months, four months, and 12 months.

Children with a risk condition should receive a fourth dose of 13vPCV, by the addition of a dose at age six months, as well as two doses of 23vPPV at four years old and then at least five years later.

Anyone over the age of 12 months with a **diagnosed risk condition** should receive one dose of 13vPCV when diagnosed with the condition, and two doses of 23vPPV.

Aboriginal and Torres Strait Islander adults over 50 years old should be vaccinated with one dose of 13vPCV and two doses of 23vPPV (12 months post 13vPCV) and the next dose at least five years later.

Non-Indigenous adults aged 70 years and over should receive one dose of 13vPCV/15vPCV/20vPCV (no preference on which conjugate vaccine).

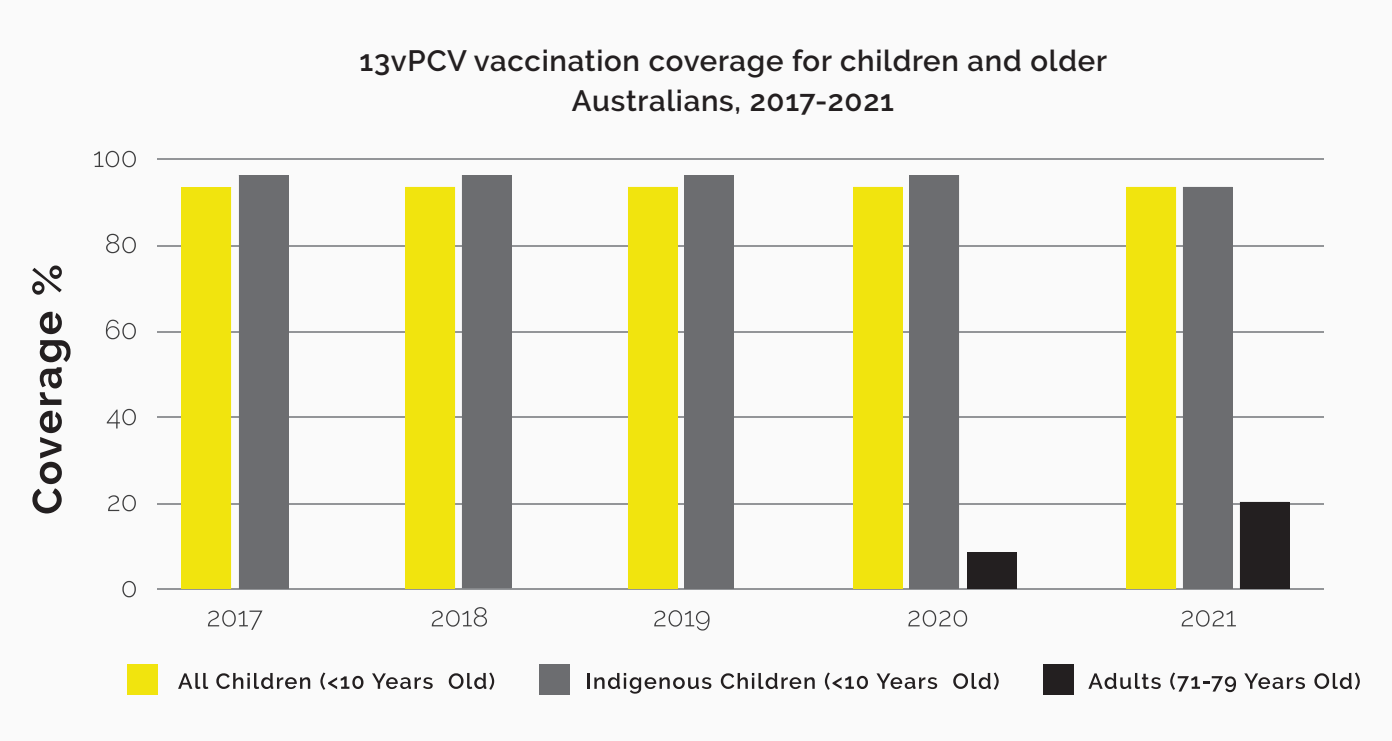
Source: Department of Health and Aged Care

Vaccination coverage rates

Recent data reveal that vaccination coverage in Australia varies significantly between different cohorts and not everyone who is eligible is being vaccinated against PD.

NCRIS data reveal 13vPCV vaccination rates are much lower for older adults than for children, 17-20 per cent versus 95 per cent (Figure 9). The low uptake amongst this older high-risk group may be due to lack of awareness of PD by patients and healthcare providers and highlights a missed chance for opportunistic vaccination. [5, 27, 34]

Figure 9: *13vPCV vaccination coverage for children and older Australians, 2017-2021 [5]*



*Source: NCIRS**

** Data only available for 70-years and 71 to 79-year age groups for 2020 and 2021. 70-year age data not included.*

** Vaccination data not available prior to 2017 for children and 2020 for adults.*

Children are being vaccinated, adults are not

Australia's immunisation program is not reaching all high-risk groups and therefore not providing necessary protection. As discussed, in recent years PD vaccination rates for children have been impressively high with 95.4 per cent of all children reported as fully vaccinated against PD at 60 months of age in 2021 (Appendix B). However, vaccination coverage rates in older Australians and Aboriginal and Torres Strait Islander adults are lagging. Worryingly, of adults aged 71-79 years only 20 per cent are reported as fully vaccinated against PD in 2021. This is in contrast to older Australian's influenza vaccination rates which were 68.5 per cent in 2021. [5] In 2022, PCV13 coverage amongst 70 year olds was 33.8 per cent but only 22.1 per cent for 69 year olds. [43] It is important to note that mandatory reporting of NIP vaccinations started in 2021 and therefore, interpretation of these data has been done with caution. However, these low rates have been attributed to barriers to vaccine uptake including a lack of awareness of PD amongst healthcare providers and individuals, compared to other diseases such as influenza [44]. Lessons can be learnt from what drives high influenza vaccination rates and turned into action to increase PD vaccination coverage for the older population.

> *"Vaccination coverage in children is very good. The bigger issue is in people with co-morbidities. System changes are needed in primary care. There is the need to increase scope and awareness amongst health care providers such as push and pull mechanisms to increase access to uptake of vaccines."*
>
> **- Mr. Mark Brooke,** CEO Lung Foundation Australia

Despite high vaccination rates our younger population is faced with the issue of vaccine failure, which is due to an inadequate immune response or a wane in immunity over time. Whilst a large proportion of the younger population are vaccinated against PD, vaccine failure has meant that children are still at risk of serious IPD infection from particular serotypes. This is particularly the case for serotype 3. Studies have shown that the immune response that 13vPCV produces in children is lower than that produced for other serotypes. [45] Vaccine failure means that despite the process of vaccination, and trusting that being vaccinated means children are protected, they remain at risk of PD and severe IPD infections. [22] This failure of the available vaccines to prevent our younger population against IPD infections is placing a significant weight on our healthcare system. Both improving vaccine coverage and reducing vaccine failure must be addressed to reduce the burden PD places on Australians.

Capturing and quantifying the burden

There are a range of diagnostic tools available for IPD. The choice of test is dependent upon clinical presentation, setting and clinician preference. These tests can involve collection of urine, blood, CSF or sputum/phlegm. [1, 2] Once collected, samples are tested for presence of *S. Pneumoniae.*

> *Culture testing is not accurate in assessing the burden of IPD and specifically the burden of serotypes. To understand the true burden of IPD more enhanced molecular testing is needed.*
>
> **- Epidemiologist**

In Australia, confirmation of cases for reporting to the NNDSS require laboratory evidence from a culture or nucleic acid test. Urinary antigen tests are also available to diagnose IPD. There are limitations to some of these methods making them less reliable in quantifying the true burden of disease. Table 2 below presents the advantages and limitations of various testing modalities.

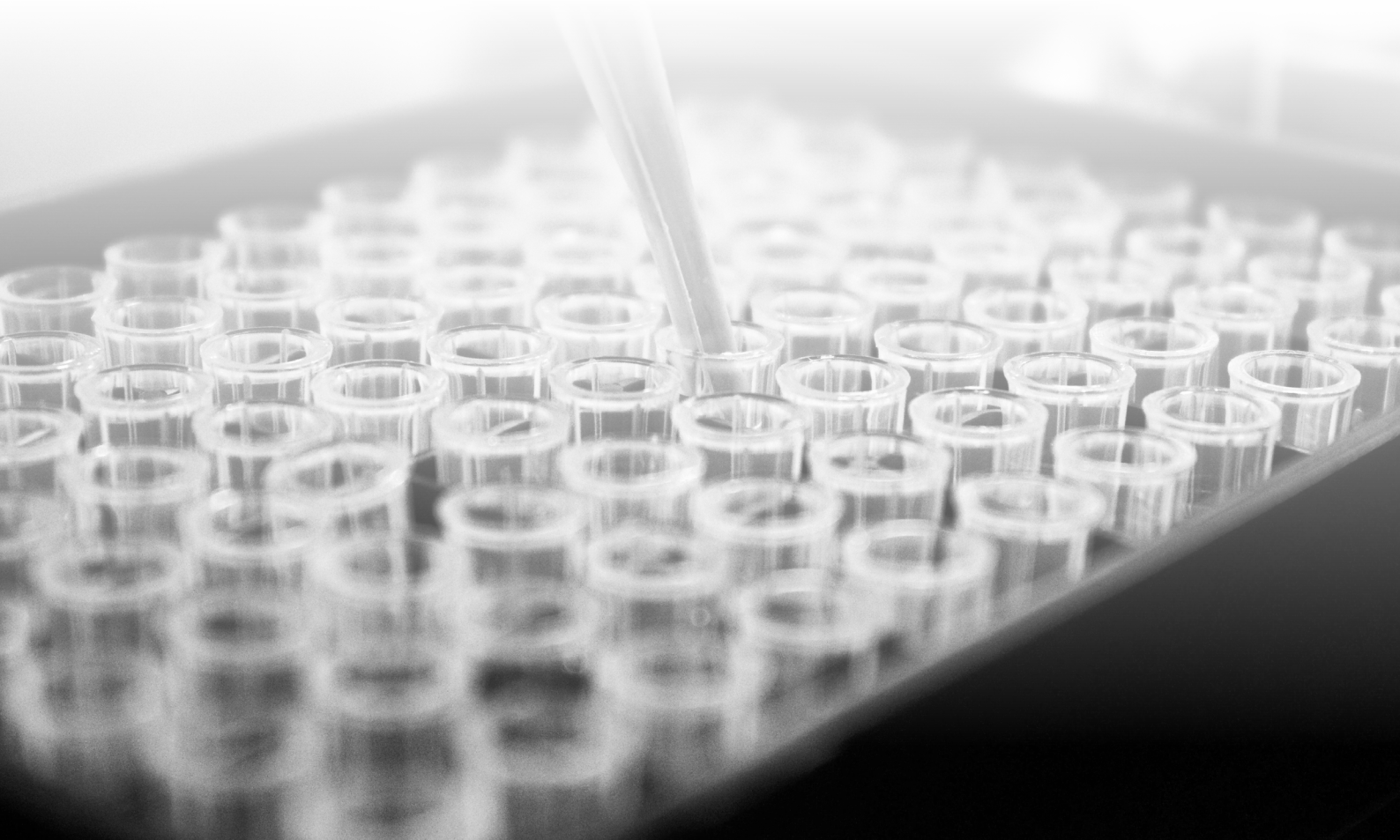


Table 2: *Summary of testing practices for PD. [10, 27, 46, 47]*

TESTING MODALITY	ADVANTAGES	LIMITATIONS
Culture testing - Routinely used to confirm IPD cases	• Isolation of *S. pneumoniae* from blood or other normally sterile sites has 100 per cent specificity for IPD. • 98 per cent specificity for diagnosis of meningitis.	• Bacteria are not always detected leading to underreporting or non-serotyped IPD cases. • Takes at least 24 hours • Sensitivity dependent on clinical setting, volume of sample from patient, and if antibiotics have been used as treatment.
Nucleic acid amplification test	• Only small sample required • Quick results, less than one hour	• Unable to perform AMR susceptibility testing • Difficulty differentiating colonisation from infection when using respiratory sample.
Urinary antigen testing – Detects *S. pneumoniae* antigens.	• 60 – 100 per cent accurate for diagnosis of community acquired pneumonia. • Simple to use. • Rapid results.	• Only 50 per cent specific in children. • Greater likelihood of false positives following PD vaccination. • May present positive results weeks after a *S. pneumoniae* infection has resolved. • Limited to specific serotypes, some tests detecting only 13 out of 100.

Better surveillance is needed to understand the true burden of non-invasive PD and IPD

IPD was added to the NNDSS as a significant public health risk in 2001. [16] This supports both Federal and State/Territory Governments to monitor the spread of disease and better understand national trends while also quantifying the burden. [48, 49] These data influence public health policy, such as access to targeted vaccines and support strategy development aimed at addressing the significant burden of PD in Australia. [48]

With current culture testing showing limited sensitivity, gaps in quantifying the true burden of IPD can be surmised. In combination with a lack of incentives for clinicians to test for the disease, particularly in primary care, underreporting of IPD on the NNDSS in Australia is suspected. [46] That is, despite the public health surveillance measures, we are not identifying all the cases, making quantifying the true burden of PD difficult.

Without knowing the true burden, it is impossible to implement targeted and fit-for-purpose prevention strategies.

A very recent example of the benefits of active sentinel surveillance is the respiratory disease incidence tracking during the COVID-19 pandemic. This provided valuable insight on the impact of both public health and preventative measures in controlling the burden of disease. [50] If similar data can be collected for IPD, via enhanced surveillance, including identification of the most prevalent serotypes, it will be possible to determine the effectiveness of vaccines on the market and determine if, how and when vaccine failure is occurring. Better surveillance also ensures that we are investing resources to ensure that our most vulnerable populations are adequately protected from PD.

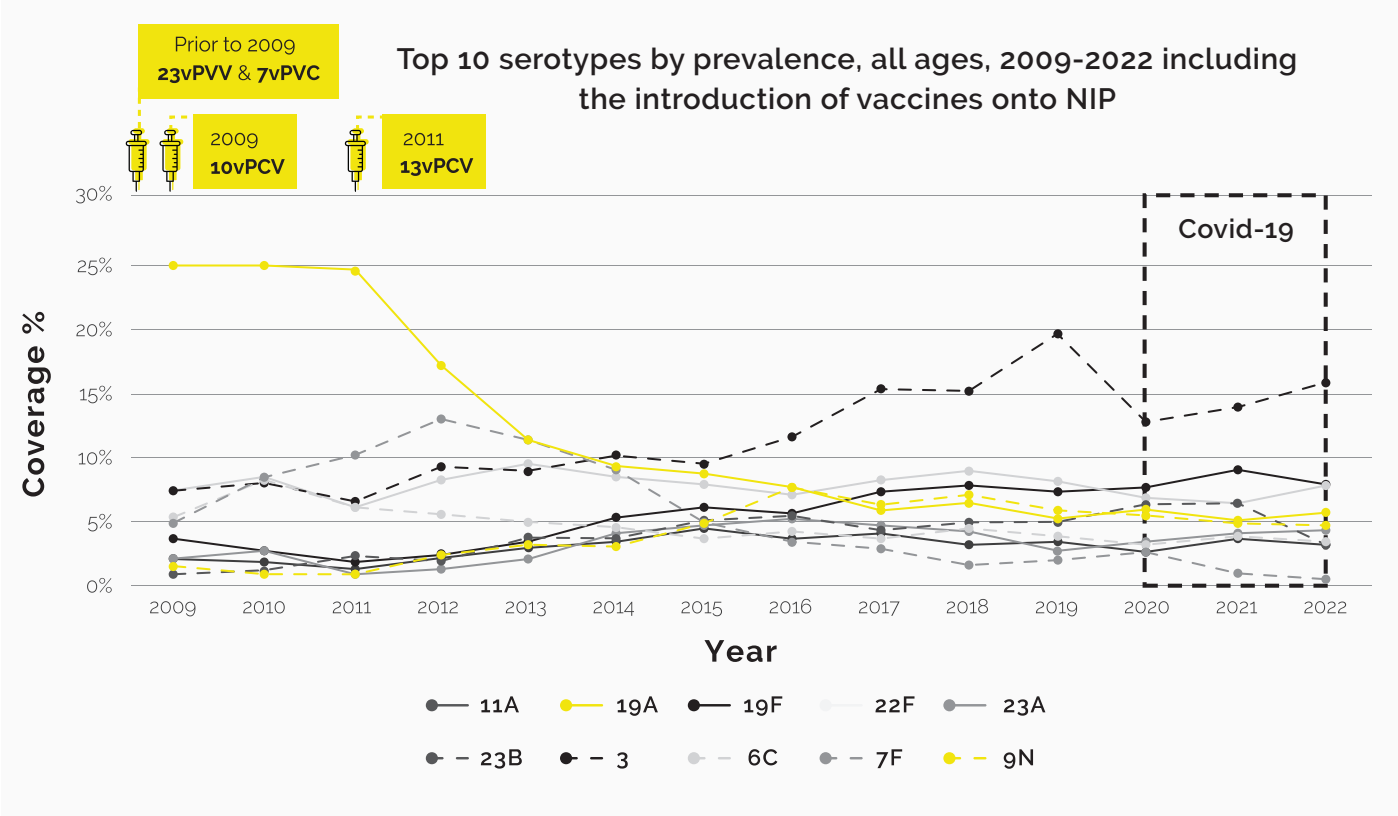
Opportunity: Improve the way we test, diagnose, and collect PD data in order to understand and prevent the patterns of disease.

Not all serotypes are equal

There are over 100 different variants or "serotypes" of *S. pneumoniae*. Some pneumococcal serotypes cause more severe disease than others. [6]

Between 2009 and 2022, there were 23,401 IPD cases of which 92 per cent were serotyped. From 2009 to 2022, across all ages, the top ten serotypes were 3, 19A, 22F, 7F, 19F, 23A, 23B, 9N, 11A and 15A. These serotypes accounted for 61.8 per cent of identified IPD cases (Figure 10). [7]

Figure 10: *Top 10 serotypes by prevalence, all ages, 2009-2022 including the introduction of vaccines onto NIP*



Source: NNDSS data

In 2009, serotype 19A was the most dominant serotype associated with IPD cases (25 per cent). By 2016, serotype 3 emerged as the dominant IPD serotype (12 per cent) reaching a peak in 2019 of 19.5 per cent of all IPD cases.

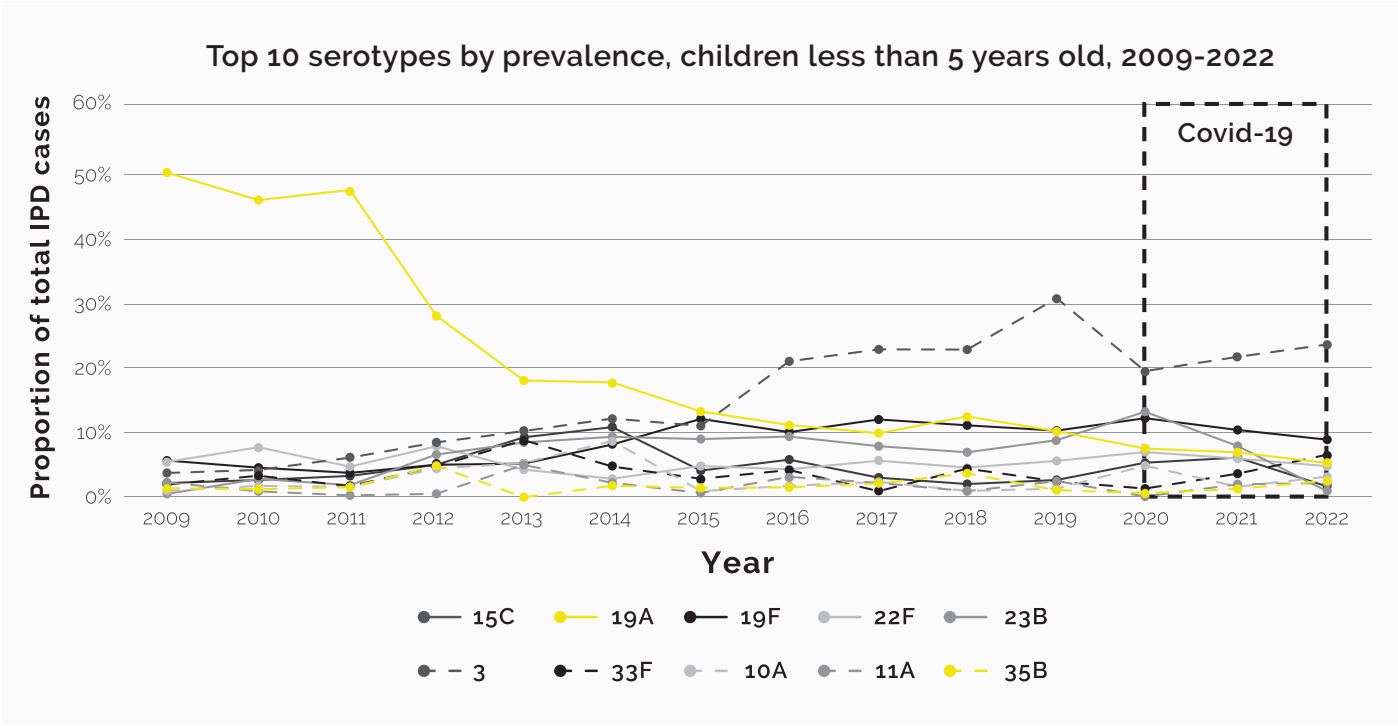
Following the introduction of 13vPCV which replaced 7vPCV in 2011, there was a 42 per cent reduction in cases of IPD caused by the additional six serotypes covered in the new vaccine from 2011-2014. [51]

The pattern of dominant serotypes in Australian children aged less than five years old was similar to the total Australian population. IPD cases due to serotype 19A were the most common between 2009 and 2015, before serotype 3 IPD cases becoming dominant from 2016 to 2022 (Figure 11).

Serotype 3's evasive nature should be of concern to both clinicians and policy makers, as well as the focus for future vaccine development.

Hospitalisations due to empyema amongst children have increased and this is attributed to serotype 3. [22]

Figure 11: *Top 10 serotypes by prevalence, children less than 5 years old, 2009-2022*



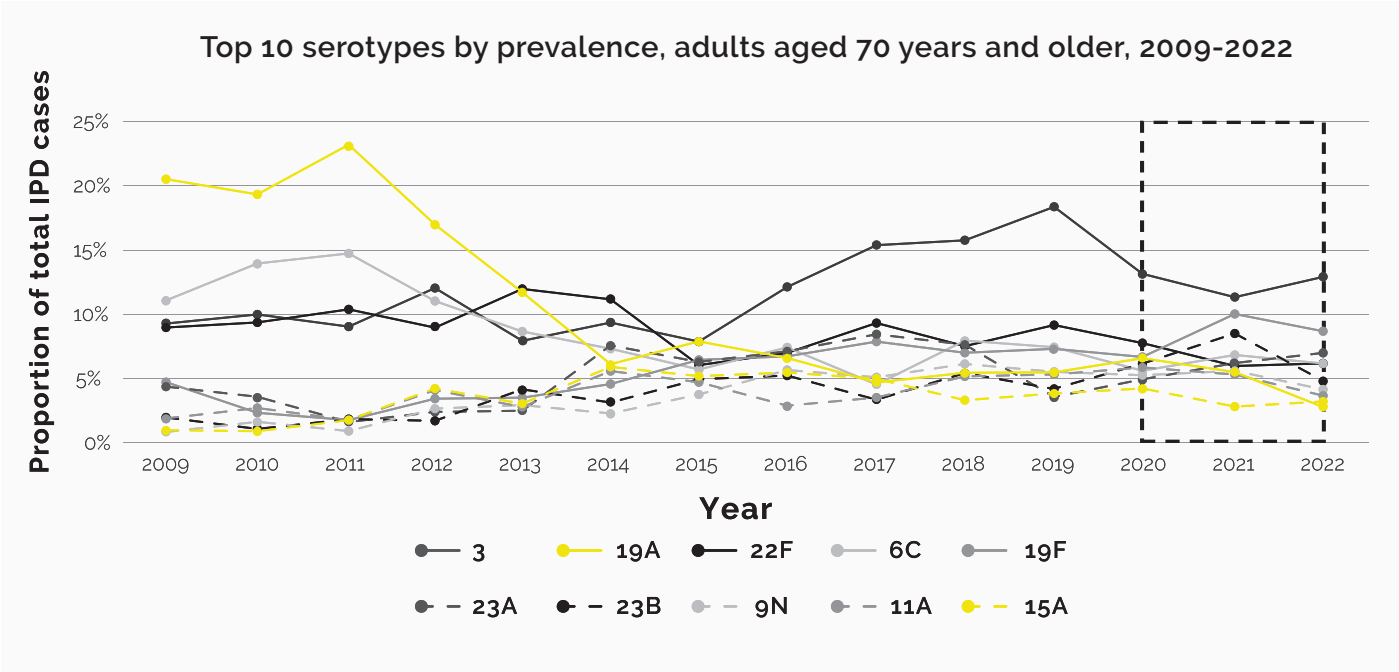
Source: NNDSS data

Serotype 3 is still the most dominant serotype and a big issue.

- Paediatrician

For Australians aged 70 years or older, whilst 19A serotype was dominant in 2009, there was a sharp decline by 2013 (Figure 12). As with the total population and children aged less than five years old, by 2016 serotype 3 had become the dominant serotype.

Figure 12: *Top 10 serotypes by prevalence, adults aged 70 years and older, 2009-2022*



Source: NNDSS data

In 2019, 64.8 per cent of IPD cases were attributed to serotypes that are included in vaccines available in Australia. [7] The majority of these serotypes (Figure 12) are covered by 23vPPV and 13vPCV. [7] This is particularly concerning when vaccines are the best preventative strategy we have against severe disease. To effectively address the burden of IPD in Australia, it is essential we continue to vaccinate all eligible citizens with vaccines that target the most prevalent and pathogenic serotypes.

Serotype 3 – the "sugar coated killer"

Serotype 3 is a unique serotype of *S. pneumoniae* due to its capsular polysaccharide which can resist vaccines and has increased virulence. Serotype 3–influenced invasive disease is the most severe and has an approximately 30 per cent mortality rate which increases to 47 per cent when infected individuals have multiple co-morbidities. [6] Whilst some other serotypes such as serotypes 31 and 11A have higher mortality rates, serotype 3 occurs more frequently, can evade vaccine-induced protection, and causes the worst outcomes. [52] For this reason, it has been labelled the "sugar-coated killer". [6]

Given the data show the ongoing high prevalence of serotype 3 infections, a new approach such as targeted funding into research and diagnostic tools to address particular serotypes may be required for optimal protection.

> *"Serotype 3 is still the most dominant serotype and a big issue. There is a higher proportion of empyema due to serotype 3. While we have vaccines for Pneumococcal disease, we still don't have a vaccine that is as effective against serotype 3 as it needs to be."*
>
> **- Professor Terry Nolan**

> *Serotype 3 is known to be really tricky and the holy grail in pneumococcal vaccines. It is a major cause of disease.*
>
> **- Paediatrician**

What are the consequences of serotype replacement?

Serotype replacement occurs when the introduction of a vaccine targeting specific serotypes creates an opening for the emergence of serotypes that are not included in that vaccine. Depending on the extent of this replacement, the emergence of serotypes can potentially negate the benefit of a newly introduced vaccine. [53]

We know that following the introduction of 7vPCV in 2001, there was an increase in the number of cases caused by serotypes not covered in this vaccine. [4] When the 13vPCV vaccine was introduced, there was a reduction in the number of IPD cases due to the additional six serotypes it covered. This reduction then plateaued and there was a steady increase of IPD cases due to the 11 serotypes additionally covered in the 23vPPV vaccine and those not covered by either vaccine. [3]

As mentioned earlier, the NNDSS data are used to track the effectiveness of available vaccines and inform changes to the NIP schedule. [7] With an understanding of how serotype replacement occurs and better real time data, we can predict future trends, particularly how quickly the emergence of other serotypes occurs after the introduction of a new vaccine. Better and more timely data collection and surveillance practices under the NNDSS will ensure that the data used to inform new vaccine development is up to date and accurate. Additionally, this data will be more accurate in tracking the increase in IPD according to serotype, including those covered in vaccines.

Opportunity: Leverage national data to inform access to vaccines that target and produce immunity to the identified problematic serotypes.

Why are we missing the target?

Although preventative strategies for PD are currently available in Australia, we are yet to address the true burden of disease due to low adult vaccine rates, a complex vaccine schedule and, at times, breakthrough infection or vaccine failure. Despite our world class PD vaccination program, our most vulnerable continue to be at risk of PD infection and carry the burden of disease.

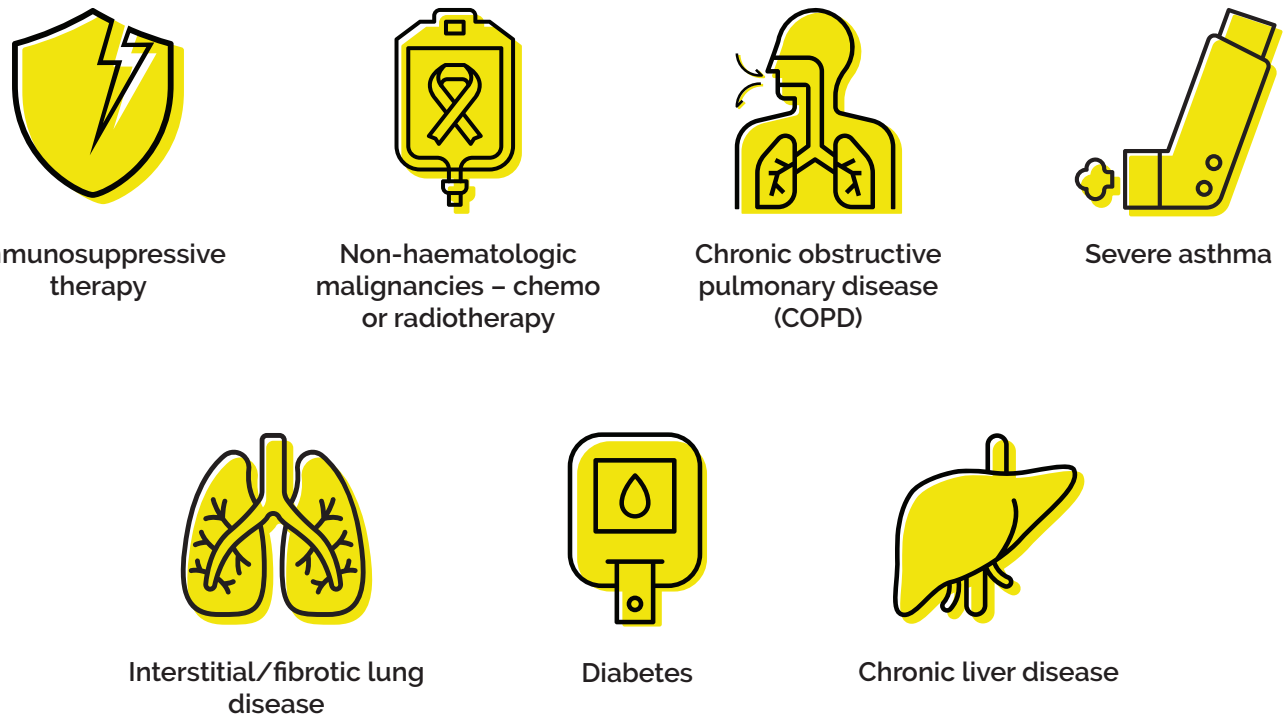
High risk groups are still missing out

Under the current NIP, there are a number of vulnerable Australians who are not eligible for the pneumococcal vaccine despite having medical conditions considered at risk for serious illness. The Australian Immunisation Handbook lists a number of identified risk factors for PD however this list is comprised of funded and unfunded risk factors.

Some of the at-risk conditions eligible to receive free vaccinations include sickle cell disease, CSF leak and HIV infection. [4, 16] This means for those with unfunded conditions, to protect themselves from PD as recommended by health professionals, they need to privately fund the vaccine.

Figure 13: *The PD risk factors that are not funded under the NIP include:*

The PD risk factors that are not funded under the NIP include: [55, 56]



> *An unfunded vaccine program for people at high risk will not be successful.*
>
> **- Professor Robert Booy**

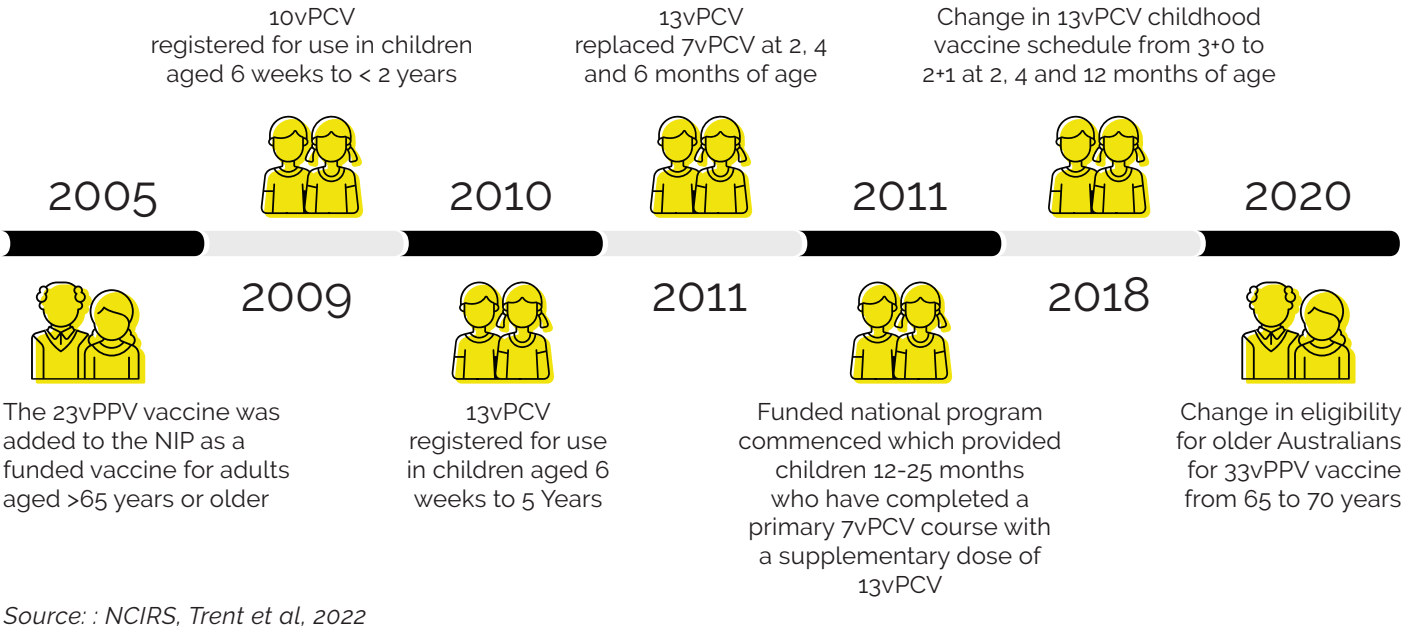
Experts emphasise that it is highly unlikely that those with at risk but unfunded conditions will access PD vaccinations, particularly when it is priced at between $125 - $200 AUD per vaccine. [10-12] Vaccine coverage data is not recorded for at risk patients, so there is a lack of understanding of how well this group is vaccinated and if they are being protected against PD. This disparity in access among groups at greatest risk of IPD who experience a significant burden of PD infection in Australia is a gap in Australia's NIP vaccination schedule.

Opportunity: Improve access to funded vaccines for all people identified by clinicians and the schedule as at high-risk of non-invasive PD/IPD.

The impacts of a changing vaccination schedule

Since 2019, there have been multiple changes to the vaccine schedule for eligible Australians. Due to the requirement for multiple doses and vaccines types available, along with changes to the schedule (Figure 14), the complex nature of the vaccine schedule in Australia has proven to be a barrier for vaccine uptake. [10]

Figure 14: *Timeline of key updates to the PD vaccine schedule in Australia. [54, 55]*



Source: : NCIRS, Trent et al, 2022

There are reports of confusion amongst vaccinating healthcare professionals resulting from the 2020 decision to change eligibility for older Australians (for the 23vPPV vaccine) from 65 years old to 70 years old. The hypothesis is that vaccine uptake has decreased as a result. [28] This is concerning as a decrease in vaccine uptake in older individuals negates the positive impacts resulting from the introduction of the 13vPCV vaccine.

Another key change resulted from an increasing number of cases of IPD due to 13vPCV serotypes in fully vaccinated children, prompting a review and change of the child vaccination program in 2018. Children now receive a 2+1 schedule (13vPCV at two and four months old and a booster at 12 months old) compared to the previous 3+0 (13vPCV at two, four and six months old) schedule. With this change policy makers aimed to significantly improve protection through the childhood immunisation program and curtail the increasing cases of IPD amongst children. [24]

> *"An online tool had to be made to take out the guess work on what vaccine patients should be getting, when they should be getting it and is it funded or not."*
>
> **- Nurse Practitioner and Immunisation Hub Coordinator**

The success of Australia's childhood immunisation program has ensured that currently 95 per cent of Australian infants and children are vaccinated for PD. [5] The eligible adult population is, however, lagging. Adult vaccination is often opportunistic, GPs offering vaccination during a routine appointment or by pharmacists during a visit to the local pharmacy. Multiple changes in the PD vaccine schedule have led to a gap in clinical awareness, resulting in reduced uptake of the vaccine particularly in the older cohort which urgently needs to be addressed.

Opportunity: Enhance clinical awareness and knowledge so that vaccination for PD is front of mind for adult populations.

We have a National Immunisation Strategy but is it enough?

In conjunction with the NIP, Australia has a National Immunisation Strategy which comprises eight priority areas designed to support and strengthen immunisation, ranging from improving coverage to ensuring vaccine supply and an adequately skilled immunisation workforce. [56] Despite this strategy, including the NIP, stakeholders highlighted that clinicians and researchers have identified there is a lack of patient awareness of required vaccination or who is eligible to receive the vaccine. [10]

Moreover, in the last three years, post-pandemic, vaccine fatigue has been identified as a barrier for the uptake of vaccines, particularly in high-risk populations. [10] For this reason, opportunistic vaccination campaigns need to be tailored to target populations at greatest burden of disease incorporating patient education on the benefits of the PD vaccine. [10]

From the COVID-19 vaccine roll out and influenza programs, we know that other health professionals, such as pharmacists, can successfully vaccinate and often leverage opportunistic interactions with eligible patients. In most states and territories, only doctors and nurses can administer PD vaccines, however in Queensland and Victoria pharmacists are able to administer to particular groups. By increasing the range of health professionals who can provide PD vaccines and encouraging different opportunities for vaccination, we can greatly increase access to opportunistic vaccination. [10]

Opportunity: Enhance vaccination programs and opportunistic settings, including access to administer NIP funded vaccines.

System changes can support uptake

System changes at the primary health care level can provide an additional layer of protection to ensure vaccination opportunities are not missed. There are a number of screening programs in Australia that successfully rely on GPs and healthcare practices to prompt patients, such as the cervical cancer screening program. [57]

A similar system to remind GPs and patients that they are eligible for PD vaccination has the potential to improve uptake, particularly among older Australians who regularly interact with healthcare professionals. As there is not a consistent practice or clinic management software used across the country, these programs could be linked to the AIR or My Health Record to receive updates and notifications regarding vaccination reminders, as someone becomes eligible due to age or co-morbidity. These push and pull mechanisms of health information exchange and system changes would include setting up reminders in practice software to prompt primary care clinicians to offer the PD vaccines to high-risk groups, particularly older Australians. This would assist in increasing uptake of vaccines amongst vulnerable groups.

> *"The inclusion of reminders into software at a structural and system will be effective for improving vaccine uptake."*
>
> **- Advisory Committee**

Realising the opportunities

We know that vulnerable populations are not accessing vaccines that they are eligible for, certain serotypes continue to cause the most disease, and better data would help to understand and track this dangerous disease.

This report identifies key areas that need to be addressed to overcome the burden of PD and IPD in Australia:

- Improve the way we test, diagnose, and collect non-invasive PD and IPD data in order to understand and prevent the patterns of disease.
- Leverage national data to inform access to vaccines that target and produce immunity to the identified problematic serotypes.
- Improve access to funded vaccines for all people identified by clinicians and the schedule as at high-risk of non-invasive PD/IPD.
- Enhance clinical awareness and knowledge so that vaccination for PD is front of mind for adult populations.
- Enhance vaccination programs and opportunistic settings, including access to administer NIP funded vaccines.

Detailed recommendations

To address these opportunities and prevent the burden of non-invasive PD and IPD in Australia we present six recommendations that can considerably reinforce Australia's fight against this preventable disease. These recommendations are based on evidence from comprehensive review of academic and grey literature, and informed by interviews with policymakers, clinicians, and patient advocates, epidemiological analysis, and the contributions of our project Advisory Committee.

RECOMMENDATION 1

Develop a national PD strategy to reduce the burden of disease, including invasive and non-invasive disease.

A national strategy co-designed with Government, healthcare professionals, patient advocate groups, and policy makers, will create a collaborative and coordinated approach to address the burden of PD. With investment from the Australian Government, the national strategy could encompass the five recommendations set out below.

A focus on preventive measures targeting our most vulnerable populations, better surveillance and testing practices, improving vaccination rates and access to vaccines, as well as providing education, and increasing awareness of PD are critical elements of this strategy. We also consider that funding targeted research into diagnostic tools, prevention, and care via enhancing existing systems to encourage vaccination and broadening opportunities for vaccination will considerably reduce the incidence of IPD.

RECOMMENDATION 2

Enhance surveillance and testing practices for PD to ensure better data are available to quantify the true burden of disease.

Australia has made great strides in IPD surveillance via notification and data collection on the NNDSS. Yet there is a lack of incentives for health care professions to test for non-invasive PD/IPD in the clinical setting, particularly primary care. This undermines Australia's ability to capture and identify the true burden of disease. Specifically, better data is needed to identify this burden amongst high-risk populations.

To quantify this burden, clinical testing practices need to evolve to be more routine and robust. The adoption of better or alternate testing practices, such as urine antigen testing, by health care professionals will also assist in identifying the true burden caused by specific serotypes such as serotype 3. More sensitive diagnostic testing such as molecular technologies is needed to understand the true burden of serotype specific non-invasive PD/IPD.

Improving data collection by building upon existing sources but also implementing enhanced surveillance, the collection of a combination of epidemiological, microbiological and other necessary data, will enable better monitoring, preparedness and response to PD.

We anticipate that the 2021 introduction of mandatory reporting of all NIP vaccination will improve vaccination coverage data going forward. However, further improvements by including detail in the data, such as whether those vaccinated have any at-risk condition for PD, will help determine if those most vulnerable are accessing the vaccines and if not, to help determine and overcome barriers to vaccination.

RECOMMENDATION 3

Increase the availability of funded PD vaccines under the NIP for high-risk populations.

While PD vaccines are currently funded under the NIP in Australia, targeting some of the most at-risk of populations for PD is missing. Currently the NIP funds PD vaccinations for those who have certain medical conditions that put them at greater risk of non-invasive PD/IPD. However, there are several identified "risk conditions" listed by the Australian Immunisation Handbook which are not eligible for NIP funding. These conditions include COPD, diabetes, severe asthma, and chronic liver disease. Whilst it is recommended that people with these conditions receive PD vaccinations, without access to free vaccines, it is unlikely this high-risk group will be covered.

Similarly, a recent change in the schedule has resulted in a reduction in access to vaccines to older Australians by increasing the eligible age for vaccine from 65 to 70 years of age. As highlighted in this report, the age group of 65 to 69 years old remains an at-risk group and this change to the schedule prohibits the availability of funded vaccination for this population.

Therefore, there is a need for the Australian Government to expand the availability of funded vaccines for people with these additional co-morbidities and return the eligible age for vaccination to 65 years old to ensure all high-risk populations can access vaccines.

RECOMMENDATION 4

Through a targeted PD awareness campaign, provide information to empower and enable patients and healthcare professionals to make informed decisions about PD prevention.

PD is not well-known compared to other infectious diseases such as influenza or COVID-19. There is a need for educating the general population, as well as treating healthcare teams across our system, to increase awareness of disease risks and encourage vaccination. In Australia, the vaccination coverage for the older population (71 to 79-year-old) and the older Aboriginal and Torres Strait Islander population (71 to 79-year-old) in 2021, is below 21 per cent and must be a key priority. [5]

Targeted awareness campaigns run by Federal and State/Territory health departments will assist to educate and raise awareness of PD within the community and bring the public health benefits of vaccinations to the forefront. This awareness campaign should also aim to reach the broader public, so the information is widespread.

RECOMMENDATION 5

Incorporate NIP vaccination schedule into prescribing and practice software.

The PD vaccine schedule in Australia is complex and ongoing changes to the vaccine schedule have caused confusion for patients and clinicians. Incorporating push and pull mechanisms at a systems level, such as vaccination reminders into prescribing and practice software, is a tangible recommendation to address the low vaccines uptake rates in high-risk populations. This recommendation complements Recommendation 2 by encouraging the adoption of a holistic approach through system changes.

RECOMMENDATION 6

Implement opportunistic vaccination programs and wrap around services to enhance vaccination delivery.

We know that prevention is better than cure, preventative measures are the most successful in addressing the burden of disease and vaccines are the best preventative strategy against PD. [2] By engaging in opportunistic vaccination and wrap around services that are needs-driven, such as community-based vaccination programs and/or pharmacist vaccination services, we can increase uptake rates of vaccination in the population and consequently as a ripple effect amongst individuals at high-risk. Australia has previously successfully implemented paediatric specialist vaccination services that can be leveraged for PD and adapted for the adult population.

These six recommendations provide a tangible way forward for Australia to reduce the burden of non-invasive PD/IPD. We are fortunate to live in a country with access to innovative vaccines and quality healthcare. Leveraging opportunities that exist within this system will enable our most vulnerable to avoid the impact of an inherently preventable disease.

RECOMMENDATIONS	OPPORTUNITIES				
	Improve the way we test, diagnose, and collect non-invasive PD and IPD data to understand and prevent the patterns of disease.	Leverage national data to inform access to vaccines that target and produce immunity to the identified problematic serotypes.	Improve access to funded vaccines for all people identified by clinicians and the schedule as at high-risk of non-invasive PD/IPD.	Enhance clinical awareness and knowledge so that vaccination for PD is front of mind for adult populations.	Enhance vaccination programs and opportunistic settings, including access to administer NIP funded vaccines.
Develop a national PD strategy to reduce the burden of disease, including invasive and non-invasive disease.	✓	✓	—	✓	✓
Enhance surveillance and testing practices for PD to ensure better data are available to quantify the true burden of disease, including those caused by specific serotypes, to inform Australia's national immunisation strategy.	✓	✓	—	—	—
Increase the availability of funded PD vaccines under the NIP for high-risk populations.	—	—	✓	✓	✓
Through a targeted PD awareness campaign, provide information to empower and enable patients and healthcare professionals to make informed decisions about PD prevention.	—	—	✓	✓	✓
Incorporate the NIP vaccination schedule into prescribing and practice software.	—	—	—	✓	✓
Implement opportunistic vaccination programs and wrap around services to enhance vaccination delivery.	—	—	✓	✓	✓

Appendix A – Methodology of Epidemiological Analysis

Methodology for incidence of invasive pneumococcal disease in Australia.

The number of annual cases of IPD in Australia was analysed from 2009 to 2022 to understand the longitudinal trends in both incidence of cases and variation in causative pneumococcal serotypes.

Analysis was conducted between June and September 2023.

Approach

Data for this analysis were sourced from the NNDSS public dataset for IPD [7]. This dataset includes de-identified variables for all reported (notified) IPD cases in Australia from 2009 to 2021. To ensure currency of the analysis, data for IPD cases in 2022 were provided directly by the Office of Health Protection and Response, Department of Health and Aged Care.

The following variables were included in the analysis where necessary:

- Year (diagnosis date)
- Serotype of *S. pneumoniae* causing the notified case.
- State or Territory of notification which sends the case to NNDSS
- Age group (5-year age groups)
- Sex (male, female, X or unknown)
- Indigenous status (Indigenous, non-Indigenous or unknown)
- Clinical category of IPD (Pneumonia, meningitis etc.)
- Vaccination history (type and number of vaccines administered to each case)

Analysis included descriptive statistics (percentages or counts) of incidence of IPD cases and causative serotypes by year, stratified by other variables listed above. Where data are presented as incidence rates, Australian annual population statistics were sourced from the Australian Bureau of Statistics. [58, 59]

Interpretation

Variation in serotypes over time assists in understanding the impact of relevant vaccines on IPD incidence and the emergence of serotypes with no vaccine coverage.

Annual incidence of IPD has been used as a proxy for health care burden as the NNDSS dataset only includes IPD cases where healthcare was sought. [7]. Consequently, the data presented in this report are likely an underestimation of the incidence of IPD in the community.

For further information on data caveats and interpretation please go to the data custodian website: National Notifiable Diseases Surveillance System (NNDSS) public dataset – pneumococcal disease (invasive) (health.gov.au)

Age Groups – Older Australians

When discussing older Australians this report uses a number of different age parameters, e.g., 65 years and over, 70 years of age and 71-79 years. This is due to different data sources, including publications, government reports and NNDSS data.

Appendix B – Vaccination coverage rates

13vPCV vaccination coverage for children, 2020-2021 [5]

Year	Vaccine	Age	Indigenous	All Children
2021	13vPCV	12 months (dose 2 or 3) 24 months (dose 3) 60 months (dose 3)	96.1 per cent 96.3 per cent 97.8 per cent	95.9 per cent 95.4 per cent 95.4 per cent
2020	13vPCV	12 months (dose 2 or 3) 24 months (dose 3) 60 months (dose 3)	96.7 per cent 96.8 per cent 97.4 per cent	96.5 per cent 95.6 per cent 95.2 per cent
2019	13vPCV	12 months (dose 2 or 3) 24 months (dose 3) 60 months (dose 3)	97.0 per cent 96.7 per cent 96.9 per cent	96.5 per cent 95.6 per cent 95.2 per cent
2018	13vPCV	12 months (dose 2 or 3) 24 months (dose 3) 60 months (dose 3)	95.8 per cent 96.8 per cent 96.0 per cent	95.7 per cent 95.7 per cent 93.7 per cent
2017	13vPCV	12 months (dose 2 or 3) 24 months (dose 3) 60 months (dose 3)	92.5 per cent 96.5 per cent 95.6 per cent	94.2 per cent 95.4 per cent 93.1 per cent

13vPCV vaccination coverage for older Australians, 2020-2021 [5]

Year	Vaccine	Age	Indigenous	All	Source
2021	13vPCV	70 years 71-79 years	18.8 per cent 20.7 per cent	17.2 per cent 20.1 per cent	NCIRS Annual Report 2021 [5]
2020	13vPCV	70 years 71-79 years	2.0 per cent 9.8 per cent	2.2 per cent 8.7 per cent	NCIRS Annual Report 2021 [5]

Abbreviations

Abbreviation	Description
ACIR	Australian Childhood Immunisation Register
AIR	Australian Immunisation Register
AMR	Antimicrobial Resistance
CNDSS	Canadian Notifiable Disease Surveillance System
COPD	Chronic Obstructive Pulmonary Disease
CSF	Cerebrospinal Fluid
GP	General Practitioner
HIV	Human Immunodeficiency Virus
IPD	Invasive Pneumococcal Disease
IV	Intravenous
NIP	National Immunisation Program
NNDSS	National Notifiable Diseases Surveillance System
PD	Pneumococcal Disease
UKHSA	UK Health Security Agency

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