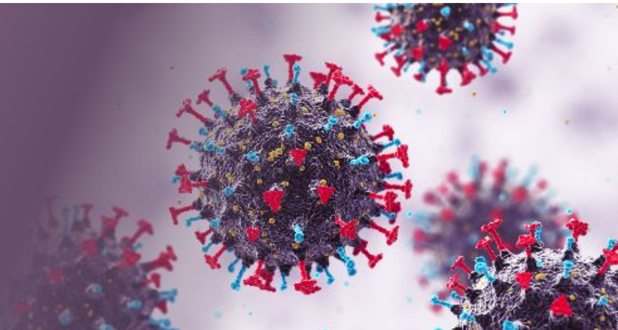
Pertussis and pneumococcal epidemiology and vaccination rate: how has the landscape changed and where do we need to focus?

11:05

Dr Rama Kandasamy

Paediatrician and immunisation specialist at the Sydney Children's Hospital Network



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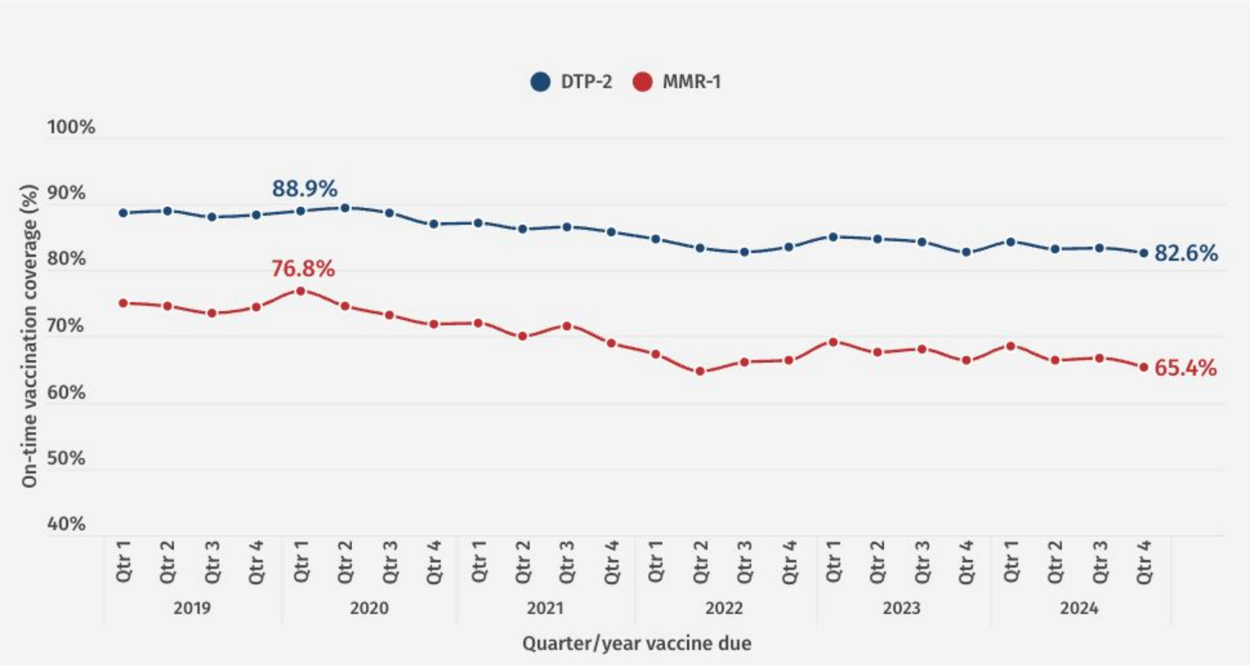
Pertussis and pneumococcal epidemiology and vaccination rates. How has the landscape changed and where do we need to focus?

Dr Rama Kandasamy
Staff Specialist Immunisation, NCIRS, The Children's Hospital at Westmead
Senior Lecturer, Faculty of Medicine and Health, University of Sydney
NHMRC Emerging Leader Investigator

Vaccine coverage

Fully vaccinated coverage

On-time vaccination



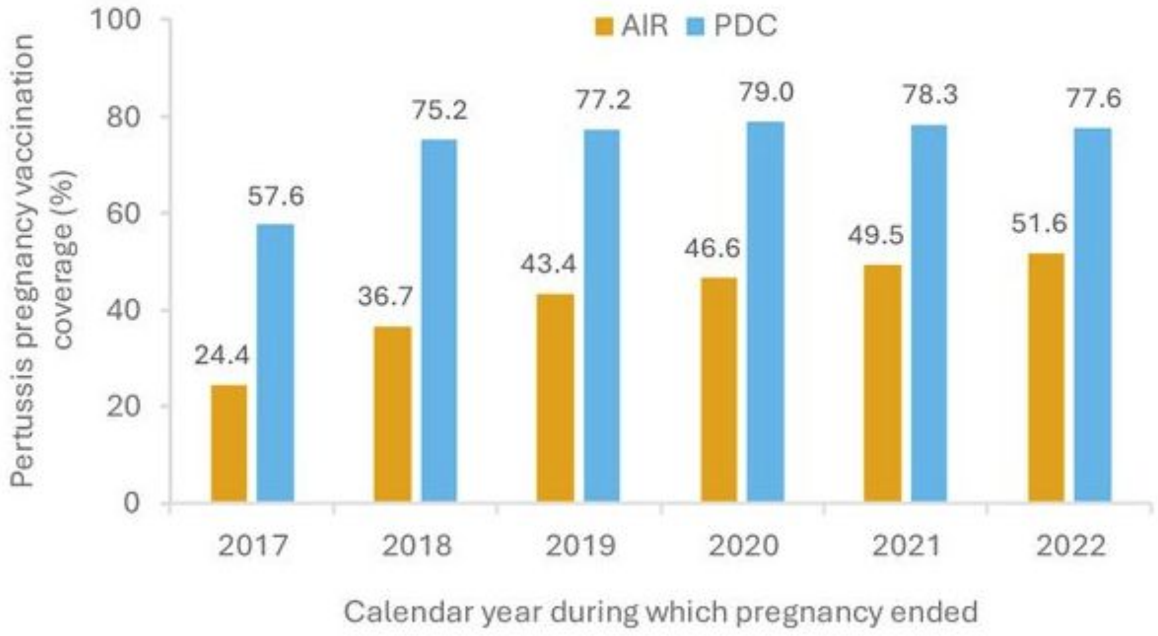
Largest decrease in coverage was noted at the 12-month time-point

Timely receipt of pertussis vaccines early in life is particularly important for reducing disease burden

https://ncirs.org.au/immunisation-coverage-data-and-reports/annual-immunisation-coverage-report-2024-interim-data#all_children

Vaccine coverage - antenatal

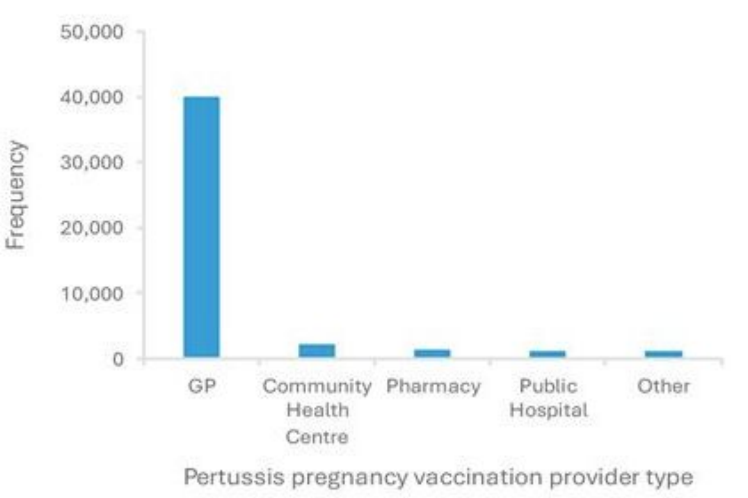
NSW antenatal pertussis vaccine coverage



Nationally funded program started in 2018

Coverage in NSW has shown a slight trend down in recent years

Different models of antenatal care likely to be a factor too



Preprint: https://www.medrxiv.org/content/10.1101/2025.01.23.25320512v1

Pertussis:

- *Bordetella pertussis*
- Gram-negative encapsulated coccobacillus

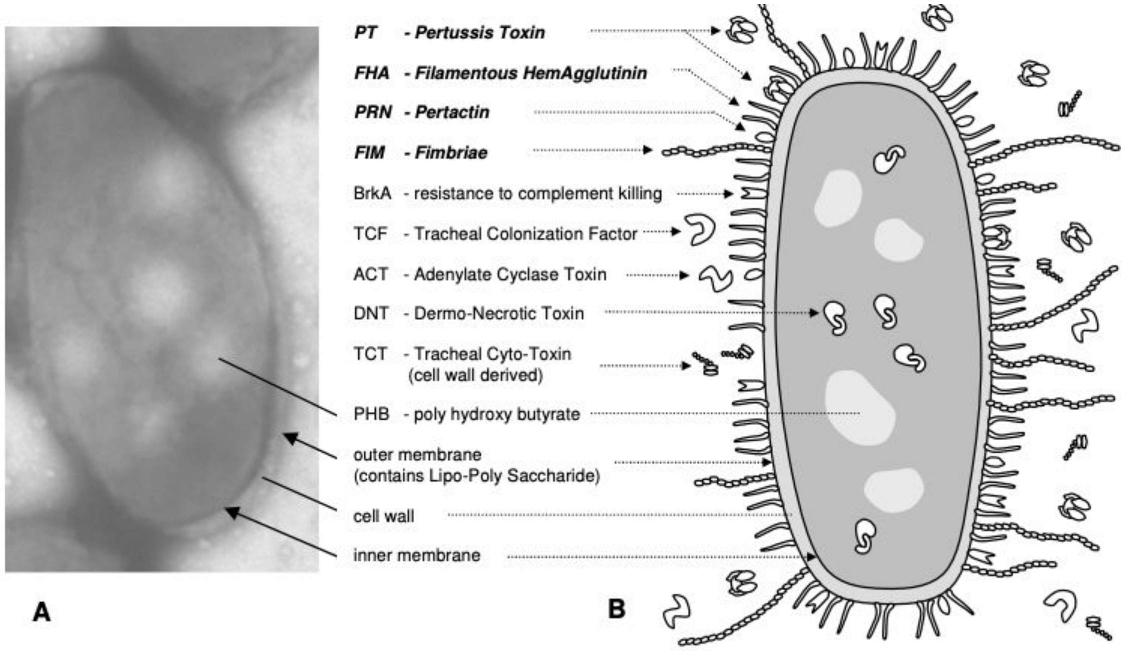


Figure 1. A: Electron microscopic picture of *B. pertussis*. B: schematic representation of *B. pertussis*, including the antigens and structures that play an important role in the ability of *B. pertussis* to cause whooping cough. The antigens that are components of acellular whooping cough vaccines are indicated in bold italics.

Whooping cough

Fever, runny nose, and cough

Paroxysms of coughing with associated colour change, apnoea and vomiting

M. Thalen. 2007, Biologicals
https://www.abc.net.au/news/2017-05-04/whooping-cough-cases-spike-northern-nsw/8497706

The current program of pertussis vaccination and how it evolved

dTpa 3rd trimester

DTPa 2, 4, 6, and 18 months

DTPa 4 years

dTpa 12 years

1906 – Pertussis first identified

1920 – Limited use of pertussis vaccine

1942 – Pertussis vaccination programs started in most jurisdictions using whole-cell vaccine

1953 – DTPw vaccine as a 3 dose schedule introduced

1975 – National recommendation and funding for DTPw at 3, 4, 5, and 18 months

1994 – Dose at 4-5 years recommended

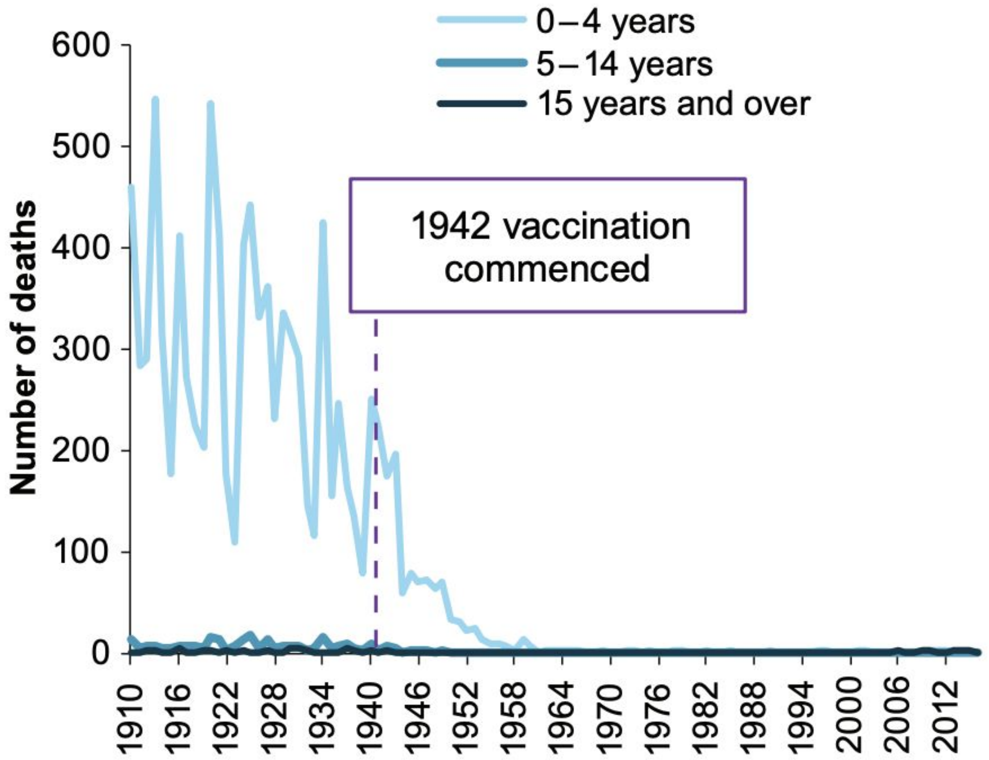
1999 – DTPa nationally recommended for all childhood DTP doses

2018 – dTpa funded for all women during 3rd trimester of pregnancy

https://www.ncirs.org.au/sites/default/files/2018-11/Diphtheria-tetanus-pertussis-history-July-2018.pdf

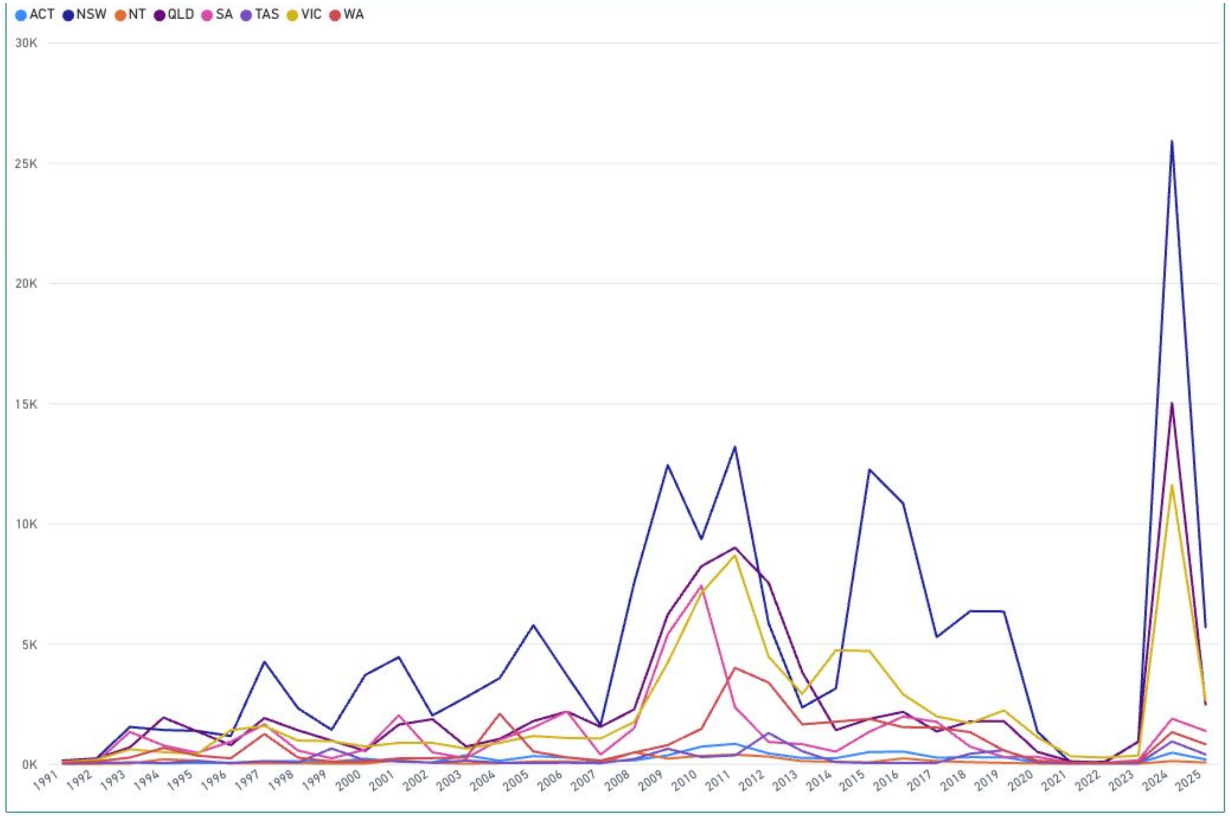
Effectiveness of the pertussis vaccination program in Australia

Mortality



Sources: AIHW analysis of National Mortality database; AIHW 2010 GRIM books.

Notifications



1991 2025

https://www.aihw.gov.au/getmedia/303c1ab7-9b04-4544-9c5d-852c533ac87a/aihw-phe-236_whoopingcough.pdf.aspx
https://nindss.health.gov.au/pbi-dashboard/
https://www1.health.gov.au/internet/main/publishing.nsf/Content/2A15CD097063EF40CA2587CE008354F1/$File/australian_vaccine_preventable_disease_epidemiological_review_series_pertussis_2013_2018.pd

Current challenges and future directions

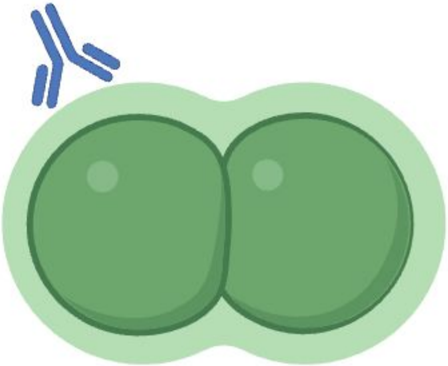
Challenges

- Limited vaccine impact on transmission
- Blunting due to maternal vaccination
- Adaptation of pertussis to vaccine use
- Downward momentum in coverage

Possible solutions

- Development of live attenuated whole cell vaccines given intranasal
  - Provides mucosal immunity
  - Wider range of surface proteins
- Need for ongoing surveillance, including molecular surveillance.
- Modelling suggesting evidence for blunting may not be observed until >5 years after introduction of maternal vaccination
- Better understanding of changes in coverage

Pneumococcus: A common cause of bacterial pneumonia and meningitis amongst young children and older adults.

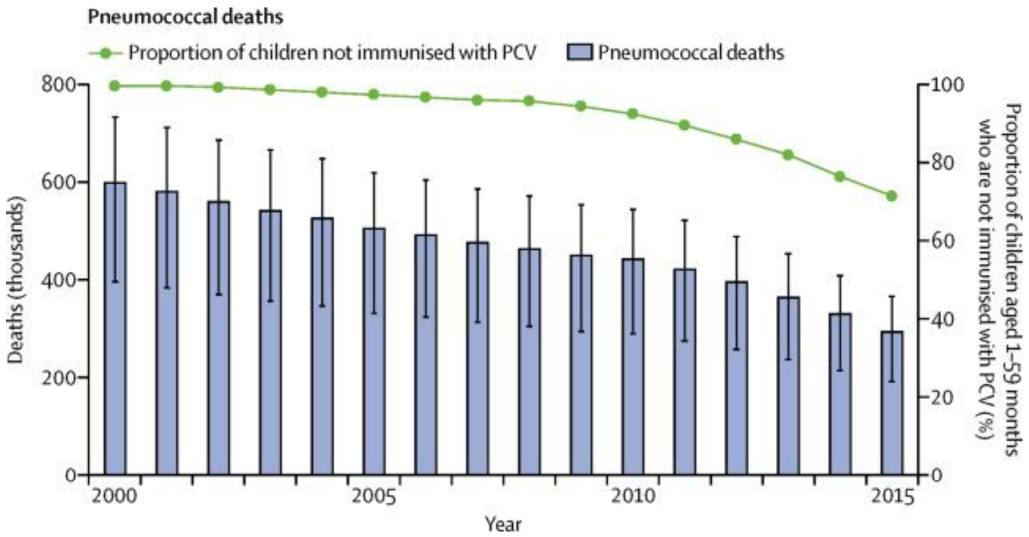


- Outer polysaccharide capsule
- Over 100 different serotypes
- Some serotypes are more likely to cause disease

2015 estimations in children under 5 years, globally
- 8.9 million cases of pneumococcal pneumonia
- 83,900 cases of pneumococcal meningitis
- 294,000 deaths

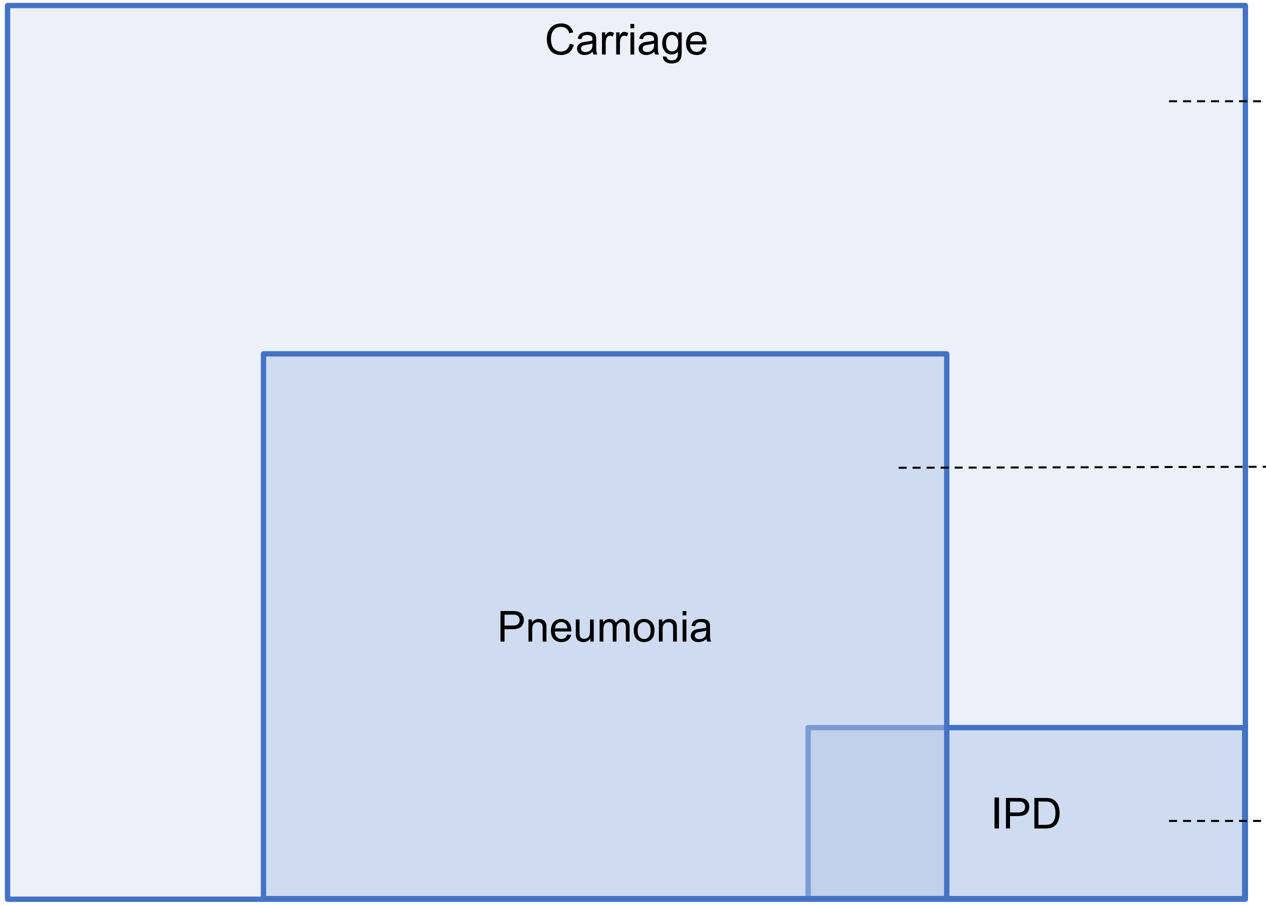
- Beta-lactams are the first line treatment of community acquired pneumonia.
- Currently very low penicillin resistance rates among disease causing pneumococci in Australia

There has been a progressive decline in disease and deaths secondary to pneumococcus through the implementation of pneumococcal conjugate vaccines among children.



https://www.thelancet.com/journals/langlo/article/PIIS2214-109X(18)30247-X/fulltext#fig2
https://www.safetyandquality.gov.au/sites/default/files/2023-11/aura_2023_fifth_australian_report_on_antimicrobial_use_and_resistance_in_human_health.pdf

The interplay between carriage and disease



~50-60% children <5 years will be carrying at any given time
Relatively low cost to conduct
Does it reflect the range of serotypes causing pneumonia and IPD?
This is main reason for using pneumococcal vaccines…. ?

Estimated incidence <5yrs : 187/100,000
No diagnostic test
This is the main reason for using pneumococcal vaccines….?

Estimated incidence <5 yrs: 21/100,000
Does it reflect the range of serotypes causing pneumonia?
This is the main reason for using pneumococcal vaccines…. ?

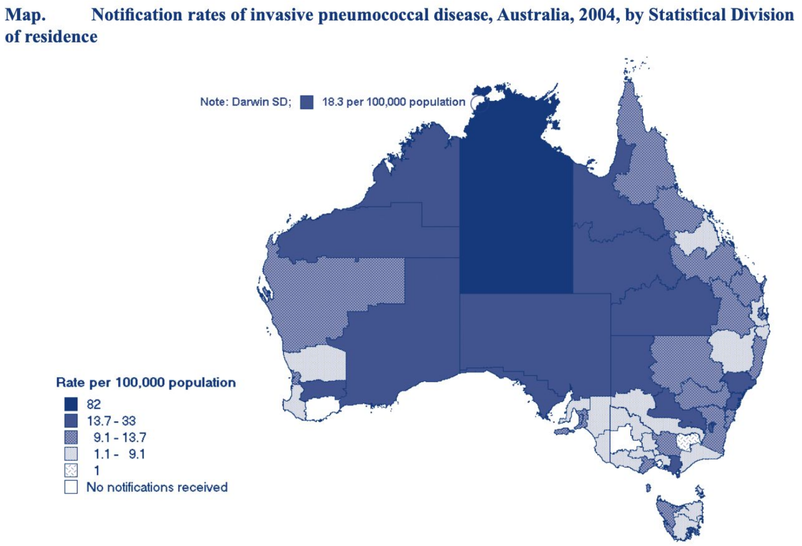
Paediatric PCV recommendations in Australia

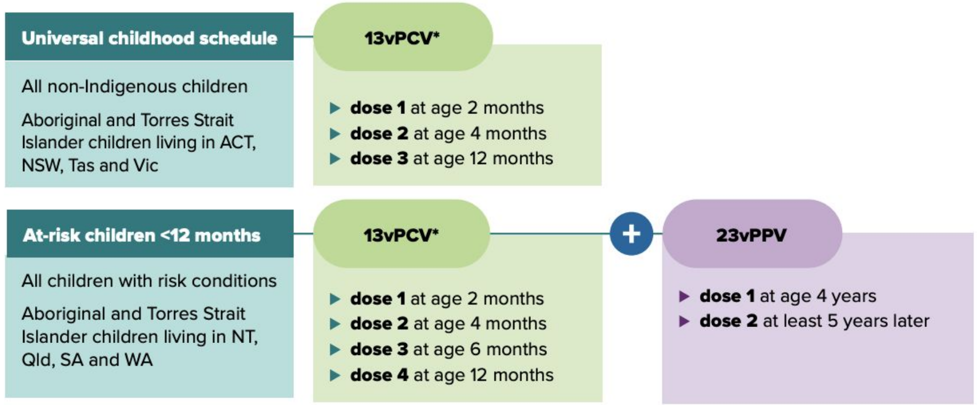
PCV7 (3+0)
Jan 2005 -> June 2011

PCV13 (3+0)
July 2011 -> June 2018

PCV13 (2+1)
July 2018 -> present

PCV15 and PCV20
PCV15 and PCV20 are available as alternatives to PCV13 but are not currently NIP-funded.

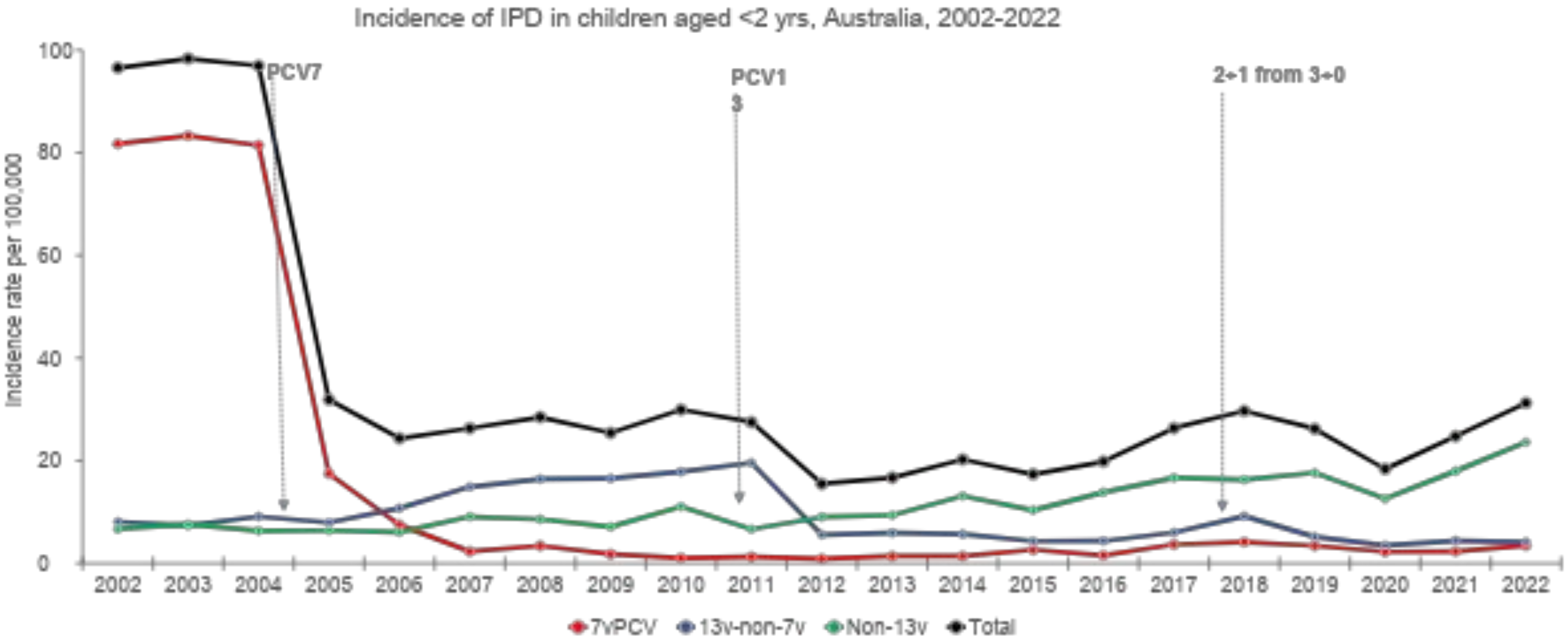




- 1880 – Pneumococcus identified by Sternberg and Pasteur
- 1911 – first pneumococcal vaccine used (killed whole-cell)
- 1930's – 1940's development of polysaccharide vaccine
- 1977 – development of PPV14
- 1983 – development of PPV23
- 1987 – First conjugated Hib vaccine licensed in the USA
- 2000 – PCV7 used in infants in USA

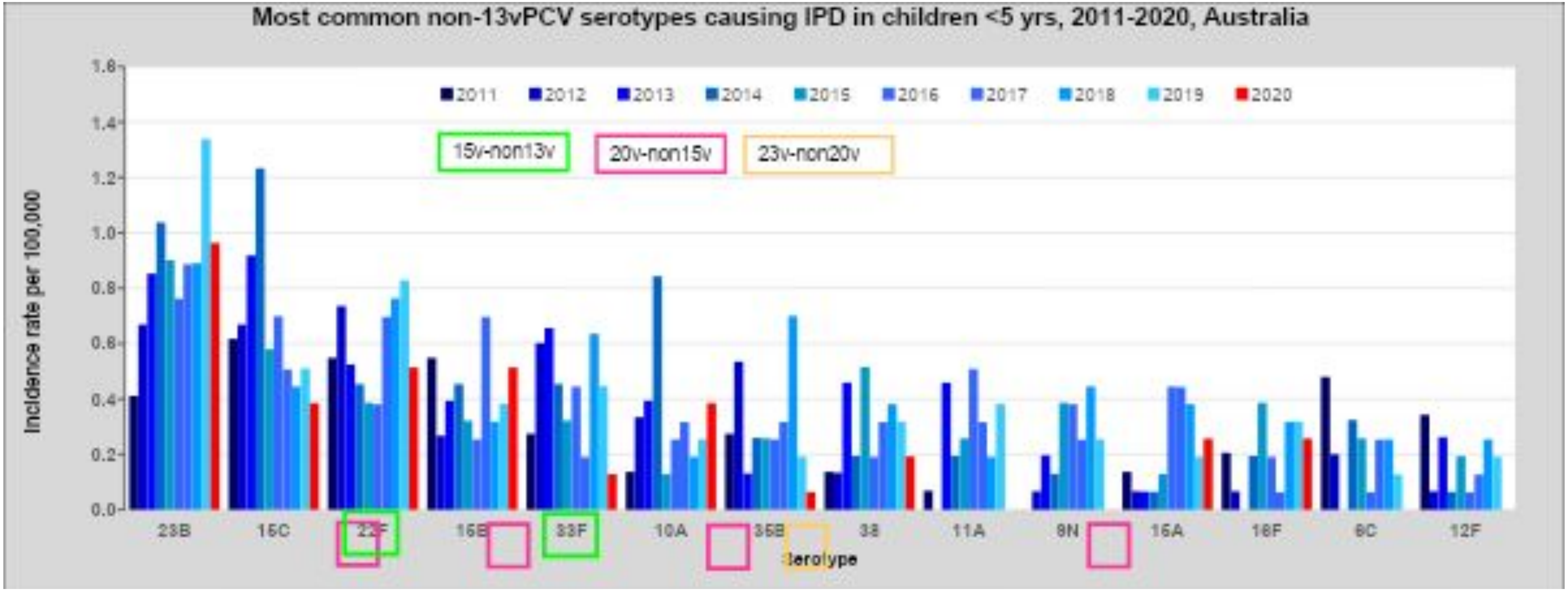
Roche et al 2006. https://www1.health.gov.au/internet/main/publishing.nsf/Content/cda-cdi3001-pdf-cnt.htm/$FILE/cdi3001.pdf

Impact of successive PCV programs in Australia on IPD



Data Source: National enhanced IPD surveillance data, NNDSS, EIPDSWG,CDNA
Data request ID# 547 (Nov)/2022, May 2023 data extract
Denominator for rate calculations: ABS estimates Sep 2022 release

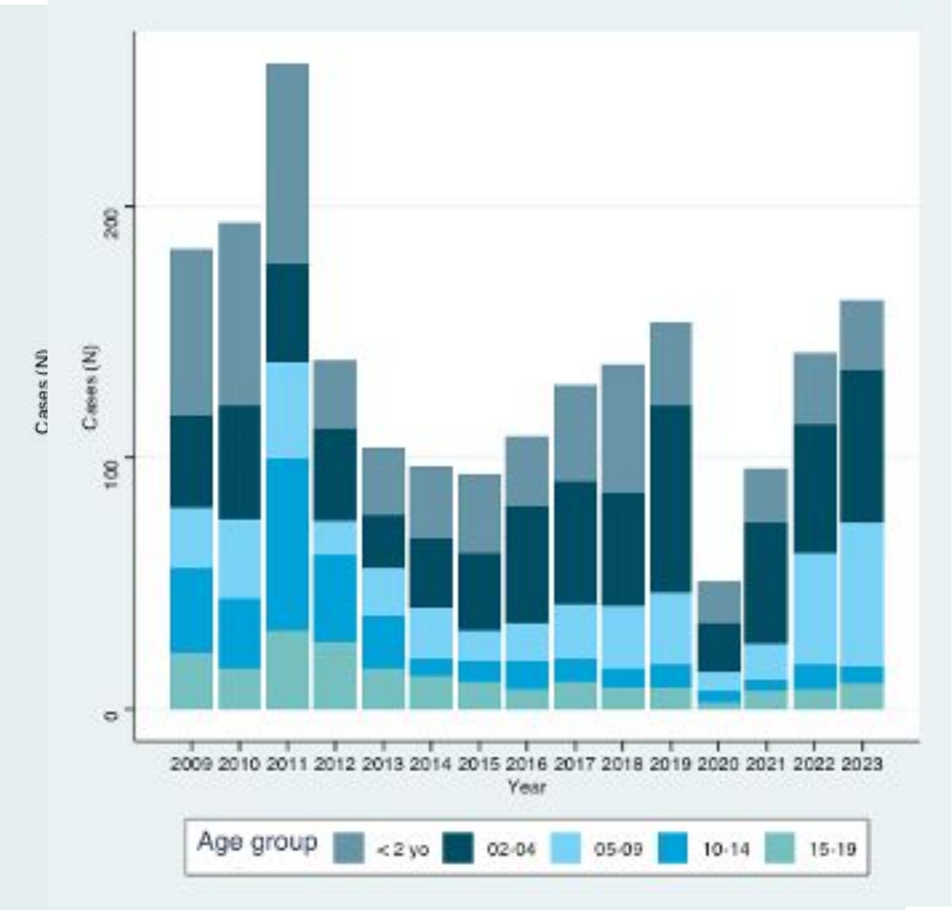
NVTs causing most IPD post PCV13, in children



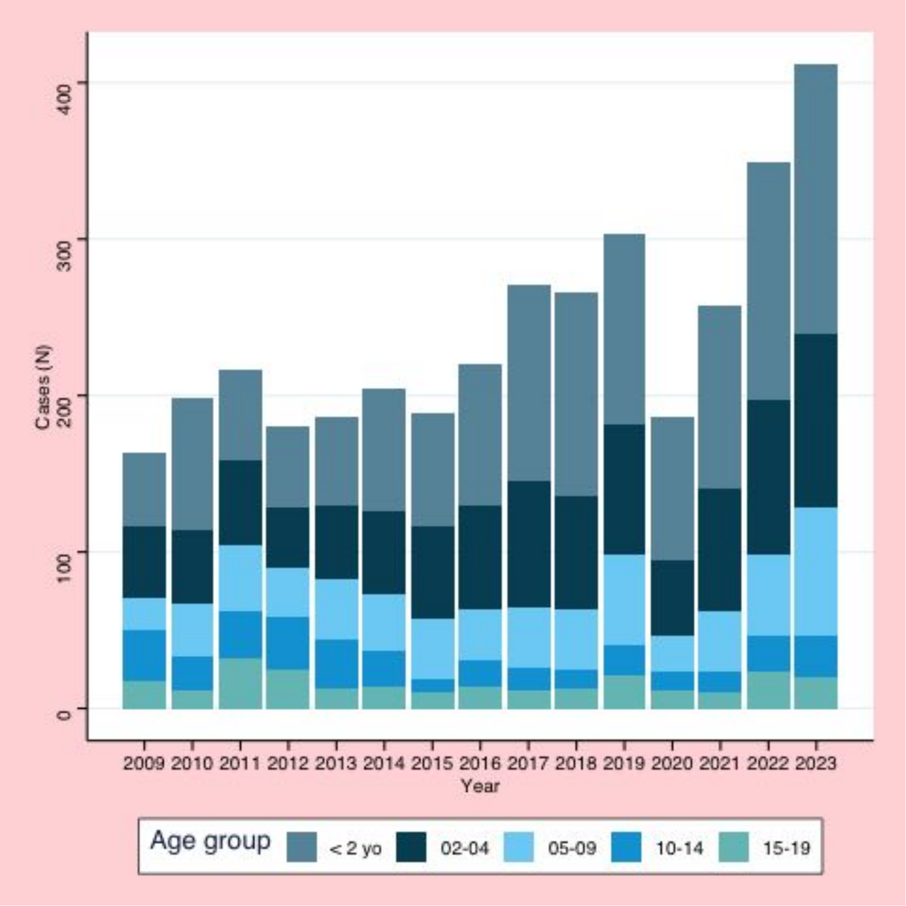
National enhanced IPD surveillance data, National Interoperable Notifiable

Is there a shift in the age distribution of disease?

IPD due to PCV13 serotypes in Australian children



IPD due to non-PCV13 serotypes in Australian children



Graphs generated from data available via the National Notifiable Diseases Surveillance System (NNDSS) public dataset – pneumococcal disease (invasive)

What about the future for pneumococcal disease prevention?

- Growing need to adapt to ongoing emergence of strains not covered by currently used PCVs.
  Will we use higher valency PCVs or multiple PCVs which cover different serotypes or something novel?

- Growing body of evidence to indicate expansion of both vaccine and non-vaccine serotype invasive disease in pre-school age children (and adults).
  Do we need a dose of PCV later in childhood?
  Could we give a combination of different PCVs
  Will new vaccine platforms provide better coverage

- There are a growing range of different vaccine products becoming available.
  IPD data are useful but don't provide the full scope of pneumococcal disease burden or vaccine effect/impact

- Human susceptibility to disease is a significant factor. Screening people for genetic variations associated with increased disease risk may help target tailored prevention strategies.

Q & A

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