Invasive pneumococcal disease in Australia, 2011 and 2012

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Abstract

In Australia, there were 1,883 cases (8.3 per 100,000 population) of invasive pneumococcal disease (IPD) notified to the National Notifiable Diseases Surveillance System (NNDSS) in 2011 and 1,823 cases (8.0 per 100,000) in 2012. The overall rate of IPD in Indigenous Australians was 9 times the rate of IPD in non-Indigenous Australians in 2011 and 7 times in 2012. Following the July 2011 introduction of the 13-valent pneumococcal conjugate vaccine (13vPCV) to the National Immunisation Program, rates of IPD in children aged less than 5 years decreased from 19.5 per 100,000 in 2011 to 12.6 per 100,000 in 2012. In Indigenous adults aged 50 years or over the rates of IPD caused by serotypes included in the 23-valent pneumococcal polysaccharide vaccine (23vPPV) continued to increase in both 2011 (47.2 per 100,000) and 2012 (51.2 per 100,000). The rates of IPD in non-Indigenous adults aged 65 years or over caused by serotypes included in the 23vPPV also increased in 2011 (10.1 per 100,000) and 2012 (11.2 per 100,000). There were 134 deaths attributable to IPD in 2011 and 126 in 2012, although it should be noted that deaths may be under-reported. The number of invasive pneumococcal isolates with reduced penicillin susceptibility remained low and reduced susceptibility to ceftriaxone/cefotaxime continued to be rare. *Commun Dis Intell* 2016;40(2):E267–E284.

Keywords: Australia, invasive pneumococcal disease, communicable disease surveillance, epidemiology, annual report

Introduction

Pneumococcal disease, caused by *Streptococcus pneumoniae,* is a major cause of morbidity and mortality worldwide.[1] Pneumococcal disease is generally classed as either noninvasive or invasive pneumococcal disease (IPD). Noninvasive forms of the disease include otitis media, sinusitis and bronchitis. Noninvasive forms of the disease are not nationally notifiable and are not discussed in this report. IPD tends to be more severe and occur when the pathogen enters the blood stream or other sterile sites resulting in clinical manifestations such as pneumonia, bacteraemia, and meningitis.[1,2] This report describes the epidemiology of IPD in Australia for the years 2011 and 2012.

The burden of pneumococcal disease is greatest in infants and the elderly and it is these groups that are mostly targeted by the National Immunisation Program (NIP). In 1999, the 23-valent pneumococcal polysaccharide vaccine (23vPPV) was first funded by the NIP for Aboriginal and Torres Strait Islander adults aged greater than 50 years. NIP-funded 23vPPV has since been extended to include all adults aged 65 years or over and medically at-risk children. The 7-valent pneumococcal conjugate vaccine (7vPCV) was first registered for use in Australia in late 2000 and in mid-2001 it was funded by the NIP for Aboriginal and Torres Strait Islander infants and other at risk children. In January 2005, NIP-funded 7vPCV was extended to all infants nationally, together with a catch-up program for all children aged less than 2 years. In 2009, 10-valent pneumococcal conjugate vaccine (10vPCV) was funded by the NIP for children residing in the Northern Territory, replacing the 7vPCV and the 23vPPV in this group. In 2011, the 13-valent pneumococcal conjugate vaccine (13vPCV) replaced both the 7vPCV and the 10vPCV on the NIP and a supplementary dose of 13vPCV was made available to eligible infants who had completed a primary course of 7vPCV or 10vPCV.[3,4]

Annual and quarterly IPD surveillance reports are published regularly in *Communicable Diseases Intelligence*. In addition, a subset of IPD notification data, including serotype, age, sex Indigenous status, clinical categories and vaccination history are publicly available from the Australian National Notifiable Diseases Surveillance System (NNDSS) IPD Public Data Set.[5]

Methods

Data collection

IPD has been a nationally notifiable disease in Australia since 2001. To varying degrees across jurisdictions, medical practitioners, laboratories and other health professionals are required under state and territory public health legislation to report cases of laboratory confirmed IPD to state and territory health authorities. The *National Health Security Act 2007* provides the legislative basis for the national notification of communicable diseases and authorises the exchange of health information between the state and territory governments and

the Commonwealth. State and territory health departments transfer these notifications regularly to the NNDSS.

Core data, including serotype, sex, age, Indigenous status, pneumococcal vaccination history and outcome (alive or dead), are collected for all notifiable cases of IPD. In addition to the core data, enhanced surveillance data on notified cases of IPD are collected and these include information relating to risk factors, clinical category, antibiotic susceptibilities and, when relevant, date died. In 2011 and 2012, core data were available for all notified cases of IPD, whereas the availability of enhanced data varied across states and territories (Table 1). The data reported in this report on mortality include deaths within the first 1 to 2 weeks of diagnosis and that overall deaths may be under-reported.

The Enhanced Invasive Pneumococcal Disease Surveillance Working Group (EIPDSWG), a working group of the Communicable Diseases Network Australia, ensures routine and standardised reporting of trends and emerging issues relating to IPD.

The data presented in this report represent a point in time analysis of notified cases of IPD in Australia. Cases having a date of diagnosis from 1 January 2011 to 31 December 2012 inclusive were extracted from the NNDSS in July 2014 and analysed with a focus on the age groups targeted by the NIP. Date of diagnosis is a derived field within the NNDSS and represents the onset date of illness, or where the onset date was not known, the earliest of the specimen collection date, the notification date, or the notification receive date. Due to the dynamic nature of the NNDSS, data in this report may vary from data reported in other NNDSS reports and reports of IPD notifications at the state or territory level.

Australian Bureau of Statistics mid-year estimated resident populations were used to calculate notification rates (per 100,000 population).[6]

Statistical significance of the change of rates of IPD notifications overall and in some selected age groups in 2011 and 2012 compared with the previous year was ascertained using incidence rate ratios (IRRs) and 95% confidence interval assuming a Poisson distribution. Statistical analyses were performed using Stata version 10 Texas, USA: Stata Corp.

The evaluation of vaccination status in this report is described in Table 2. These definitions are applied to the vaccination fields reported to the NNDSS and are agreed to by the EIPDSWG.

Table 1: Enhanced invasive pneumococcal disease surveillance data collection performed by states and territories in 2011 and 2012

Age group	State or territory
All ages	Australian Capital Territory, Northern Territory, Queensland (except Metro South and Gold Coast Public Health Units), Tasmania, South Australia, Victoria,[1] Western Australia
Under 5 years	New South Wales, Queensland (Metro South and Gold Coast Public Health Units), Victoria*
Over 50 years	New South Wales and Victoria*

* Prior to 30 June 2012, Victoria followed up the collection of enhanced data on all ages. Between 1 July and 31 December 2012, Victoria only followed up the collection of enhanced data in the under 5 years and the 50 years or over age groups.

Table 2: Definitions of vaccination status and vaccine failure used in this report

Category	Definition
Fully vaccinated	Those that have completed the primary course of the relevant vaccine(s) required for their age according to the most recent edition of *The Australian Immunisation Handbook,* at least 2 weeks prior to disease onset with at least 28 days between doses of vaccine. NB: A young child who has had all the required doses for their age but is not old enough to have completed the primary course would not be classified as fully vaccinated.
Vaccination validation	Written confirmation of vaccination through the Australian Childhood Immunisation Register, state or territory immunisation register or health record.
Vaccine failure	Where a fully vaccinated child (as defined above) is diagnosed with IPD due to a serotype covered by the administered vaccine.

Case definition

According to the national IPD case definition, only laboratory confirmed cases of IPD are notifiable and therefore reported to the NNDSS. A laboratory confirmed case IPD is defined as the detection of *S. pneumoniae* from a normally sterile site, such as blood or cerebrospinal fluid either by culture or by nucleic acid amplification testing (NAAT).[7,8] Cases that meet this case definition are referred to a pneumococcal reference laboratory for serotype identification.

Serotype identification

The serotype information in this report is obtained through 2 methods. For culture positive specimens isolated from the vast majority of cases, serotypes were determined using the Quellung reaction, the gold standard method for serotyping using antisera produced by Statens Serum Institut, Denmark. Where pneumococcus has been detected by nucleic acid amplification test only, molecular serotyping was used to identify serotypes. Molecular serotyping may also be used to confirm indeterminate or equivocal results produced by the standard serotyping method. The Australian Government, through the National IPD Laboratory Surveillance Project, funds the serotyping of all *S. pneumoniae* isolates causing invasive disease.

Indigenous status

Cases of IPD were reported indicating the Indigenous status of the individual. The definition of an Aboriginal or Torres Strait Islander person within the NNDSS aligns with the Commonwealth definition, that is, an Aboriginal or Torres Strait Islander is determined by descent, self-identification and community acceptance. Completeness of Indigenous status reporting is described in the results section of this report.

Vaccination schedule

There were several amendments to the NIP schedule in 2011 with the most notable being the replacement of the 7vPCV and the 10vPCV for all infants with the 13vPCV and the subsequent catch-up program (Table 3).[3,4] There are now 4 pneumococcal vaccines available in Australia, each targeting multiple serotypes (Table 4).[3] Note that in this report serotype analysis is generally grouped according to vaccine composition. A detailed analysis of sero-

Table 3: Amendments to the National Immunisation Program pneumococcal vaccination schedule for 2011 and 2012

Vaccine type	NIP pneumococcal vaccination schedule
7-valent pneumococcal conjugate vaccine (7vPCV)	From 2005 to July 2011, 7vPCV was funded nationally for all infants as a 3-dose primary vaccination schedule consisting of doses at 2, 4 and 6 months of age without a booster in the 2nd year of life.
10-valent pneumococcal conjugate vaccine (10vPCV)	From October 2009 to September 2011, 10vPCV replaced the use of the 7vPCV in all children aged <2 years in the Northern Territory.
13-valent pneumococcal conjugate vaccine (13vPCV)	From July 2011, the 13vPCV replaced the 7vPCV for all infants. From October 2011, the 13vPCV replaced the 10vPCV for infants in the Northern Territory. From October 2011 to September 2012, a single supplementary dose of 13vPCV for children aged 12–35 months who completed primary vaccination with either 7vPCV or 10vPCV was made available for 12 months. From October 2012, a booster dose of 13vPCV was made available for Aboriginal and Torres Strait Islander children at 12-18 months of age living in the Northern Territory, South Australia, Queensland and Western Australia.
23-valent pneumococcal polysaccharide vaccine (23vPPV)	From October 2011, the 23vPPV booster dose for Aboriginal and Torres Strait Islander children aged 18–24 months living in the Northern Territory, South Australia, Queensland and Western Australia ceased.

Table 4: *Streptococcus pneumoniae* serotypes targeted by pneumococcal vaccines

Vaccine type	Serotypes targeted by the vaccine
7-valent pneumococcal conjugate vaccine (7vPCV)	4, 6B, 9V, 14, 18C, 19F and 23F
10-valent pneumococcal conjugate vaccine (10vPCV)	1, 4, 5, 6B, 7F, 9V, 14, 18C, 19F and 23F
13-valent pneumococcal conjugate vaccine (13vPCV)	1, 3, 4, 5, 6A, 6B, 7F, 9V, 14, 18C, 19A, 19F and 23F
23-valent pneumococcal polysaccharide vaccine (23vPPV)	1, 2, 3, 4, 5, 6B, 7F, 8, 9N, 9V, 10A, 11A, 12F, 14, 15B, 17F, 18C, 19F, 19A, 20, 22F, 23F and 33F

types grouped by 10vPCV has not been included in this report as NIP-funded 10vPCV was restricted to infants residing in the Northern Territory and it was only available on the NIP for a 2 year period.

More information on the scheduling of the pneumococcal vaccination can be found in *The Australian Immunisation Handbook*.[3] The history of pneumococcal vaccination recommendations and practices is available through the National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases.[4]

Results

Invasive pneumococcal disease notifications and rates

In 2011, 1,883 cases of IPD were reported to the NNDSS, representing a rate of 8.3 per 100,000 population. This was a 12% increase in the rate of IPD compared with that in 2010 (n = 1,640; 7.4 per 100,000) (IRR 1.12, 95% CI 1.05–1.20, $P < 0.01$). In 2012, 1,823 cases of IPD were reported, representing a rate of 8.0 per 100,000 and a 3.5% decrease in the rate of IPD in 2011 (IRR 0.96, 95% CI 0.90–1.03) (Table 5).

The total number of IPD cases notified to the NNDSS in 2011 was the highest number reported in any year since 2005 when the 7vPCV for all infants and the 23vPPV for all adults aged 65 years or over was introduced to the NIP (Figure 1).

Similar to previous years, the largest number of IPD cases was notified by New South Wales (2011: n = 529; 2012: n = 581) while the Northern Territory recorded the highest jurisdiction specific rate of IPD (2011: 55.8 per 100,000; 2012: 30.5 per 100,000) in both 2011 and 2012. The Australian Capital Territory recorded the lowest rate in 2011 (n = 26, 7.1 per 100,000), while in Victoria recorded the lowest rate in 2012 (6.8 per 100,000) (Table 5).

Similar to previous years, the number of cases of IPD was greatest in the winter months with the peak number of notifications occurring in August in both 2011 (n = 257) and 2012 (n = 271) (Figure 2). The peak number of notifications for those aged less than 5 years occurred slightly earlier, in June in 2011 (n = 44) and May in 2012 (n = 26).

Figure 1: Notified cases and rates of invasive pneumococcal disease, Australia, 2002 to 2012

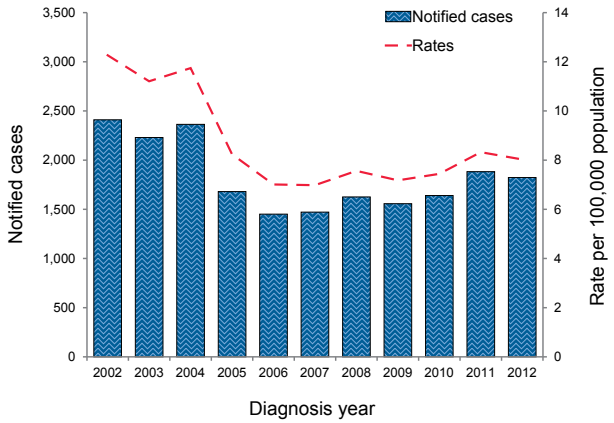
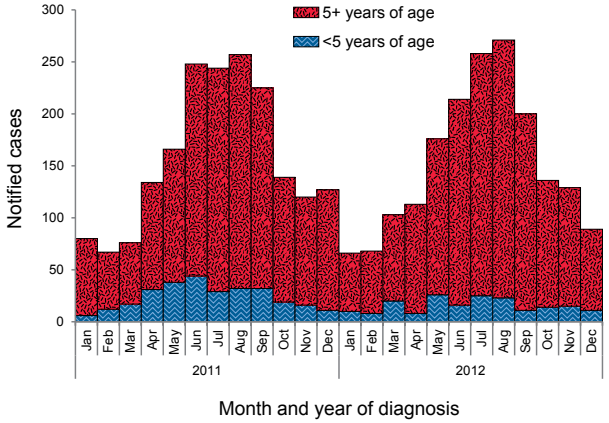


Figure 2: Notified cases of invasive pneumococcal disease, Australia, 2011 and 2012, by month, year of diagnosis and age group



Age and sex distribution

In both 2011 and 2012, in almost all age groups the notification rate of IPD was higher in males than in females. Overall, the male to female ratio was 1.2:1 in 2011 and 1.1:1 in 2012. As with previous years, the highest notification rate in 2011 was among the elderly aged 85 years or over (35.4 per 100,000) and in children aged 1 year (32.6 per 100,000). In 2012, the highest notification rates were again in the elderly aged 75 years or over while the rate in children aged 1 year reduced by 45% to 18.1 per 100,000 (IRR 0.55, 95% CI 0.39–0.78, $P < 0.01$) (Table 6). The lowest rates of IPD occurred in those aged between 10 and 29 years.

In 2011, 166 cases of IPD were notified in children aged under 2 years, representing a rate of 28.3 per 100,000. This was a 7% decrease on the rate of IPD reported in this age group in 2010 (n = 180; 30.5 per 100,000). In 2012, the rate of IPD in children aged under 2 years was 15.9 per 100,000 (n = 94) and a 44% decrease compared with the rate of IPD in 2011 (IRR 0.56, 95% CI 0.43–0.73, $P < 0.01$) (Figure 3).

Table 5: Notified cases and rates of invasive pneumococcal disease, Australia, 2011 and 2012 by state or territory, age group and Indigenous status

Age and Indigenous status	ACT	NSW	NT	Qld	SA	Tas.	Vic.	WA	Aust.
2011									
Notified cases aged <5 years									
Indigenous	0	6	13	9	1	0	0	23	52
Non-Indigenous	2	67	4	43	23	5	45	31	220
Unknown	0	0	0	6	0	0	9	0	15
Total	2	73	17	58	24	5	54	54	287
Notified cases aged 5–64 years									
Indigenous	2	11	85	33	12	1	3	93	240
Non-Indigenous	17	150	18	137	50	21	173	53	619
Unknown	0	101	0	37	1	0	40	0	179
Total	19	262	103	207	63	22	216	146	1,038
Notified cases ≥65 years									
Indigenous	0	1	6	5	0	0	0	1	13
Non-Indigenous	5	189	3	53	54	20	124	42	490
Unknown	0	4	0	17	2	0	32	0	55
Total	5	194	9	75	56	20	156	43	558
Total									
Indigenous	2	18	104	47	13	1	3	117	305
Non-Indigenous	24	406	25	233	127	46	342	126	1329
Unknown	0	105	0	60	3	0	81	0	249
Total	26	529	129	340	143	47	426	243	1,883
Rate (per 100,000 population)	7.1	7.3	55.8	7.6	8.7	9.2	7.7	10.3	8.3*
Indigenous status completeness (%)	100	80	100	82	98	100	81	100	87
2012									
Notified cases aged <5 years									
Indigenous	0	4	8	8	2	1	0	4	27
Non-Indigenous	3	62	3	18	9	4	34	16	149
Unknown	0	0	0	8	0	0	3	0	11
Total	3	66	11	34	11	5	37	20	187
Notified cases aged 5–64 years									
Indigenous	0	9	46	54	15	2	4	69	199
Non-Indigenous	16	153	7	135	58	22	133	85	609
Unknown	0	116	0	31	0	0	59	1	207
Total	16	278	53	220	73	24	196	155	1,015
Notified cases ≥65 years									
Indigenous	0	4	4	5	0	1	2	5	21
Non-Indigenous	8	233	4	74	47	15	141	55	577
Unknown	0	0	0	15	0	0	8	0	23
Total	8	237	8	94	47	16	151	60	621
Total									
Indigenous	0	17	58	67	17	4	6	78	247
Non-Indigenous	27	448	14	227	114	41	308	156	1,335
Unknown	0	116	0	54	0	0	70	1	241
Total	27	581	72	348	131	45	384	235	1,823
Rate (per 100,000 population)	7.2	8.0	30.5	7.6	7.9	8.8	6.8	9.6	8.0
Indigenous status completeness (%)	100	80	100	84	100	100	82	100	87

* Statistically significant increase compared with previous year ($P<0.01$).

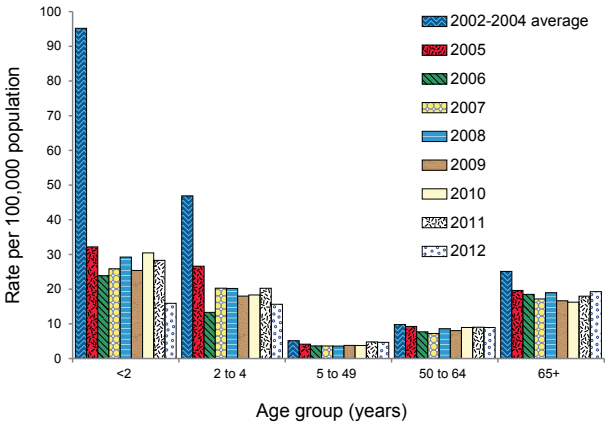
In 2011, 558 cases of IPD were notified in adults aged 65 years or over, representing a rate of 18.0 per 100,000. This was an 11% increase in the rate of IPD reported in this age group in 2010 (n = 485; 16.2 per 100,000). In 2012, 621 cases were reported in adults aged 65 years or over, representing a rate of 19.3 per 100,000 and a 7% increase on the rate of IPD reported in this age group in 2011 (Figure 3).

Table 6: Notification rates per 100,000 of invasive pneumococcal disease, Australia, 2011 and 2012, by age group and sex

Age group	Male		Female		Total	
	2011	2012	2011	2012	2011	2012
0	25.0	11.8	22.9	15.9	24.0	14.1
1	41.5	22.6	23.3	13.3	32.6	18.1*
2	16.9	14.4	15.1	13.8	16.0	14.1
3	14.5	7.9	13.1	7.6	13.8	7.8
4	11.5	8.6	10.7	10.4	11.1	9.5
0–4	21.8	13.0	17.0	12.2	19.5	12.6
5–9	7.9	4.7	6.7	4.3	7.3	4.5
10–14	2.8	3.2	3.9	2.1	3.3	2.7
15–19	3.7	3.7	2.1	1.8	2.9	2.8
20–24	2.8	1.6	2.9	3.0	2.8	2.3
25–29	3.5	3.5	3.4	3.8	3.4	3.7
30–34	4.7	6.1	5.4	4.8	5.0	5.5
35–39	6.2	6.5	4.9	8.1	5.5	7.3
40–44	8.3	8.0	5.0	5.5	6.7	6.7
45–49	8.5	6.6	4.2	6.0	6.3	6.3
50–54	7.3	8.0	5.7	7.8	6.5	7.9
55–59	8.5	9.0	7.8	7.0	8.1	8.0
60–64	12.4	12.5	13.5	10.2	13.1	11.4
65+	20.0	19.9	16.3	18.8	18.0	19.3
65–69	15.5	14.3	12.3	11.2	13.9	12.8
70–74	14.1	16.7	12.5	11.2	13.3	13.9
75–79	18.8	18.4	11.4	21.3	14.8	19.9
80–84	23.9	25.0	21.0	23.4	22.3	24.1
85+	45.8	42.9	29.7	36.4	35.4	38.7
Total	9.0	8.3	7.6	7.8	8.3	8.0

* Statistically significant increase compared with previous year (P<0.01).

Figure 3: Notification rates of invasive pneumococcal disease, Australia, 2002 to 2012, by age group



Invasive pneumococcal disease in the Indigenous population

Indigenous status was reported in 87% of notifications in both 2011 and 2012. In 2011, 305 cases of IPD were notified in the Indigenous population, representing a rate of 53.0 per 100,000 and 16% of all cases. This was a 52% increase compared with the rate of IPD in this group in 2010 (34.8 per 100,000, n = 196) (IRR 1.52, 95% CI 1.27–1.83, $P < 0.01$). In 2012, 247 cases were reported in the Indigenous population, representing a rate of 42.0 per 100,000, 14% of all cases, and a 21% decrease on the rate of IPD in this group in 2011. The increased number of notifications during 2011 and 2012 compared with previous years was mostly due to an outbreak of serotype 1 among the Indigenous populations in the Northern Territory, Western Australia and to a lesser extent Queensland (Table 7). The rate of IPD in the Indigenous population was 9 times higher than the rate of IPD in the non-Indigenous population in 2011 (6.0 per 100,000) and 7 times

Table 7: Notified cases of invasive pneumococcal disease due to serotype 1 in Indigenous Australians, Australia, 2008 to 2012, by state or territory

Year	State or territory								Total
	ACT	NSW	NT	Qld	SA	Tas.	Vic.	WA	
2008	0	0	0	2	0	0	0	0	2
2009	0	1	0	1	0	0	0	0	2
2010	0	2	6	0	4	0	0	15	27
2011	0	1	51	12	2	0	0	44	110
2012	0	0	14	20	1	0	0	15	50

higher in 2012 (6.0 per 100,000). Further analyses of the Indigenous population group are provided throughout the report.

Invasive pneumococcal disease in children by Indigenous status

The rate of IPD in Indigenous children aged less than 5 years was 73.4 per 100,000 in 2011 (n = 52) and 37.1 per 100,000 in 2012 (n = 27). The rate of IPD in Indigenous children aged less than 5 years in 2011 had increased by 37% compared with that in 2010 (n = 37, 53.5 per 100,000); however this change was not statistically significant (IRR 1.37, 95% CI 0.89–2.15). The rate in non-Indigenous children aged less than 5 years was 15.7 per 100,000 in 2011 (n = 220) and 10.6 per 100,000 in 2012 (n = 149) (Figure 4). In 2011 and 2012, the rate of IPD among Indigenous children aged less than 5 years was 4.5 to 5 times higher than the rate of IPD in non-Indigenous children.

Table 8, Figure 5 and Figure 6 show the notified cases and rates of IPD in children aged less than 5 years by Indigenous status and smaller age groups over the last decade.

The rate of IPD in Indigenous children has shown large fluctuations over the last decade due to the small number of notifications. However, the higher number of notifications among Indigenous children in 2011 is mostly due to an

Figure 4: Notified cases and rates of invasive pneumococcal disease in children aged less than 5 years, Australia, 2002 to 2012, by Indigenous status

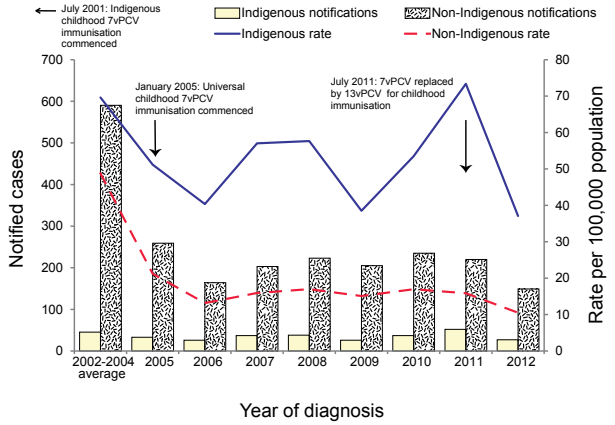


Figure 5: Notified cases and rates of invasive pneumococcal disease in Indigenous children aged less than 5 years, Australia, 2002 to 2012, by age group

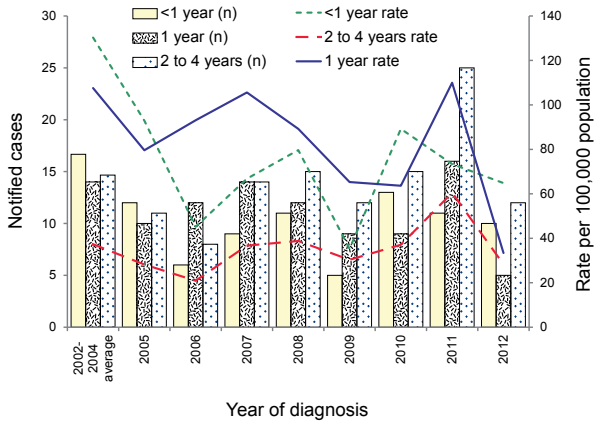


Figure 6: Notified cases and rates of invasive pneumococcal disease in non-Indigenous children aged less than 5 years, Australia, 2002 and 2012, by age group

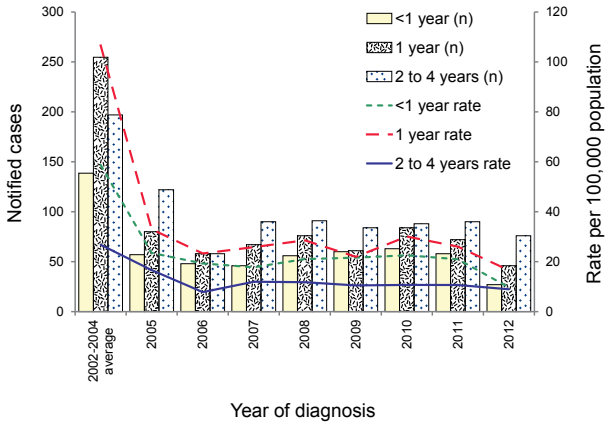


Table 8: Notified cases and rates of invasive pneumococcal disease in children aged less than 5 years, Australia, 2011 and 2012, by age group and Indigenous status

Age group		Indigenous		Non-Indigenous	
		2011	2012	2011	2012
<1 year	Number of cases	11	10	58	27
	Rate per 100,000	73.4	64.8	21.0	9.7
1 year	Number of cases	16	5	72	46
	Rate per 100,000	110.0	33.4	26.0	16.6
2 to 4 years	Number of cases	25	12	90	76
	Rate per 100,000	60.5	28.3	10.7	9.0

outbreak of serotype 1 observed in the Northern Territory, Western Australia and Queensland in that year. In 2011, 38% (20/52) of all notifications in Indigenous children were due to serotype 1 and 65% of those notifications were in Indigenous children aged 2 to 4 years (13/20).

Mortality

In 2011 and 2012, there were 134 and 126 deaths respectively, attributed to IPD and notified to NNDSS. Of those cases reported to have died, approximately 10% (n = 14) in 2011 and 7% (n = 9) in 2012 were reported as Indigenous (Table 9).

In those aged less than 5 years, there were 6 deaths associated with IPD in 2011 and 1 death in 2012 giving a case fatality rate (CFR) of 2.1% and 0.5% respectively. Of those 7 deaths, none were potentially preventable by the 7vPCV. Three of the deaths were caused by serotype 19A, which is included in the 13vPCV. However,

Table 9: Deaths reported to the National Notifiable Diseases Surveillance System and case fatality rates for invasive pneumococcal disease, Australia, 2011 and 2012, by age group, Indigenous status and state or territory

	State or territory								
	ACT	NSW	NT	Qld	SA	Tas.	Vic.	WA	Aust.†
2011									
Notified cases aged <5 years									
Deaths	0	1	0	3	0	0	0	2	6
CFR* %	0.0	N/A	0.0	N/A	0.0	0.0	0.0	3.7	2.1
Notified cases aged 5–64 years									
Deaths	1	15	4	10	5	2	9	6	52
CFR* %	5.3	N/A	3.9	N/A	7.9	9.1	N/A	4.1	5.0
Notified cases ≥ 65 years									
Deaths	0	37	1	5	4	5	18	6	76
CFR* %	0.0	N/A	11.1	N/A	7.1	25.0	11.5	14.0	13.6
Total									
Total deaths	1	53	5	18	9	7	27	14	134
Completeness %	-	-	-	-	-	-	-	-	61
Indigenous status									
Indigenous deaths	0	1	4	3	1	0	0	5	14
Non-Indigenous deaths	1	49	1	12	7	7	21	9	107
Unknown status deaths	0	3	0	3	1	0	6	0	13
2012									
Notified cases aged <5 years									
Deaths	0	0	0	0	0	0	1	0	1
CFR* %	0.0	N/A	0.0	0.0	0.0	0.0	2.7	0.0	0.5
Notified cases aged 5–64 years									
Deaths	1	11	3	7	4	3	6	2	37
CFR* %	6.3	N/A	5.7	N/A	5.5	12.5	N/A	1.3	3.6
Notified cases ≥65 years									
Deaths	2	36	2	9	2	3	24	10	88
CFR* %	25.0	N/A	25.0	9.6	4.3	18.8	15.9	16.7	14.2
Total									
Total deaths	3	47	5	16	6	6	31	12	126
Completeness %	-	-	-	-	-	-	-	-	61
Indigenous status									
Indigenous deaths	0	1	2	2	2	1	0	1	9
Non-Indigenous deaths	3	46	3	12	4	5	29	11	113
Unknown status deaths	0	0	0	2	0	0	2	0	4

* Case fatality rates (CFR) are not presented for those jurisdictions reporting less than 50% completeness of death data in that age group or if that jurisdiction does not actively follow up all cases in that age group as per Table 1.

† Total for Australia includes all jurisdictional data irrespective of individual jurisdictional data completeness.

all 3 cases received their vaccinations prior to the July 2011 introduction of the 13vPCV to the NIP. One death was caused by serotype 7F, which is also included in the 13vPCV. This case died after the introduction of the 13vPCV to the NIP but was too young for vaccination. Further details, including Indigenous status, serotype and vaccination history, of these 7 deaths are shown in Table 10.

In the 65 years or over age group, there were 76 deaths (Indigenous: n = 2; non-Indigenous: n = 74) associated with IPD in 2011 and 88 deaths (Indigenous: n = 4; non-Indigenous: n = 84) in 2012, giving CFRs of 13.6% and 14.2% respectively. Of those deaths, 76% (58/76) in 2011 and 59% (52/88) in 2012 were attributable to a serotype included in the 23vPPV. The most frequently reported 23vPPV serotypes associated with death were 19A (2011: 33%, 19/58; 2012: 27%, 14/52) and 3 (2011: 20%, 12/58; 2012: 25%, 13/52).

Risk factors

Risk factor data were provided for 62% (2,307/3,706) of cases reported in 2011 and 2012 combined. Of the cases with risk factor data reported, 80% (1,850/2,307) of cases reported at least 1 risk factor. Table 11 shows data on the risk factors for IPD in specified population subgroups for 2011 and 2012 combined.

In children aged less than 5 years, the most frequently reported known risk factor in the Indigenous population was 'Other' (65%; 26/40), e.g. asthma, previous pneumonia ,or exposure to

Table 10: Characteristics of deaths attributable to invasive pneumococcal disease in children aged less than 5 years, Australia, 2011 and 2012

Case	Year of diagnosis	Sex	Age (months)	Indigenous status	Serotype	Vaccine type and number of doses	Risk factors
1	2011	Female	22	Non-Indigenous	22F	7vPCV: 3 doses	Childcare attendee
2	2011	Male	5	Non-Indigenous	19A	7vPCV: 1 doses	No risk factor identified
3	2011	Male	12	Indigenous	19A	7vPCV: 1 doses	No risk factor identified
4	2011	Male	12	Non-Indigenous	19A	7vPCV: 3 doses	No risk factor identified
5	2011	Male	7	Non-Indigenous	11A	7vPCV: 3 doses	Unknown
6	2011	Female	1	Indigenous	23B	0	No risk factor identified
7	2012	Female	1	Non-Indigenous	7F	0	Information not supplied

Table 11: Number of risk factors reported for invasive pneumococcal disease notifications, Australia, 2011 and 2012, by risk factor and vaccine targeted population sub-group

Risk factor*	Children aged less than 5 years		Indigenous aged 50 years or over	Non-Indigenous aged 65 years or over
	Indigenous	Non-Indigenous		
Premature (<37 weeks gestation)	10	21	N/A	N/A
Congenital or chromosomal abnormality	4	15	0	0
Anatomic or functional asplenia	0	1	0	14
Immunocompromised	2	22	21	189
Chronic illness	12	20	91	498
Childcare attendee	6	57	N/A	N/A
Previous episode of IPD	4	4	8	14
Other†	26	20	71	371
No risk factor identified	26	105	2	49
Unknown or not reported	13	145	14	302
Total known risk factors	40	119	111	716
Total	79	369	127	1,067

* Case may be reported with more than 1 risk factor.

† Other risk factors include but are not limited to, asthma, previous pneumonia and exposure to smoke.

smoke, followed by chronic illness (30%; 12/40). In the non-Indigenous population, the most frequently reported known risk factor was childcare attendee (48%; 57/119) followed by immunocompromised (18%; 22/119).

In both the adult population groups described in Table 11, the most frequently reported known risk factor was chronic illness (Indigenous aged 50 years or over: 82%, 91/111; non-Indigenous aged 65 years or over: 70%, 498/716) followed by 'Other' (Indigenous aged 50 years or over: 64%, 71/111; non-Indigenous aged 65 years or over: 52%, 371/716).

Pneumococcal serotypes causing invasive disease

Pneumococcal serotypes were identified for 94% (1,775/1,883) of cases in 2011 and 95% (1,729/1,823) of cases in 2012. Of those cases with a serotype identified:

- 8% (139/1,775) of cases in 2011 and 7% (124/1,729) of cases in 2012 were due to a serotype included in the 7vPCV;
- 19% (340/1,775) of cases in 2011 and 18% (312/1,1729) of cases in 2012 were due to one of the additional 3 serotypes (1, 5 and 7F) included in the 10vPCV [10vPCV (non-7vPCV)];
- 32% (561/1,775) of cases in 2011 and 27% (462/1,1729) of cases in 2012 were due to one of the additional 3 serotypes (3, 6A and 19A) included in the 13vPCV [13vPCV (non-10vPCV)]; and
- 69% (1,227/1,775) of cases in 2011 and 67% (1,153/1,729) of cases in 2012 were due to one of the additional 16 serotypes included in the 23vPPV that are not included in the 7vPCV [23vPPV (non-7vPCV)].

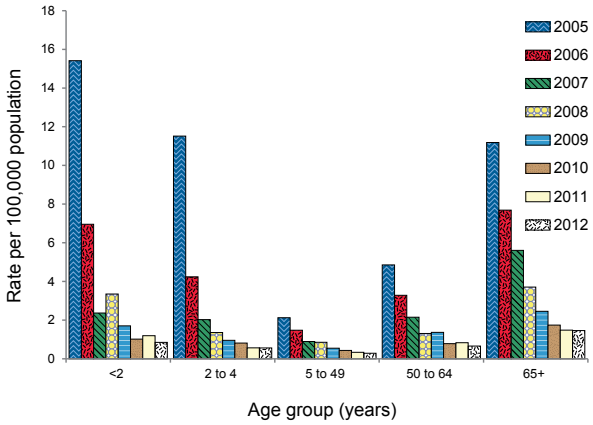
Table 12 and Table 13 shows data on serotypes, grouped by pneumococcal vaccine, age group and Indigenous status for 2011 and 2012. Note that these tables do not include cases with an unknown Indigenous status.

In 2011 and 2012, the most frequently reported serotypes causing IPD were 19A (2011: n = 430; 2012: n = 293), 7F (2011: n = 184; 2012: n = 213), 1 (2011: n = 155; 2012: n = 97), 3 (2011: n = 120; 2012: n = 156), 22F (2011: n = 114; 2012: n = 137) and 6C (2011: n = 108; 2012: n = 96). These 6 serotypes accounted for 59% (1,111/1,883) of all notifications in 2011 and 54% (992/1,823) in 2012.

7-valent pneumococcal conjugate vaccine serotypes

In 2011, 139 cases of IPD due to serotypes included in the 7vPCV were notified, representing a rate of 0.6 per 100,000. This was a 10% decrease on the number in 2010 (n = 155) and an 85% decrease on the number in 2005 (n = 909). In 2012, 124 cases of IPD due to 7vPCV serotypes were notified (0.5 per 100,000), which was an 11% decrease on the number in 2011 and an 86% decrease on the number recorded in 2005. Since the 2005 introduction of the 7vPCV, there has been an overall decrease in the notification rate of IPD due to serotypes included in the 7vPCV across all age groups. However, in recent years this decline appears to have plateaued across all age groups (Figure 7).

Figure 7: Notification rates for invasive pneumococcal disease caused by 7vPCV serotypes, Australia, 2005 to 2012, by age group



In children aged less than 5 years, there were 12 cases of IPD due to 7vPCV serotypes reported in 2011 (0.8 per 100,000) and 10 cases in 2012 (0.7 per 100,000). In both 2011 and 2012, the rate of IPD due to 7vPCV serotypes in Indigenous children aged less than 5 years remained unchanged from the 2010 rate of 1.4 per 100,000 (2011: n = 1; 2012: n = 1). In non-Indigenous children, there were 10 cases of IPD due to 7vPCV serotypes in 2011 (0.7 per 100,000) and 8 cases in 2012 (0.6 per 100,000) (Figure 8). One case of IPD due to a 7vPCV serotype in 2011 and 1 case in 2012 was reported with an unknown Indigenous status.

In the period (January 2005 to July 2011) that the 7vPCV was available on the NIP to children aged less than 5 years, there was an overall increase in the rate of IPD due to non-7vPCV serotypes in this age group, with 257 cases (17.5 per 100,000)

Table 12: Notified cases of invasive pneumococcal disease, Australia, 2011, by pneumococcal vaccine serotypes, age and Indigenous status*

	Indigenous			Non-Indigenous		
Vaccine type	n	%	Cumulative (%)	n	%	Cumulative (%)
<5 years						
7vPCV	1	2	2	10	5	5
10vPCV (non-7vPCV)	20	40	42	22	11	16
13vPCV (non-10vPCV)	10	20	62	123	60	76
Non-conjugate serotypes	19	38	100	49	24	100
Total	50	100		204	100	
23vPPV (non-7vPCV)	41	82		164	80	
5-49 years						
7vPCV	14	7	7	21	7	7
10vPCV (non-7vPCV)	91	48	56	94	30	36
13vPCV (non-10vPCV)	14	7	63	92	29	65
Non-conjugate serotypes	70	37	100	110	35	100
Total	189	100		317	100	
23vPPV (non-7vPCV)	141	75		236	74	
50-64 years						
7vPCV	2	4	4	31	12	12
10vPCV (non-7vPCV)	10	22	26	35	13	25
13vPCV (non-10vPCV)	8	17	43	86	32	57
Non-conjugate serotypes	26	57	100	116	43	100
Total	46	100		268	100	
23vPPV (non-7vPCV)	29	63		184	69	
65+ years						
7vPCV	1	8	8	43	9	9
10vPCV (non-7vPCV)	1	8	17	27	6	15
13vPCV (non-10vPCV)	2	17	33	153	33	48
Non-conjugate serotypes	8	67	100	243	52	100
Total	12	100		466	100	
23vPPV (non-7vPCV)	4	33		269	58	
Total						
7vPCV	18	6	6	105	8	8
10vPCV (non-7vPCV)	122	41	47	178	14	23
13vPCV (non-10vPCV)	34	11	59	454	36	59
Non-conjugate serotypes	123	41	100	518	41	100
Total	297	100		1,255	100	
23vPPV (non-7vPCV)	215	72		853	68	

* Does not include cases with an unknown Indigenous status

reported in 2011. In 2012, following the NIP schedule change from 7vPCV to 13vPCV, there was a 35% reduction in cases due to non-7vPCV serotypes (n = 167; 11.3 per 100,000).

In 2011, 49 cases of IPD due to non-7vPCV serotypes in Indigenous children aged less than 5 years were notified, representing a rate of 69.1 per 100,000. In 2012, 26 cases of IPD due to non-7vPCV serotypes were notified (35.7 per 100,000), which was a 47% decrease on the number of notifications in 2011. In non-Indigenous children aged less than 5 years, the number of notifications due to non-7vPCV serotypes in 2012 (n = 133; 9.4 per 100,000) was a 31% decrease on the number of notifications in this group in 2011 (n = 194; 13.8 per 100,000) (Figure 8).

Table 13: Notified cases of invasive pneumococcal disease, Australia, 2012, by pneumococcal vaccine serotypes, age and Indigenous status

Vaccine type	Indigenous			Non-Indigenous		
	n	%	Cumulative (%)	n	%	Cumulative (%)
<5 years						
7vPCV	1	4	4	8	6	6
10vPCV (non-7vPCV)	9	33	37	12	9	14
13vPCV (non-10vPCV)	2	7	44	55	39	53
Non-conjugate serotypes	15	56	100	66	47	100
Total	27	100		141	100	
23vPPV (non-7vPCV)	17	63		93	66	
5-49 years						
7vPCV	11	7	7	16	6	6
10vPCV (non-7vPCV)	50	33	40	89	31	36
13vPCV (non-10vPCV)	10	7	46	78	27	63
Non-conjugate serotypes	82	54	100	106	37	100
Total	153	100		289	100	
23vPPV (non-7vPCV)	100	65		223	77	
50-64 years						
7vPCV	3	7	7	22	8	8
10vPCV (non-7vPCV)	8	18	25	42	14	22
13vPCV (non-10vPCV)	5	11	36	87	30	52
Non-conjugate serotypes	28	64	100	140	48	100
Total	44	100		291	100	
23vPPV (non-7vPCV)	22	50		208	71	
65+ years						
7vPCV	1	5	5	46	8	8
10vPCV (non-7vPCV)	5	25	30	34	6	15
13vPCV (non-10vPCV)	6	30	60	163	30	44
Non-conjugate serotypes	8	40	100	304	56	100
Total	20	100		547	100	
23vPPV (non-7vPCV)	15	75		314	57	
Total						
7vPCV	16	7	7	92	7	7
10vPCV (non-7vPCV)	72	30	36	177	14	21
13vPCV (non-10vPCV)	23	9	45	383	30	51
Non-conjugate serotypes	133	55	100	616	49	100
Total	244	100		1,268	100	
23vPPV (non-7vPCV)	154	63		838	66	

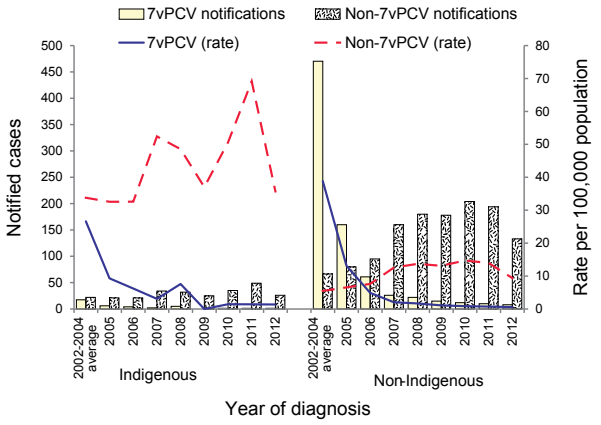
* Does not include cases with an unknown Indigenous status.

13-valent pneumococcal conjugate vaccine serotypes

In 2011, there were 182 cases of IPD in children aged less than 5 years due to the 6 additional serotypes included in the 13vPCV (1, 5, 7F, 3, 6A and 19A) over the 7vPCV [13vPCV (non-7vPCV)], representing a rate of 12.4 per 100,000. In 2012, following the July 2011 NIP schedule change from 7vPCV to 13PCV, there were 82 cases of IPD in children aged less than 5 years due to those 13vPCV (non-7vPCV) serotypes (5.5 per 100,000). This was a 55% decrease on the number of cases reported in 2011.

In Indigenous children aged less than 5 years, there was an overall reduction in the number of IPD cases caused by 13vPCV (non-7vPCV) serotypes,

Figure 8: Notified cases and rates of invasive pneumococcal disease caused by 7vPCV and non-7vPCV in children aged less than 5 years, 2002 to 2012, by Indigenous status



in particular serotypes 1 and 19A, following the introduction of the 13vPCV to the NIP. In 2011, there were 8 cases of IPD in Indigenous children due to serotype 19A and 20 cases due to serotype 1. In 2012, cases of IPD in Indigenous children due to 19A reduced by 75% (n = 2) while cases due to serotype 1 also reduced by 75% (n = 5). Overall, the rate of IPD in Indigenous children due to 13vPCV (non-7vPCV) serotypes reduced from 42.3 per 100,000 in 2011 to 15.1 per 100,000 in 2012 (Figure 9).

Similarly, in non-Indigenous children aged less than 5 years, there was an overall reduction in IPD cases caused by 13vPCV (non-7vPCV) serotypes following the introduction of the 13vPCV to the NIP and this was mostly due to a reduction in IPD caused by 19A. There were 114 cases of IPD in non-Indigenous children due to serotype 19A in 2011 and 42 in 2012. IPD cases in non-Indigenous children due to serotype 7F decreased from 14 cases in 2011 to 9 cases in 2012, while cases due to serotype 3 increased from 9 cases in 2011 to 12 cases in 2012. Overall, the rate of IPD in non-Indigenous children due to 13vPCV (non-7vPCV) serotypes reduced from 10.3 per 100,000 in 2011 to 4.8 per 100,000 in 2012 (Figure 9).

Note that in the last decade there have been no cases of IPD due to serotype 5 notified in children aged less than 5 years.

23-valent pneumococcal polysaccharide vaccine serotypes

In Indigenous adults aged 50 years or over, the number of notifications caused by serotypes included in the 23vPPV has continued to show an overall increase with 36 cases (47.2 per 100,000) reported in 2011 and 41 cases (51.2 per 100,000) in 2012. Unlike previous years, the number of notifications due to 23vPPV serotypes in non-Indigenous adults aged 65 years or over increased in both 2011 (n = 312, 10.1 per 100,000) and 2012 (n = 360, 11.2 per 100,000) (Figure 10).

In Indigenous adults aged 50 years or over, the number of notifications due to non-23vPPV serotypes remained steady with 22 cases in 2011 (28.8 per 100,000) and 23 cases in 2012 (28.7 per 100,000). The number of notifications caused by non-23vPPV serotypes in non-Indigenous adults aged 65 years or over continued to show an overall increase with 154 cases in 2011 (5.0 per 100,000) and 187 cases in 2012 (5.8 per 100,000) (Figure 10).

In both 2011 and 2012, the most frequent serotype causing disease in Indigenous adults aged 50 years

Figure 9: Notified cases and rates of invasive pneumococcal disease caused by 13vPCV (non-7vPCV) serotypes in children aged less than 5 years, 2002 to 2012, by Indigenous status

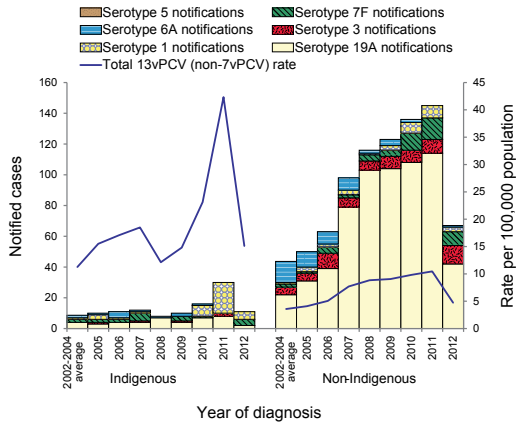
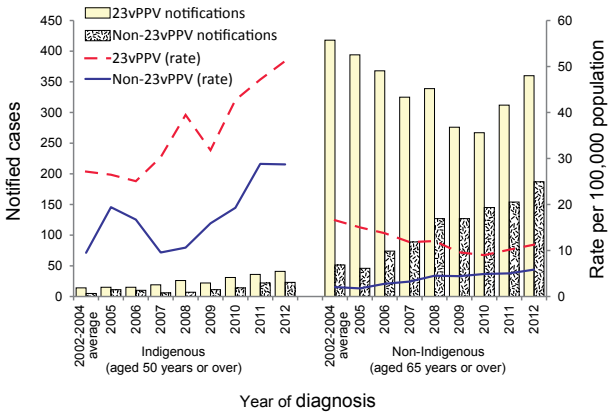


Figure 10: Notified cases and rates of 23vPPV and non-23vPPV serotypes causing invasive pneumococcal disease in Indigenous adults aged 50 years or over and non-Indigenous adults aged 65 years or over, 2002 to 2012



or over was serotype 1 (2011: n = 8; 2012: n = 9) and a result of the serotype 1 outbreak observed over that period. The 5-year mean of serotype 1 notifications during the 5 years prior to 2011 was 1.8 notifications. The next most frequent serotype was 19A (n = 6) and 6C (n = 6) in 2011 and 3 in 2012 (n = 5). In both 2011 and 2012, the number of notifications due to serotype 6A in Indigenous adults aged 50 years or over remained similar to previous years (2011: n = 0; 2012: n = 2).

In both 2011 and 2012, the most frequent serotype causing disease in non-Indigenous adults aged 65 years or over was serotype 19A (2011: n = 109; 2012: n = 90). The next most frequent serotype was 6C (n = 56) in 2011 and 3 in 2012 (n = 67). The number of notifications due to serotype 6A in non-Indigenous adults aged 65 years or over has continued to decline, with the number of notifications in 2011 (n = 5) and 2012 (n = 6) being half that of the number notified in 2010 (n = 12).

Vaccine failures

In children aged less than 5 years who were fully vaccinated, there were 6 cases in 2011 and 10 cases in 2012 that were considered to be a vaccine failure according to the definition described in Table 2. In 2011 and 2012 combined, 13 cases were characterised as a 7vPCV failure, 2 cases were a 13vPCV failure and the remaining case was a 10vPCV failure. Serotype 19F was reported as the cause of disease in 63% (n = 10) of these cases (Table 14).

Antibiotic resistance

Penicillin and ceftriaxone/cefotaxime susceptibility data were analysed only for jurisdictions that reported susceptibility data for more than 50% of cases. In 2011, penicillin and ceftriaxone/cefotaxime susceptibility completeness was suitable for reporting for all jurisdictions except Victoria. In 2012, penicillin and ceftriaxone/cefotaxime susceptibility completeness was suitable for reporting for all jurisdictions except Western Australia.

Penicillin

Penicillin susceptibility data were reported for 68% (1,275/1,883) of cases in 2011 and 76% (1,389/1,823) of cases in 2012; and of those, 12% (151/1,275) of cases in 2011 and 10% (132/1,389) of cases in 2012 were reported with reduced susceptibility to penicillin (Table 15). Of those cases with reduced susceptibility to penicillin in 2011 (excluding Victoria), 149 cases were serotyped. Of those serotyped cases, 17% (26/149) were due to a serotype in the 7vPCV, 85% (126/149) were due to a serotype in the 23vPPV and serotypes 9V (n = 4), 19A (n = 93) and 19F (n = 14) accounted for 75% (111/149) of serotyped cases.

Table 14: Characteristics of vaccine failures in children aged less than 5 years, Australia, 2011 and 2012

Case	Year of diagnosis	Age	Indigenous status	Serotype	Vaccine type and number of doses	Clinical category	Risk factors
1	2011	3 years	Non-Indigenous	14	7vPCV: 3 doses	Bacteraemia	Yes
2	2011	4 years	Indigenous	18C	7vPCV: 3 doses	Bacteraemia	Yes
3	2011	10 months	Non-Indigenous	19F	7vPCV: 3 doses	Pneumonia	Unknown
4	2011	2 years	Not reported	19F	7vPCV: 3 doses	Bacteraemia	No
5	2011	2 years	Non-Indigenous	19F	7vPCV: 3 doses	Other	Unknown
6	2011	3 years	Non-Indigenous	19F	7vPCV: 3 doses	Pneumonia	Yes
7	2012	3 years	Indigenous	9V	7vPCV: 1 dose & 10vPCV: 3 doses	Pneumonia	Yes
8	2012	12 months	Non-Indigenous	19A	13vPCV: 3 doses	Pneumonia	Unknown
9	2012	16 months	Non-Indigenous	19F	13vPCV: 3 doses	Septic arthritis	Unknown
10	2012	20 months	Non-Indigenous	19F	7vPCV: 3 doses	Bacteraemia	Unknown
11	2012	22 months	Non-Indigenous	4	7vPCV: 3 doses	Pneumonia	No
12	2012	2 years	Non-Indigenous	19F	7vPCV: 3 doses	Pneumonia	Yes
13	2012	20 months	Non-Indigenous	19F	7vPCV: 3 doses	Bacteraemia	Yes
14	2012	3 years	Non-Indigenous	19F	7vPCV: 3 doses	Bacteraemia	Yes
15	2012	4 years	Non-Indigenous	19F	7vPCV: 3 doses	Pneumonia plus Other sterile site not specified	Yes
16	2012	2 years	Non-Indigenous	6B	7vPCV: 3 doses	Meningitis	Yes

Of those cases with reduced susceptibility to penicillin in 2012 (excluding Western Australia), 126 cases were serotyped. Of those serotyped cases, 17% (22/126) were due to a serotype in the 7vPCV, 60% (76/126) were due to a serotype in the 23vPPV and serotypes 9V (n = 9), 19A (n = 59) and 19F (n = 7) accounted for 60% (75/126) of serotyped cases.

Ceftriaxone/cefotaxime

Ceftriaxone/cefotaxime susceptibility was reported in 59% (1,118/1,883) of cases in 2011 and 68% (1,242/1,823) of cases in 2012; of those, 2% (22/1,118) of cases in 2011 and 2% (20/1,242) of cases in 2012 were reported with reduced susceptibility to ceftriaxone/cefotaxime (Table 15).

Of those cases with reduced susceptibility to ceftriaxone/cefotaxime in 2011 (excluding Victoria), 22 cases were serotyped. Of those serotyped cases, 50% (11/22) were due to a serotype in the 7vPCV, 59% (13/22) were due to a serotype in the 23vPPV and serotypes 9V (n = 2), 19A (n = 10) and 19F (n = 7) accounted for 86% (19/22) of serotyped cases.

Of those cases with reduced susceptibility to ceftriaxone/cefotaxime in 2012 (excluding Western Australia), 18 cases were serotyped. Of those serotyped cases, 39% (7/18) were due to a serotype in the 7vPCV, 61% (11/18) were due to a serotype in the 23vPPV and serotypes 9V (n = 1), 19A (n = 10) and 19F (n = 6) accounted for 94% (17/18) of serotyped cases with reduced susceptibility to the third generation cephalosporins.

Table 15: *Streptococcus pneumoniae* susceptibility to penicillin and ceftriaxone/cefotaxime for selected states and territories,* 2011 and 2012

	9V	19F	All 7vPCV serotypes	19A	All 23vPPV	Not specified	All isolates
2011							
Penicillin							
Resistant	1	6	11	16	27	1	30
Intermediate	3	8	15	77	99	1	121
Sensitive	10	20	75	200	853	30	1,124
Total tested	14	34	101	293	979	32	1,275
Total isolates with reduced susceptibility (%)	4 (29%)	14 (41%)	26 (26%)	93 (32%)	126 (13%)	2 (6%)	151 (12%)
Ceftriaxone/cefotaxime							
Resistant	1	2	3	2	3	0	6
Intermediate	1	5	8	8	10	0	16
Sensitive	10	20	73	264	815	16	1,096
Total tested	12	27	84	274	828	16	1,118
Total isolates with reduced susceptibility (%)	2 (17%)	7 (26%)	11 (13%)	10 (4%)	13 (2%)	0 (0%)	22 (2%)
2012							
Penicillin							
Resistant	6	6	13	20	24	2	47
Intermediate	3	1	9	39	52	4	85
Sensitive	10	25	72	183	876	31	1,257
Total tested	19	32	94	242	952	37	1,389
Total isolates with reduced susceptibility (%)	9 (47%)	7 (22%)	22 (23%)	59 (24%)	76 (8%)	6 (16%)	132 (10%)
Ceftriaxone/cefotaxime							
Resistant	1	2	3	3	4	2	9
Intermediate	0	4	4	7	7	0	11
Sensitive	13	23	76	213	845	23	1,222
Total tested	14	29	83	223	856	25	1,242
Total isolates with reduced susceptibility (%)	1 (7%)	6 (21%)	7 (8%)	10 (4%)	11 (1%)	2 (8%)	20 (2%)

* Susceptibility data are restricted to jurisdictions with completeness suitable for reporting, that is, greater than 50% completeness

Discussion

Following the 2005 introduction of the 7vPCV for all infants on the NIP, Australia achieved a significant reduction in the overall rate of IPD in the community. Whilst Australia has maintained lower rates of IPD since the introduction of 7vPCV, there has also been a small but gradual rate increase in the IPD rate, largely due to non-7vPCV serotypes. In 2011, Australia recorded its highest overall rate of IPD since 2005 which was largely driven by the increased number of cases caused by serotype 19A and a serotype 1 outbreak that occurred amongst the Indigenous populations of the Northern Territory, Western Australia and Queensland.[9,10] Other countries that have implemented a national 7vPCV program, such as the United Kingdom, the United States of America and Norway, have experienced a similar non-7vPCV serotype replacement pattern, with serotype 19A emerging as a dominant serotype, after the introduction of 7vPCV.[11–13]

In Australia from 2005 to 2011, the majority of all cases caused by non-7vPCV serotypes were due to serotypes 19A, 3 and 22F; and more recently serotypes 7F, 1 and 6C. A reduction in the number of notifications due to 19A, 1 and 6C was observed following the mid-2011 NIP schedule change from 7vPCV and 10vPCV to 13vPCV. However, notifications due to serotypes 7F, 3 and 22F continued to increase. Serotype 6C is not included in any of the registered vaccines in Australia but immunogenicity data suggests that immune responses to 6A, which is included in the 13vPCV, could provide cross protection against IPD due to serotype 6C.[14] Infections due to serotypes 3 and 7F continued to rise in 2012, despite their inclusion in the 13vPCV.

The impact of the 2011 NIP schedule change from 7vPCV and 10vPCV to 13vPCV for infants was most evident in children aged less than 5 years. In 2012, and following the introduction of the new vaccine, the rate of IPD due to 13vPCV (non-7vPCV) serotypes halved in this cohort, while the rate of IPD caused by 7vPCV serotypes remained stable. In 2011 and 2012, there were no deaths in children aged less than 5 years that were preventable by the 7vPCV. Four deaths were due to serotypes included in the 13vPCV but each of these cases occurred prior to the introduction of the 13vPCV or in a child too young for vaccination.

The reduction of the IPD rate in non-Indigenous children post the introduction of 13vPCV is largely due to the decline in disease caused by serotype 19A but despite this, serotype 19A remains the most frequently isolated cause of IPD in this cohort. Notifications in non-Indigenous children due to serotype 3 recorded a small increase despite its inclusion in the 13vPCV. Canada has observed a similar rise in serotype 3 notifications following the introduction of the 13vPCV and other studies have suggested that 13vPCV may be less effective in protecting against IPD due to serotype 3.[15–18]

The reduction of the IPD rate in Indigenous children post the introduction of 13vPCV is largely due to the tapering of the serotype 1 outbreak and to a lesser extent the decline in serotype 19A. The serotype 1 outbreak observed during this reporting period contributed to the large increase in IPD notifications recorded in Indigenous children in 2011, in particular, those in children aged between 2 and 5 years.[9,10] It is important to note that the Northern Territory was using a 4 dose 10vPCV vaccine schedule for infants for the period October 2009 to October 2011 and did not experience any cases of serotype 1 disease in 10vPCV vaccinated infants during the outbreak.

In both Indigenous and non-Indigenous adults eligible for the 23vPPV on the NIP, rates of IPD due to 23vPPV serotypes have increased in 2011 and 2012. The rate of IPD due to 23vPPV serotypes in Indigenous adults has shown a marked overall increase since 2006. In recent years, the serotype 1 outbreak has contributed to the rise in notifications. However, excluding the serotype 1 notifications, the Indigenous adult population is still experiencing an overall increase in IPD due to 23vPPV serotypes.

In 2008, a Cochrane review found that there is strong evidence to support the effectiveness of the 23vPPV against IPD. However, several studies included in this review as well as more recent publications, suggest that the protective effect could range from 40% to 80% in different populations.[19–21] The data described in this report with regards to the Indigenous population suggest that either the vaccine has only a moderate effect in this cohort and/or vaccine uptake in this cohort is less than optimal. The most recent data published on the uptake of NIP recommended vaccines in the Aboriginal and Torres Strait Islander population was collected and analysed a decade ago and reported pneumococcal vaccine coverage of only 34% in Indigenous adults aged 50 years or over and that coverage varied between jurisdictions.[22]

Other countries that have introduced the 13vPCV into a childhood vaccination schedule have also observed a reduction in IPD in the adult population within 3 years of the vaccine's introduction.[12,18,23] The observation period of this report constituted only 18 months of 13vPCV use in children and thus far the herd immunity effect on the adult population in Australia is not yet evident.

In 2011 and 2012, the proportion of cases with reduced susceptibility to penicillin returned to

levels seen prior to the slight increase reported in 2010. This was likely due to an overall reduction in cases caused by serotypes 19A following the introduction of the 13vPCV. In both 2011 and 2012, reduced susceptibility to ceftriaxone/cefotaxime remained uncommon in Australia. The proportion of isolates with reduced susceptibility to ceftriaxone/cefotaxime is similar to proportions described in both the United States of America and Asia.[24–26]

Post-immunisation surveillance of IPD in Australia is essential to monitor disease trends, to inform future control strategies, including the targeting of existing and new vaccines and the best options for antibiotic treatment.

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