Invasive pneumococcal disease in Australia, 2006

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Abstract

Enhanced surveillance for invasive pneumococcal disease (IPD) was carried out in all Australian states and territories in 2006 with comprehensive comparative data available since 2002. There were 1,445 cases of IPD notified to the National Notifiable Diseases Surveillance System in Australia in 2006; a notification rate of 7 cases per 100,000 population. The rates varied between states and territories and by geographical region with the highest rates in the Northern Territory, the jurisdiction with the largest proportion of Indigenous people. Invasive pneumococcal disease was reported most frequently in those aged 85 years or over (30.8 cases per 100,000 population) and in children aged one year (26.5 cases per 100,000 population). There were 130 deaths attributed to IPD resulting in an overall case fatality rate of 9%. The overall rate of IPD in Indigenous Australians was 4.3 times the rate in non-Indigenous Australians. The rate of IPD in the under two years population continued to fall in 2006, but the rate in Indigenous children (73 cases per 100,000 population) was significantly greater than in non-Indigenous children (21 cases per 100,000 population). The rates of disease caused by serotypes in the 7-valent pneumococcal conjugate vaccine (7vPCV) decreased between 2002 and 2006 by 78% in children aged under two years as a result of the introduction of a universal childhood 7vPCV immunisation program. Significant decreases in IPD caused by 7vPCV serotypes also occurred in the 2–14 years and 65 years or over age groups. Rates of disease caused by non-7vPCV in the same periods were little changed. Serotypes were identified in 94% of all notified cases, with 43% of disease caused by serotypes in the 7vPCV and 85% caused by serotypes in the 23-valent polysaccharide pneumococcal vaccine (23vPPV). The number of invasive pneumococcal isolates with reduced penicillin susceptibility remains low and reduced susceptibility to third generation cephalosporins is rare. *Commun Dis Intell* 2008;32:18–30.

Keywords: disease surveillance, pneumococcal disease, *Streptococcus pneumoniae*, *vaccination*

Introduction

Since 2001 Australia has had a comprehensive surveillance system collecting data on all cases of invasive pneumococcal disease (IPD) in children aged less than five years and on most cases in adults. Surveillance data collected includes data on vaccination status, risk factors and clinical presentation of the patient and the serotype and antibiotic susceptibility of the pneumococcal isolate.

Surveillance has documented the impact of the 7-valent pneumococcal conjugate vaccine (7vPCV) immunisation programs for Indigenous children from July 2001 and the universal 7vPCV childhood immunisation program and 23-valent pneumococcal polysaccharide vaccine (23vPPV) immunisation program for adults aged 65 years or over, from January 2005 (Table 1).

In 2007, evidence began to emerge in a defined geographic area, of an increase in incidence of IPD in Alaskan Native children with high levels of 7vPCV vaccination caused by non-7vPCV serotypes.[1] An increase in disease caused by the non-7vPCV serotype, 19A, with a significant proportion resistant to multiple antibiotics, has been reported among children in Massachusetts.[2] Maintaining post-immunisation surveillance in Australia is essential to detect such changes in the epidemiology of IPD and to direct further reduction strategies.

Methods and materials

Case definition

A case of IPD was defined as the isolation from or the detection by nucleic acid test (NAT) in blood, cerebrospinal fluid (CSF) or other sterile site of *Streptococcus pneumoniae*.

Data collection

Invasive pneumococcal disease has been a notifiable disease in some Australian states and territories for several years. In 2001, IPD was made notifiable in all states and territories and data are forwarded to the National Notifiable Diseases Surveillance System

Table 1. Recommendations and funding initiatives for pneumococcal vaccination in Australia

Vaccine	23-valent polysaccharide vaccine	7-valent conjugate vaccine
Pneumococcal serotypes	1, 2, 3, 4, 5, 6B, 7F, 8, 9N, 9V, 10A, 11A, 12F, 14, 15B, 17F, 18C, 19A, 19F, 20, 22F, 23F, 33F	4, 6B, 9V, 14, 18C, 19F, 23F
Target populations	All individuals aged 65 years or over to receive a single dose of vaccine with a booster five years later* Aboriginal and Torres Strait Islander people aged 50 years or over to receive a single dose of vaccine with a booster five years later† Aboriginal and Torres Strait Islander people aged between 15 and 49 years at high risk to receive a single dose of vaccine and appropriate booster(s)‡ Children who have underlying chronic illnesses predisposing to invasive pneumococcal disease (including asplenia and immunocompromised)§ Immunocompetent individuals with chronic illness including chronic cardiac, renal or pulmonary disease, diabetes and alcohol-related problems Individuals with cerebrospinal fluid leaks‖ Tobacco smokers¶ As a booster dose at 18 to 24 months of age following a primary course of 7vPCV in Aboriginal and Torres Strait Islander children in regions of high incidence** As a booster dose at 4 to 5 years of age following a primary course of 7vPCV in children at risk because of predisposing medical conditions**	Children at 2, 4 and 6 months of age.†† Children born between 1 January 2003 and 31 December 2004.‡‡ Additional booster dose for children in specific high-risk groups.**

* Funded in Victoria from 1998, Funded nationally from 2005.

† Targeted funded programs in north Western Australia, Far North Queensland and the Northern Territory from 1995, Funded nationally from 1999.

‡ Funded nationally from 1999. Funded for all children aged 15 years or over in the Northern Territory from 1999.

§ Targeted funded programs for high risk aged over two years in north Western Australia and the Northern Territory from 1986. Recommended nationally for children aged over two years (pre-July 2001) and children aged over five years from July 2001.

‖ Recommended nationally for children aged over two years (pre-July 2001) and children aged over five years from July 2001.

¶ Recommended nationally from 2003.

** Funded nationally from July 2001.

†† Funded nationally for Indigenous children from July 2001 and all children from 2005.

‡‡ Funded nationally as a catch-up program in 2005.

(NNDSS). Since this required changes to state and territory public health legislation, the data in 2001 were incomplete in some states and territories, but were complete for all jurisdictions from 2002. NNDSS data in 2006 comprised core data, which is a set of data collected on all cases of all notifiable diseases, as well as 'enhanced' data specific for IPD. Data are continuously cleaned and updated and totals may vary from previous years.

Clinical presentation

Clinical presentations were coded as pneumonia, meningitis, bacteraemia, other or unknown. Pneumonia was defined as blood culture or NAT positive for *S. pneumoniae* with clinical and/or radiological signs of pneumonia. Meningitis was defined as the detection of *S. pneumoniae* in the CSF and/or blood with supportive clinical findings. Bacteraemia was defined as the detection of *S. pneumoniae* in blood with no localising signs. 'Other' presentations included detection of *S. pneumoniae* in pleural, peritoneal or joint fluid. More than one clinical presentation could be recorded for each case.

Risk factors

The national surveillance working party defined risk factor categories for IPD. They include prematurity, (less than 37 weeks gestation), congenital or chromosomal abnormality, anatomical or functional asplenia, being immunocompromised, chronic illness, childcare attendee, previous episode of IPD and other (e.g. a smoker). Other risk factors defined by jurisdictions were also collected. More than one risk factor could be recorded for each case.

Antibiotic resistance

Antibiotic susceptibility results are reported from the patient's treating institutions and classified as sensitive, intermediate resistance or resistant. In some cases the results are from referral laboratories. Reduced susceptibility includes intermediate and fully resistant results.

Vaccination

The definitions of vaccination status, vaccination confirmation and vaccine failure used in this report are described in Table 2. Vaccine coverage data (7vPCV) were provided by the Australian Childhood Immunisation Register (ACIR). The ACIR records details of vaccinations given to children under the age of seven years who live in Australia.

Populations under surveillance

There were different populations under enhanced surveillance in jurisdictions in 2006 (Table 3).

Data were analysed by date of diagnosis, which was the earliest of the dates recorded in NNDSS (date of onset, specimen date, notification date or notification received date).

Data analysis

The notification rates presented in this report were calculated using population data from the Australian Bureau of Statistics (ABS). The Estimated Resident Population (ABS 3201.0) in each state and territory and in Australia as a whole, as at 30 June 2006, was used as the denominator in rate calculations. Estimates of the Indigenous Australian population were based on projections from the 2001 census.

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

Category	Definition
Fully vaccinated – aged < 15 years	Those that have completed the primary course of the relevant vaccine(s) required for their age, indigenous status, geographical location and/or other risk factor(s) according to the most recent edition of the *Australian Immunisation Handbook,* at least two weeks prior to disease onset with at least 28 days between doses of vaccine. This includes the following; • a child that received a vaccine as 'catch up' and therefore does not require a full three dose primary schedule. Providing they have had the number of doses required for the age they were at first dose they should be considered fully vaccinated. • a child <15 years who received at least one 23vPPV vaccine at aged over five years and they are not yet due a subsequent dose of 23vPPV. 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 assessed as fully vaccinated.
Fully vaccinated – aged ≥ 15 years	Those that have had the number of doses of 23vPPV required for their age, indigenous status, geographical location and/or other risk factor(s) according to the most recent edition of the *Australian Immunisation Handbook,* at least two weeks prior to disease onset with at least 28 days between doses of vaccine. NB: This is calculated on the age they were when they had their first dose of 23vPPV aged at least ≥ 15 years.
Partially vaccinated – aged < 15 years	Those that have received at least one dose, but not *all* the recommended doses of the relevant vaccine(s) required for their age, indigenous status, geographical location and/or other risk factor(s) according to the most recent edition of the *Australian Immunisation Handbook,* at least two weeks prior to disease onset with at least 28 days between doses of vaccine. This includes the following; • a child who is too young to have completed their primary course; • a child that is overdue (>8 weeks) for a subsequent dose of their primary course; • a child that is overdue for a booster dose of the relevant vaccine.
Partially vaccinated – aged ≥ 15 years	Those that have been vaccinated with at least one dose of 23vPPV but the time frame for a subsequent dose is outside the recommended schedule according to the *Australian Immunisation Handbook.*
Not vaccinated – all ages	Those that have never received a pneumococcal vaccine.
Vaccination validation	Written confirmation of vaccination through the Australian Childhood Immunisation Register, state or territory immunisation register or health record.
Vaccine failure	A fully vaccinated person (as defined above) with disease due to a serotype found in the corresponding vaccine

Table 3. Enhanced invasive pneumococcal disease surveillance data collection by states and territories in 2006

Age group	Jurisdictions
Under 5 years	Australian Capital Territory, New South Wales, Queensland (South Brisbane Public Health Unit only),
Over 50 years	New South Wales
All ages	Northern Territory, Queensland (except South Brisbane Public Health Unit), Tasmania, South Australia, Victoria, Western Australia

The ABS calculated projections based on assumptions about future births, deaths and migrations in the Indigenous population and a 'low' and 'high' estimate were reported. The 'low' estimate has been used in this report, consistent with the reporting of other national communicable diseases.

The significance of differences in rates and proportions was calculated using the Chi-square test with Yates correction.

Results

There were 1,445 notifications of IPD to NNDSS in 2006; a 14% decrease on the number of notifications in 2005 with declines in all jurisdictions of between 7.2% in Victoria and 37% in the Australian Capital Territory. The number of notifications and notification rate per 100,000 population are shown in Table 4. The Northern Territory continued to have the highest notification rate (27.1 per 100,000 population) while Victoria had the lowest (5.4 per 100,000).

When notification rates of IPD were examined by geographical distribution, variation within states and territories was apparent (Map).

The number of notifications of IPD was greater in winter months with the peak number of notifications in August (210 notifications). The effect of season was more evident in the distribution of cases aged five years or more compared with younger children (Figure 1).

Table 4. Notifications, rates and demographics of invasive pneumococcal disease cases Australia, 2006, by state or territory

	State or territory								
	ACT	NSW*	NT	Qld	SA	Tas	Vic	WA	Australia
Notifications	19	566	56	253	104	41	276	130	1,445
Rate per 100,000	5.8	8.3	27.1	6.2	6.7	8.4	5.4	6.3	7.0
Male:female ratio	1.7:1	1.3:1	1.7:1	1.4:1	1.1:1	1.3:1	1.3:1	1.1:1	1.3:1
Notifications aged < 5 years									
Total	8	62	11	46	15	5	31	18	196
Indigenous	0	3	10	5	1	0	0	7	26
Non-Indigenous	4	58	1	35	14	5	30	11	158
Unknown	4	1	0	6	0	0	1	0	12
Notifications aged 5 to 64 years									
Total	8	286	37	138	50	25	128	82	754
Indigenous	0	1*	33	22	3	0	3	46	108
Non-Indigenous	1	131*	4	106	47	24	117	36	466
Unknown	7	154*	0	10	0	1	8	0	180
Notifications ≥ 65 years									
Total	3	218	8	69	39	11	117	30	495
Indigenous	0	1	4	1	0	0	1	0	7
Non-Indigenous	1	215	4	59	39	11	108	30	467
Unknown	2	2	0	9	0	0	8	0	21

* Under the *NSW Public Health Act 1991,* all diagnoses of invasive pneumococcal infection are notifiable by laboratories. Aboriginality is not typically provided by laboratories at the time of notification. New South Wales Public Health staff undertake enhanced surveillance on cases aged less than five years and 50 years or over. Aboriginality for cases aged 5 to 49 years is likely to be incomplete and valid inferences cannot be made from this data.

Figure 1. Notifications of invasive pneumococcal disease, Australia, 2006, by month of report and age group

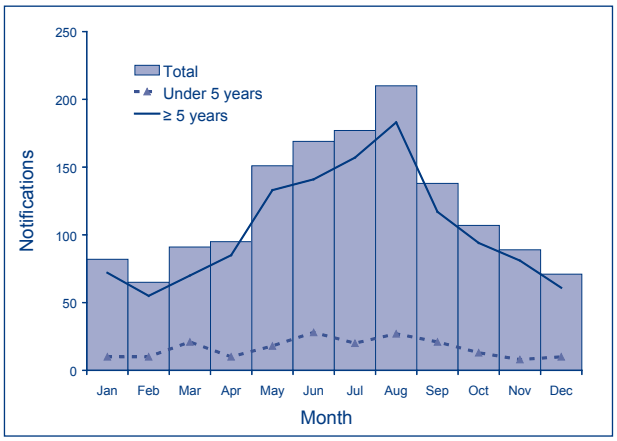
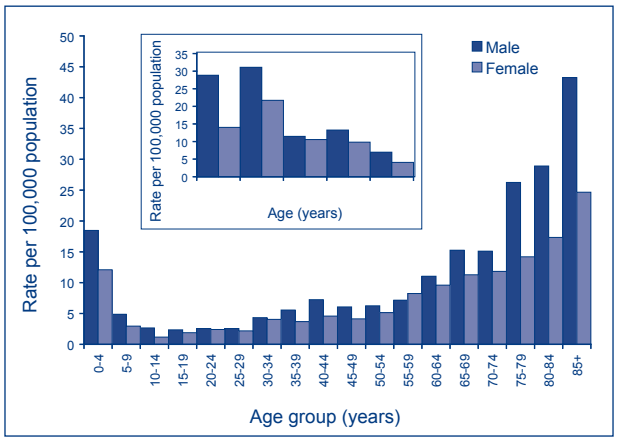


Figure 2. Notification rates of invasive pneumococcal disease, Australia, 2006, by age group and sex



The highest rates of IPD disease in 2006 were among the elderly aged 85 years or over (30.8 cases per 100,000 population) and in children aged one year (26.5 cases per 100,000 population, Figure 2). In all age groups there were more male than female cases (overall male to female ratio 1.3:1).

There were continued declines in notification rates between 2005 and 2006, in the under five year age group (from 24 to 15 per 100,000) and in children aged one year (from 36.5 to 26.5 per 100,000) reflecting the impact of the introduction of the universal 7vPCV immunisation program in 2005.

In 2006, the proportion of children aged 12 months immunised with three doses of 7vPCV was 84.6% in Indigenous children and 91.2% in non-Indigenous children. The proportion of children who are fully vaccinated against pneumococcal disease has increased steadily since 2001 (Figure 3).

Map. Notification rates of invasive pneumococcal disease, Australia, 2006, by Statistical Division of residence

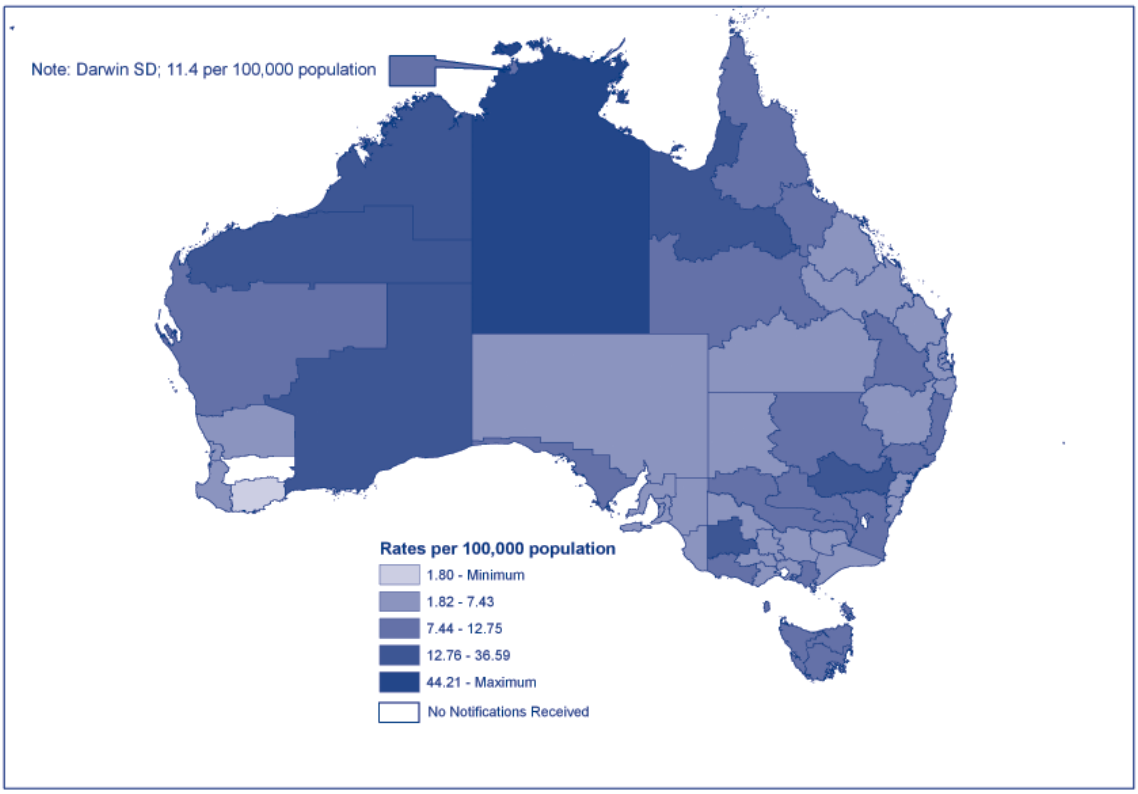
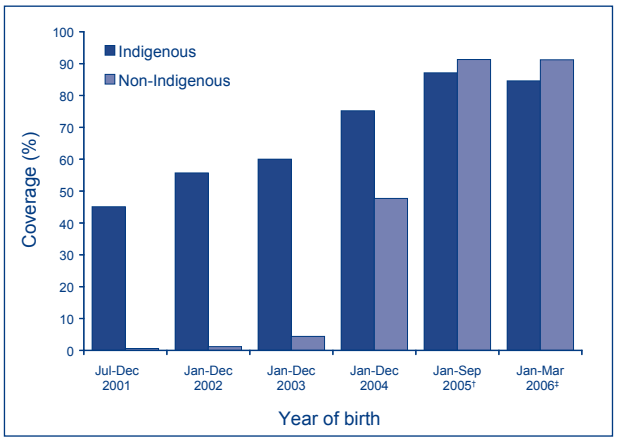


Figure 3. The proportion of children aged 12 months fully vaccinated with 7vPCV,* Australia, 2001 to 2006, by indigenous status



* Source: The Australian Childhood Immunisation Register.

† 2005 data assessed for cohort born between 1 January and 30 September 2005 only.

‡ 2006 data assessed for the cohort born between 1 January 2006 and 31 March 2006 and assessed at 30 June 2007.

Figure 4. Notification rate of pneumococcal disease, Australia, 2002 to 2006, by age group

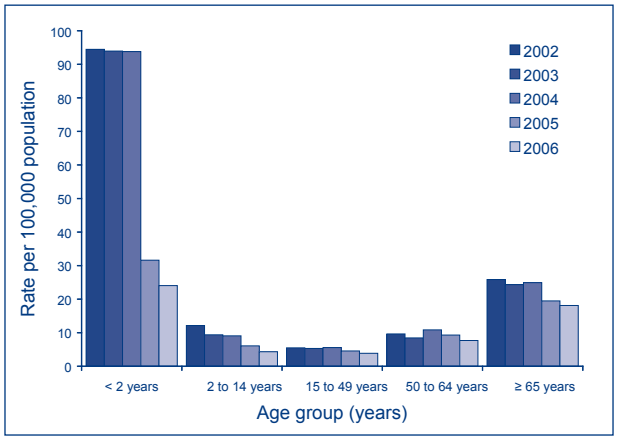
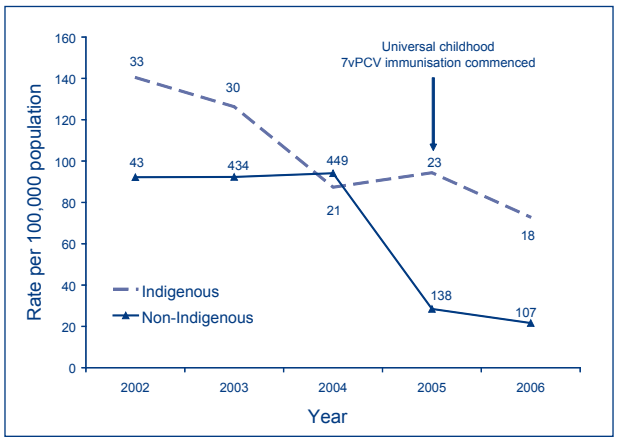


Figure 5. Notification rates of invasive pneumococcal disease in Indigenous and non-Indigenous children aged less than two years, Australia, 2002 to 2006



An examination of trends in rates of IPD in different age groups from 2002 to 2006 is shown in Figure 4. The rates in children aged under two years declined by 75% ($p<0.0001$) and in adults aged 65 years or over by 30% ($p<0.0001$) over the five-year period. Rates of IPD in other age groups not specifically targeted for pneumococcal immunisation also declined – there was a 65% ($p<0.0001$) reduction in the 2–14 year age group; a 30% ($p<0.0001$) decline in the 15–49 year age group and a 20% decline ($p<0.01$) in the 50–64 year age group.

Rates in Indigenous people

In 2006, Indigenous status was reported in 1,232 (85%) notifications. New South Wales and the Australian Capital Territory continue to have the highest proportion of incomplete reporting. There were 141 cases of IPD among Indigenous people (9.7% of all cases). This represents a rate of 28 cases per 100,000 in the Indigenous population—a rate 4.3 times that seen in the non-Indigenous population (6.5 per 100,000).

Rates in children

Rates in Indigenous children aged less than 2 years fell from 94 per 100,000 in 2005 (23 cases) to 73 cases per 100,000 population (18 cases) in 2006. In non-Indigenous children in the same age group rates fell from 28.7 cases per 100,000 population in 2005 (138 cases) to 21 cases per 100,000 population(107 cases) in 2006 (Figure 5).

Figure 6 shows the annual rates in single year age groups in children aged two years or under. In 2006, the rates of IPD in Indigenous children aged less than one year (0 to 11 months) fell from 97.6 in 2005 to 48.1 per 100,000 (from 12 to 6 cases). In 2006, the number of notifications and rate in Indigenous one year olds (12 cases, 98 per 100,000) and two year olds (5 cases, 41.5 per 100,000) were similar to those in 2005 (11 cases, 91.1 per 100,000 and 6 cases, 54 per 100,000 respectively). None of these declines in rates reached statistical significance.

In non-Indigenous children, rates fell in all three age groups: in those aged less than one year from 23.3 to 19.4 cases per 100,000 population; (57 to 51 cases); in the one year age group from 33.7 to 21.9 per 100,000; (81 to 56 cases) and in the two year age group from 27.5 to 9.1 cases per 100,000 (population 61 to 25 cases, Figure 6). All these declines in rates were highly statistically significant.

Figure 6. Rates of invasive pneumococcal disease in children aged two years and under, Australia, 2002 to 2006, by indigenous status and single year age group

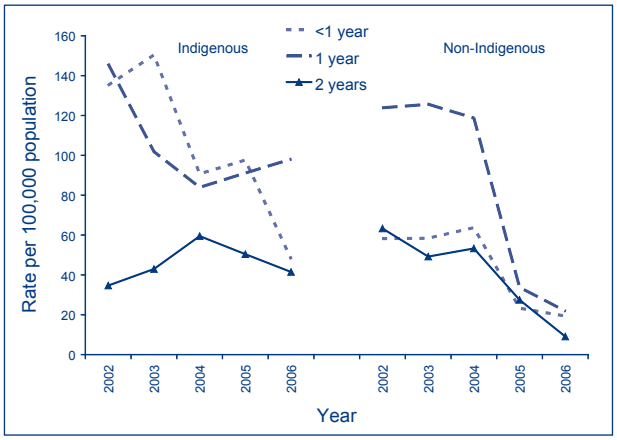
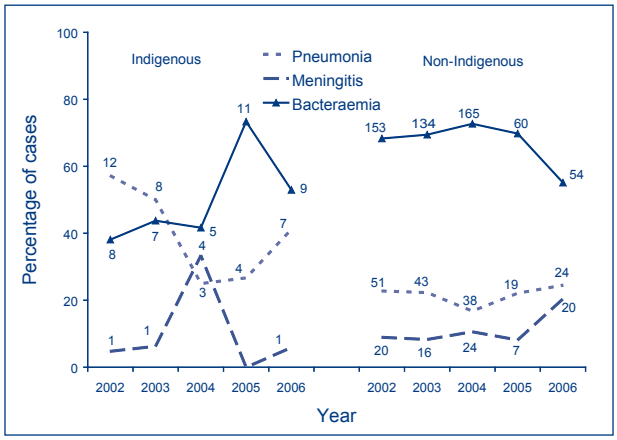


Figure 7. Changes in clinical presentation of invasive pneumococcal disease in cases aged less than two years, 2002 to 2006, by indigenous status



Clinical presentations of invasive pneumococcal disease

Clinical presentation was reported on 1,172 (81%) cases. More than one clinical presentation could be reported. Seven hundred and fifty-one (64%) were pneumonia, 307 (26%) were bacteraemia, 101 (8.6%) were meningitis and 33 were other sterile site presentations (3%). Trends in clinical presentations of IPD in Indigenous and non-Indigenous children aged less than two years are shown in Figure 7. The relative proportions of pneumonia, bacteraemia and meningitis were similar in both groups in 2006.

Deaths in invasive pneumococcal disease cases

There were 130 deaths recorded among IPD cases in Australia in 2006, a case fatality rate of 9% (Table 5). While the overall number of deaths increased by only two over the total in 2005, the case fatality rates were higher in all categories because of the lower number of cases. The case fatality rate in those aged 65 years or over (17.4%) was significantly higher than in children aged less than five years (3.1%, $p<0.0001$).

A case fatality rate for Indigenous and non-Indigenous cases was not calculated because of concerns about the completeness of indigenous status reporting particularly in the 5–64 year age group in New South Wales and the Australian Capital Territory.

Deaths are likely to be under reported as enhanced data are not collected in some jurisdictions for age groups between 5 and 50 years or 5 and 64 years. Further details of the six children aged less than five years whose deaths were associated with IPD are shown in Table 6. The four unvaccinated children all had 7vPCV serotype disease, while the two children fully vaccinated for age had non-7vPCV serotype disease.

Table 5. Deaths and case fatality rates for invasive pneumococcal disease, Australia, 2006, by age, indigenous status and state or territory

	State or territory								Australia
	ACT*	NSW*	NT	Qld	SA	Tas	Vic	WA	
Cases	19	566	56	253	104	41	276	130	1,445
Deaths	2	66	5	10	3	3	29	12	130
Deaths in under 5 years	0	3	0	0	0	0	1	2	6
Case fatality rate under 5 years	0.0	4.8	0.0	0.0	0.0	0.0	3.2	11.1	3.1
Deaths in ≥65 years	1	53	1	5	3	1	17	5	86
Case fatality rate ≥65 years	33.3	24.3	12.5	7.2	7.7	9.1	14.5	16.7	17.4
Deaths in Indigenous people	0	1	5	4	0	0	0	3	13
Deaths in non-Indigenous people	2	65	0	6	3	3	29	9	117

* Limited indigenous identity data on cases aged between 5 and 64 years in Australian Capital Territory and New South Wales.

Risk factors for invasive pneumococcal disease

Recognised risk factors were recorded in 47 (24%) of 196 cases aged less than five years. Ten (38%) Indigenous children aged less than five years with IPD had risk factors, compared with 37 non-Indigenous children (23%, p=ns, Table 7). Attending childcare was identified as an IPD risk factor in a higher proportion of non-Indigenous children than Indigenous children ($p<0.05$), while other risk factors such as exposure to smoke were more common in Indigenous children ($p<0.001$).

Pneumococcal serotypes causing disease in Australia

Pneumococcal serotypes were identified for isolates from 1,361 (94%) of all notified cases in 2006. Of these, 587 (43.1%) were serotypes in the 7vPCV and 1,154 (84.8%) were serotypes in the 23vPPV (Table 8).

The proportion of 7vPCV serotypes in cases of IPD in the Northern Territory (14.8%) and Western Australia (39%) were significantly lower than the proportion of the national total (43.1%). The proportion of 23vPPV serotypes in the Northern Territory (64.8%) was also significantly lower than the proportion in the national total (84.8%, Table 8).

An examination of the rates of IPD disease caused by 7vPCV serotypes in Indigenous children aged less than two years showed a decline in rates (from 54.2 to 12 per 100,000) between 2002 and 2006. In non-Indigenous children, rates of 7vPCV serotype disease, which fell from 73.4 per 100,000 to 15 cases per 100,000 population between 2004 and 2005, continued to decline in 2006 to 6.7 per 100,000. Rates of disease caused by non-7vPCV serotypes in the same periods were little changed for both Indigenous and non-Indigenous children—62.6 to 59.8 (2002–2006) and 17.6 to 13.5 (2004–2006 respectively, Figure 8).

Table 6. Characteristics of childhood deaths from invasive pneumococcal disease, Australia, 2006

Patient	Sex	Age (mos)	Indigenous status	Serotype	Vaccination status	Vaccine	Risk factors
Deaths preventable by 7vPCV							
1	Male	1.5	Unknown	19F	Unvaccinated	Nil	Unknown
2	Male	21.6	Indigenous	14	Unvaccinated	Nil	Unknown
3	Female	46.0	Non-Indigenous	18C	Unvaccinated	Nil	Unknown
4	Male	53.2	Non-Indigenous	4	Unvaccinated	Nil	No risk factors
Deaths not preventable by 7vPCV							
5	Female	6.6	Non-Indigenous	7F	Fully for age	7vPCV	Unknown
6	Male	13.8	Indigenous	33F	Fully for age	7vPCV	Premature chronic illness

Table 7. Risk factors* for invasive pneumococcal disease in children aged less than five years with invasive pneumococcal disease, Australia, 2006, by indigenous status

Risk factor	Indigenous n=26	Non-Indigenous n=158	Significance of difference
Premature birth	2	7	ns
Congenital abnormality	0	6	ns
Asplenia	0	0	
Immunocompromised	1	4	ns
Chronic illness	1	3	ns
Child-care attendee	0	12	ns
Previous episode of IPD	1	4	ns
Other†	7	4	p<0.0001
No risk factors	16	121	

* Child could have more than one risk factor.

† Other risk factors include exposure to smoke.

Table 8. Number and proportion* of pneumococcal serotypes in cases of invasive pneumococcal disease covered by the 7-valent and 23-valent pneumococcal vaccines, Australia, 2006, by state or territory

	State or territory								
	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Total
7v serotypes	8	242	8§	109	43	16	113	48‡	587
%	42.1	46.9	14.8	45.0	43.9	40.0	41.9	39.3	43.1
23V serotypes	14	446	35§	206	82	34	235	102	1,154
%	73.7	86.4	64.8	85.1	83.7	85.0	87.0	83.6	84.8
Total serotyped	19	516	54	242	98	40	270	122	1,361

* As a proportion of serotyped isolates, including untypable isolates (2 in New South Wales, 3 in Victoria, 1 in Queensland and 1 in the Northern Territory).

Significantly lower proportion of 7vPCV and 23vPPV serotypes compared with national total (‡ p<0.05, § p<0.0001).

Figure 8. Notification rates of 7-valent and non-7-valent serotypes causing cases of invasive pneumococcal disease in children aged less than two years, 2002 to 2006, by indigenous status

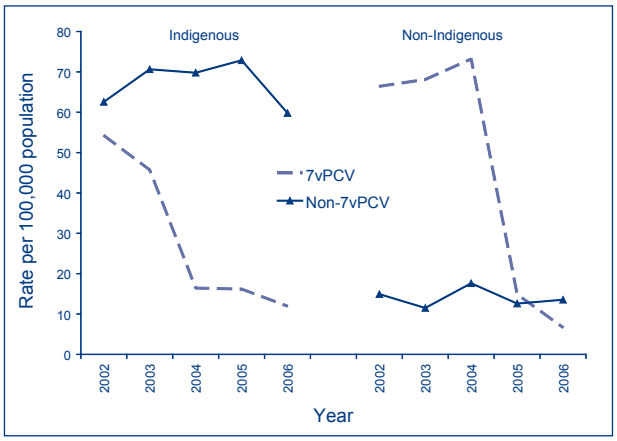
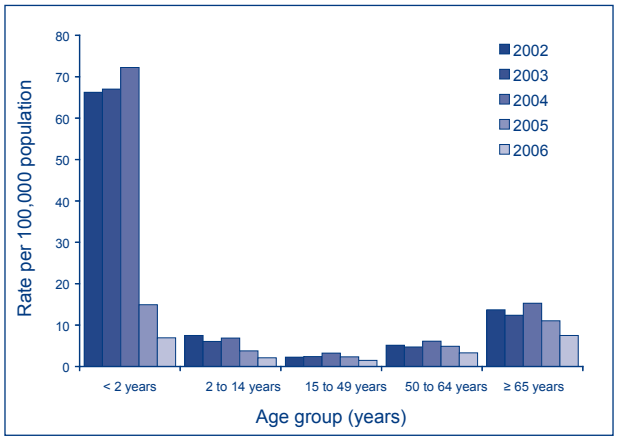


Figure 9. Rates of invasive pneumococcal disease caused by 7-valent pneumococcal vaccine serotypes, 2002 to 2006, by age group



The total population rates of IPD caused by 7-valent vaccine serotypes fell 89.6% between 2002 and 2006 in the under two years age group (66.2 to 6.9 per 100,000), 82% in the 2–14 years age group (7.5 to 2.1 per 100,000) and 46% in the 65 years or over age group (13.7 to 7.5 per 100,000). All these declines were statistically significant. There were smaller declines in the rates in the 15–49 years (32%, 2.2 to 1.5 per 100,000) and 50–64 years age group (36%, 5.1 to 3.3 per 100,000, Figure 9).

A recent study of Alaskan Native children who received 7vPCV from 2000 has identified the emergence of replacement pneumococcal disease caused by non-7vPCV strains, in particular serotypes 7F and 19A.[1] Figure 10 shows trends in the rates of IPD in Indigenous and non-Indigenous children caused by serotypes 6A, 7F and 19A between 2002 and 2006.

Serotype 7F disease remains infrequent in non-Indigenous children (less than 5 cases in all years) and in Indigenous children (2 cases in all years except 2004, Figure 10). Rates of disease caused by serotype 19A increased in Indigenous children from 1.7 per 100,000 (1 case) in 2002, to 11.9 per 100,000 (7 cases) in 2004, and declined to four cases in both 2005 and in 2006 (6.6 per 100,000). Disease caused by serotype 19A increased minimally in non-Indigenous children from 2 per 100,000 (24 cases) in 2002 to 3.2 per 100,000 (39 cases) in 2006 (p=0.07). Serotype 6A has become the most common non-vaccine serotype in Indigenous children in 2006 (8.3 per 100,000, 5 cases) and the second most common in non-Indigenous children (0.9 per 100,000, 11 cases).

Rates of IPD caused by 23vPPV serotypes in Indigenous adults aged 50 years or over due to 23vPPV serotypes increased slightly between 2002 and 2006 from 9 to 16 cases (18.5 to 28.8 per 100,00). At the

Figure 10. Rates of invasive pneumococcal disease due to serotypes 19A, 6A and 7F in Indigenous and non-Indigenous children aged less than five years, 2002 to 2006

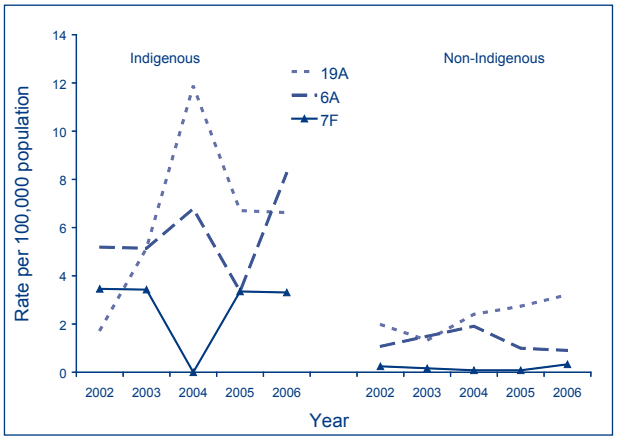
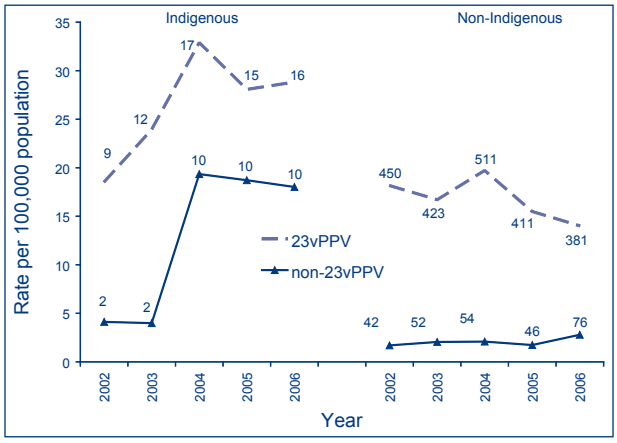


Figure 11. Notification rates of 23-valent and non-23-valent serotypes causing cases of invasive pneumococcal disease in Indigenous adults (aged more than 50 years) and non-Indigenous adults (aged 65 years or over), 2002 to 2006



same time rates of disease caused by non-23vPPV serotypes increased from 4 to 18 per 100,000 (from 2 to 10 cases).

In non-Indigenous adults aged 65 years or over rates of IPD caused by 23vPPV serotypes decreased slightly between 2005 and 2006 (from 15.5 to 14 per 100,000) and rates of non-23PPV serotype disease remained low (1.7 per 100,000 in 2005 and 2.8 per 100,000 in 2006, Figure 11).

Antibiotic resistance in invasive pneumococcal disease

The penicillin susceptibility was tested in 1,351 isolates and ceftriaxone/cefotaxime susceptibility was tested in 1,046 isolates (Table 9).

A total of 143 (10.6%) isolates had reduced susceptibility to penicillin, which was lower than the number and proportion of isolates with reduced penicillin susceptibility in 2005 (176 isolates, 12%). Thirty isolates (2.9%) had reduced susceptibility to ceftriaxone/cefotaxime in 2006, which was also lower than the number and proportion of isolates with reduced susceptibility to ceftriaxone/cefotaxime reported in 2005 (44 isolates, 3.8%).

Of the 143 isolates with reduced susceptibility to penicillin, 138 were serotyped. Ninety-three (67.4%) isolates with reduced penicillin susceptibility were serotypes in the 7vPCV and 132 (95.7%) were serotypes in the 23vPPV. Of the penicillin insensitive isolates: 36 were serotype 19A; 31 were serotype 9V; and 26 were serotype 19F, accounting for 67.4% of isolates with reduced penicillin susceptibility and with known serotypes.

Table 9. *Streptococcus pneumoniae* susceptibility to penicillin and ceftriaxone/cefotaxime, Australia, 2006, by state or territory

		State or territory								
Antibiotic	Description	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Australia
Penicillin	Resistant	0	15	1	12	1	0	3	0	32
	Intermediate	1	29	4	26	14	0	21	16	111
	Sensitive	17	450	50	220	86	40	237	108	1,208
	Total tested	18	494	55	258	101	40	261	124	1,351
	% reduced susceptibility	5.6	8.9	9.1	14.7	14.9	0.0	9.2	12.9	10.6
Ceftriaxone	Resistant	0	6	0	2	0	0	1	0	9
	Intermediate	0	11	1	3	2	0	4	0	21
	Sensitive	18	348	43	231	40	39	172	125	1,016
	Total tested	18	365	44	236	42	39	177	125	1,046
	% reduced susceptibility	0.0	4.7	2.3	2.1	4.8	0.0	2.8	0.0	2.9

Of the 30 isolates with reduced susceptibility to ceftriaxone/cefotaxime in 2006, 27 were serotyped. Twenty-five (92.6%) were serotypes in the 7vPCV and 26 (96.3%) were serotypes in the 23vPPV. There were 13 serotype 19F and 7 9V serotypes which together accounted for 74% of the ceftriaxone/cefotaxime insensitive isolates where serotype was known.

Vaccination status

Vaccination data were available for 94% of children with IPD aged less than five years and 82% of those aged 65 years or over. Seventy-two per cent of children aged less than five years with a known vaccine history were recorded as having received at least one dose of 7vPCV with 32 developing 7vPCV serotype disease. The 17 vaccine failures (based on those children who had received all the required doses of 7vPCV according to their age at 1st dose) were aged between 10 and 17 months with 19F being the most common serotype (9 cases), four cases due to 6B, two due to 18C and one case due to serotypes 23F and 4. Only one of these children was Indigenous. Three cases had risk factors for IPD disease recorded. There were no deaths among the 7vPCV vaccine failures.

Of the 403 IPD cases reported in adults aged 65 years or over with available vaccine history, 210 had received at least one vaccine. A total of 131 cases developed disease due to a 23vPPV serotype following vaccination within the recommended time frame. Of the 754 cases in persons aged between 5 and 64 years, 396 (53%) had vaccine data available. The majority (314) of these were reported as not vaccinated. A total of 42 cases of 23vPPV serotype disease occurred in persons aged 5–64 years who were fully vaccinated with 23vPPV. A large proportion of vaccine failures in cases of IPD aged more than five years were associated with one or more identified risk factors (Figure 12).

Discussion

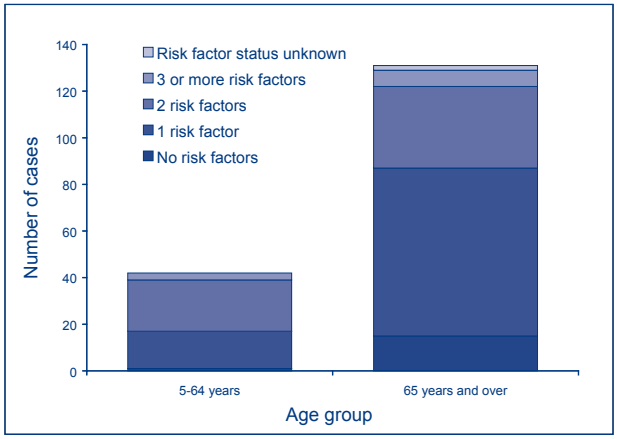
In 2006, rates of IPD due to 7vPCV serotypes continued to fall in all age groups, particularly in those targeted for immunisation. Non-vaccine serotype disease has remained unchanged, specifically in those aged less than two years. Overall rates of IPD with reduced antimicrobial susceptibility have remained low and stable.

Considerations for optimal immunisation schedules for IPD in Australia are ongoing under the auspices of the Australian Technical Advisory Group on Immunisation (ATAGI). ATAGI will examine the optimal 7vPCV schedule for high-risk Indigenous children; examine evidence for various 7vPCV schedules in the first two years of life; review the direct and indirect effects of the 7vPCV immunisation program; review data on the immunologic responses to a primary 7vPCV schedule followed by a 23vPPV boost in infants; and estimate the impact of the 7vPCV with a 23vPPV booster schedule on IPD in eligible Indigenous children. ATAGI's recommendations on the use of 23vPPV in this group are expected to be made early in 2008.

Serotypes associated with disease in populations with high levels of 7vPCV immunisation coverage attracted a lot of attention in 2006/07. In Alaskan Native children, rates of IPD fell between 1995 and 1998 after the introduction of the 7vPCV. This trend was reversed between 2001 and 2006 when the incidence increased by 82%, driven by a 140% increase in disease caused by non-vaccine serotypes. Serotype 19A represented 28% of the non-vaccine type disease. These increases were not seen in non-Native Alaskan children.[1] In Massachusetts, serotype 19A has emerged as a dominant serotype in all children aged less than 18 years, increasing from 10% of serotypes in this age group in 2001/02 to 40% in 2006. While overall rates of IPD fell in the same period by 70%, the emergence of the 19A serotype was significant because of the large proportion in 2006, were resistant to penicillin (61%), ceftriaxone (24%), and other antibiotics.[2,3]

In Australia, disease due to 19A serotype, as well as that due to 7F and 6A in the Indigenous under 5 years population has been minimal with no trends emerging. In the non-Indigenous under five years age group there has been a minimal increase in 19A serotype disease however, with recognition of natural serotype fluctuation over time, continued observation is prudent. Continued comprehensive surveillance of IPD cases will be essential to monitor the serotypes, drug resistance and the prevalence of modifiable risk factors.

Figure 12. Number of risk factors for cases of vaccine failure over five years, Australia, 2006, by age group



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ACT

ACT Pathology

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Queensland

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Western Australia

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References

1. Singleton RJ, Hennessey TW, Bulkow LR, Hammitt LL, Zulz T, Hurlburt DA, et al. Invasive pneumococcal disease caused by nonvaccine serotypes among Alaska native children with high levels of 7-valent penumococcal conjugate vaccine coverage. *JAMA* 2007;297:1784–1792.
2. Lett SM, De Maria A, Huot H, Wesson J, Karumuri S, Truong L, et al. Emergence of antimicrobial-resistant serotype 19A *Streptococcus pneumoniae* – Massachusetts, 2001–2006. *MMWR Morb Mortal Wkly Rep* 2007;56:1077–1080.
3. Pelton SI, Huot H, Finkelstein JA, Bishop CJ, Hsu KK, Kellenberg J, et al. Emergence of 19A as virulent and multidrug resistant pneumococcus in Massachusetts following universal immunization of infants with pneumococcal conjugate vaccine. *Medscape* 2007.