Invasive pneumococcal disease in Australia, 2004

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Abstract

There were 2,375 cases of invasive pneumococcal disease (IPD) notified to the National Notifiable Diseases Surveillance System in Australia in 2004; a notification rate of 11.8 cases per 100,000 population. The rate varied between states and territories and by geographical region with the highest rates in the Northern Territory. Invasive pneumococcal disease was reported most frequently in children aged less than 5 years (55.4 cases per 100,000 population). Enhanced surveillance for IPD was carried out in all states and territories, in 2004, providing additional data on 2,023 (85%) cases. The overall rate of IPD in Indigenous Australians was 3.2 times the rate in non-Indigenous Australians. There were 154 deaths attributed to IPD resulting in an overall case fatality rate of 7.6 per cent. Rates of IPD in the Indigenous and non-Indigenous under 2-year-old population were similar in 2004 (91.5 and 93.6 cases per 100,000 population, respectively) following a targeted introduction of the 7-valent pneumococcal conjugate vaccine (7vPCV) in mid-2001 for Indigenous infants and children. Serotypes of isolates were identified from 80 per cent of all notified cases, with 72 per cent of isolates belonging to serotypes represented in the 7vPCV and 91 per cent in the 23-valent polysaccharide pneumococcal vaccine (23vPPV). Comparison of serotypes in the 7vPCV target population showed that the rate of IPD due to 7vPCV serotypes decreased by 74 per cent between 2001–02 and 2003–04. Of 216 isolates with reduced penicillin susceptibility, 83 per cent belonged to pneumococcal serotypes in the 7vPCV and 95 per cent in the 23vPPV. *Commun Dis Intell* 2006;30:80–92.

Keywords: disease surveillance, pneumococcal disease, Streptococcus pneumoniae

Introduction

Streptococcus pneumoniae is a leading cause worldwide of otitis media, pneumonia, bacteraemia and meningitis. Invasive pneumococcal disease (IPD) in Australia is generally a disease of young children and older adults. The incidence of IPD in Indigenous Australians has been much higher than that in non-Indigenous Australians.

More than 90 serotypes of *S. pneumoniae* identified by the polysaccharide composition of their capsule have been described. Immunity to pneumococcal infection is thought to be serotype-specific. Vaccines containing pneumococcal polysaccharides from different numbers of serotypes have been available for many years, with a 23-valent polysaccharide vaccine (23vPPV) being used in Australia from 1986 (Table 1). Polysaccharide pneumococcal vaccines are poorly immunogenic in young children. A vaccine in which polysaccharides from seven serotypes are conjugated with a protein carrier (mutated diphtheria toxoid) was developed to provide an effective pneumococcal vaccine for children. In a trial in the United States of America (USA) in infants aged 2 to 15 months the conjugate vaccine had a protective

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efficacy of 93.9 per cent.[1] The conjugate vaccine (7vPCV) was licensed for use in Australia in January 2001 and a nationally funded vaccination program for children at high risk commenced in June 2001 (Table 1).

IPD was made a notifiable disease in all Australian states and territories in 2001 and surveillance data are reported to the National Notifiable Diseases Surveillance System (NNDSS). Additional enhanced surveillance data on IPD have also been collected since 2001 and annual reports have been published.[2,3,4] In this report, the impact of the 7vPCV vaccine on IPD in vaccine eligible children has been evaluated with respect to overall rates of disease, disease caused by vaccine and non-vaccine serotypes and levels of antimicrobial resistance.

Methods and materials

Case definition

A case of invasive pneumococcal disease was defined as the isolation from or the detection by nucleic acid test in blood, cerebrospinal fluid 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 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 2004 comprised core data, which is a set of data collected on all cases of all notifiable diseases, as well as data specific for IPD.[4]

Clinical presentation

Clinical presentations were coded as pneumonia, meningitis, bacteraemia, other or unknown. Pneumonia was defined as blood culture or nucleic acid test positive for *S. pneumoniae* with clinical and/or radiological signs of pneumonia. Meningitis was defined as the detection of *S. pneumoniae* in the cerebrospinal fluid 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.

Table 1. Recommendations for pneumococcal vaccination, Australia, 2004

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
Date implemented	1998	June 2001
Target populations	All individuals aged 65 years and over. Aboriginal and Torres Strait Islander people aged 50 years and over. Children aged over 5 years who have underlying chronic illnesses predisposing to invasive pneumococcal disease (including asplenia and immunocompromise). Immunocompetent individuals with chronic illness including chronic cardiac, renal or pulmonary disease, diabetes and alcohol-related problems. Individuals aged over 5 years 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 with underlying medical conditions and Aboriginal children aged under 5 years residing in Central Australia. Aboriginal and Torres Strait Islander children under the age of 2 years residing elsewhere in the Northern Territory (i.e. other than in Central Australia), Western Australia, South Australia and Queensland. Aboriginal and Torres Strait Islander children under the age of 2 years residing in New South Wales, the Australian Capital Territory, Victoria and Tasmania, and all non-Indigenous children without underlying medical conditions.
Data source	NHMRC Immunisation Handbook 8th edition, 2003	NHMRC Immunisation Handbook 8th edition, 2003

Vaccination

The definitions of vaccination status, vaccination confirmation and vaccine failure are shown in Table 2.

Populations under surveillance

There were differences in populations under surveillance between jurisdictions in the collection of enhanced IPD data. The age groups for whom enhanced data were collected for 2004 are shown in Table 3.

Data were analysed by date of diagnosis which was the earliest date recorded of date of onset, specimen date, notification date, or notification received date.

Table 3. Enhanced invasive pneumococcal disease surveillance data collection, 2004, by state or territory

Age group	State or territory
Under 5 years	Australian Capital Territory, New South Wales, Queensland, South Australia, Victoria
Over 50 years	New South Wales
Over 64 years	South Australia, Victoria
All ages	Northern Territory, north Queensland, Tasmania, Western Australia

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 2004, was used as the denominator in rate calculations.

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 2 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 3 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 5 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 2 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 2 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.

Estimates of the Indigenous Australian population were based on projections from the 2001 census. 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 was calculated using the Chi-square test with Yates correction.

Results

There were 2,375 notifications of IPD to NNDSS in 2004; a 9.2 per cent increase over the number of notifications in 2003. The number of notifications and notification rate per 100,000 population are shown in Table 4.

The notification rates for IPD varied between 7.8 and 17 cases per 100,000 population except in the Northern Territory where the notification rate was 46.5 cases per 100,000 population. The number of notifications in 2004 was fewer in Victoria compared with the total in 2003, but increased in all other jurisdictions.

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

The number of notifications of IPD was greatest in the winter months with the peak number of notifications in August (342 notifications). The effect of season was more evident in the distribution of cases aged five years or more compared with younger children (Figure 1).

Figure 1. Notifications of invasive pneumococcal disease, Australia, 2004, by month of report and age group

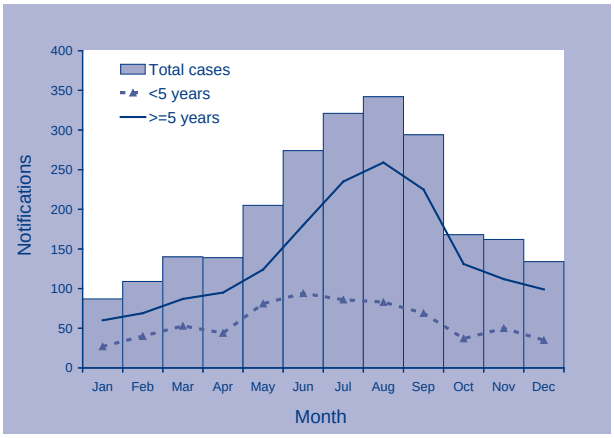


Figure 2. Notification rates of invasive pneumococcal disease, Australia, 2004, by age group and sex

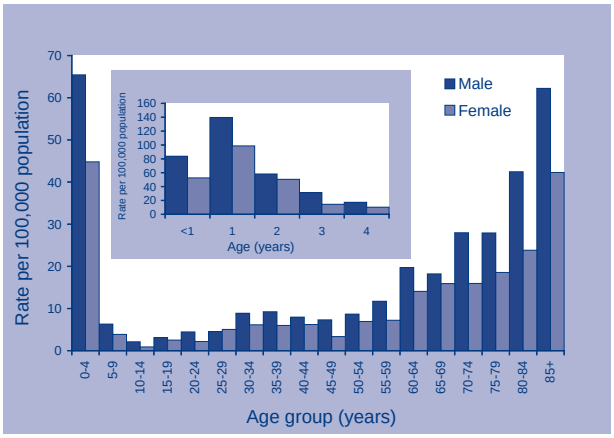
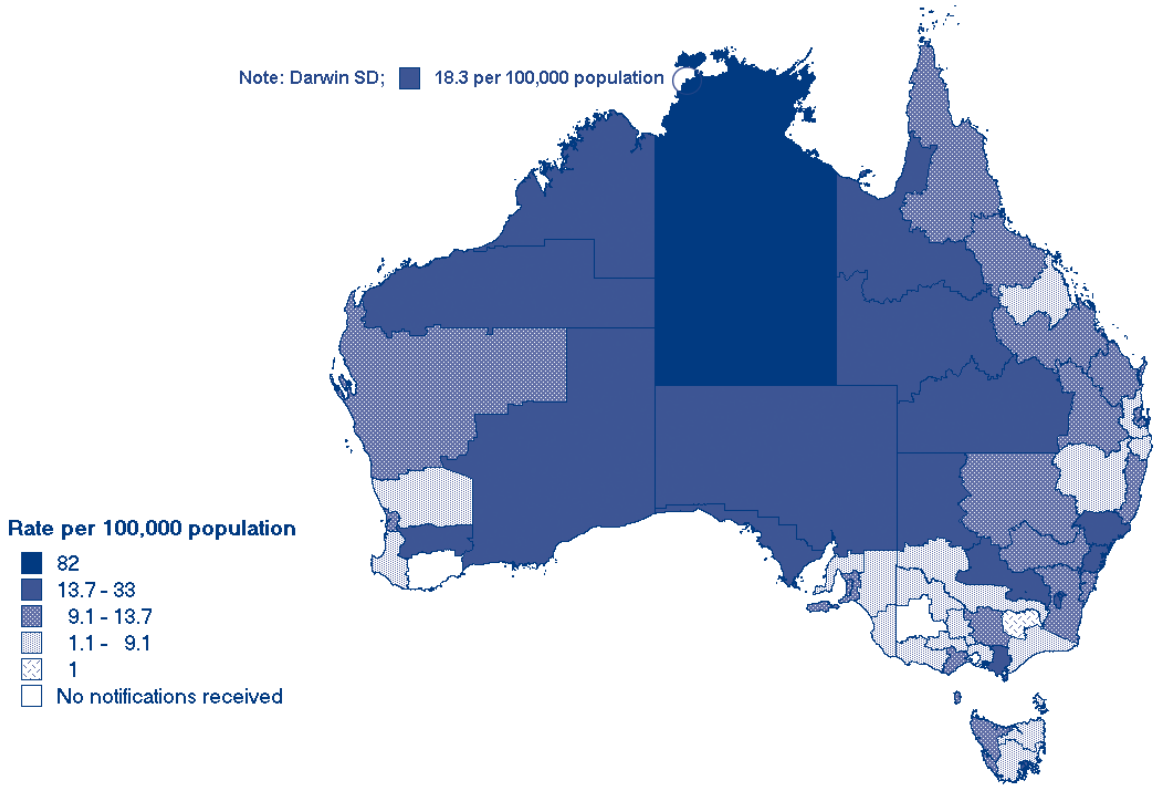


Table 4. Notifications, rates and demographics of invasive pneumococcal disease cases, Australia, 2004, by state and territory

	State or territory								Aust
	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	
Notifications	55	908	93	477	198	56	389	199	2,375
Rate/100,000	17.0	13.5	46.5	12.3	12.9	11.6	7.8	10.0	11.8
Sex									
Male:female ratio	3.2:1	1.3:1	1.2:1	1.4:1	1.5:1	1.2:1	1.4:1	1.3:1	1.4:1
Age									
<5 years	20	270	15	153	76	9	111	47	701
5 to 64 years	21	356	74	212	56	34	165	102	1,020
≥65 years	14	282	4	112	66	13	113	50	654
Indigenous status									
Indigenous	0	14	80	33	8	1	7	31	174
Non-Indigenous	3	612	13	336	188	48	354	164	1,718
Unknown	52	282	0	108	2	7	28	4	483
Enhanced surveillance cases (% of total)	26 (47%)	585 (64%)	93 (100%)	477 (100%)	198 100%)	56 (100%)	389 (99%)	199 (100%)	2,023 (85%)

Map. Notification rates of invasive pneumococcal disease, Australia, 2004, by Statistical Division of residence

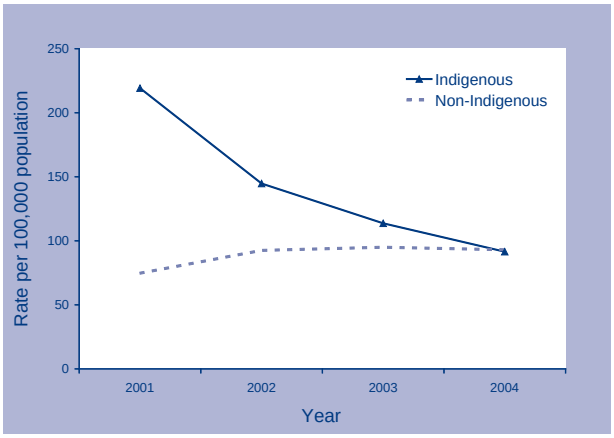


The highest rates of disease were found in children aged less than 5 years (55.4 cases per 100,000 population) and adults aged 85 years or more (48.6 cases per 100,000 population). Among children aged less than 5 years, the highest rates of IPD were recorded in children aged one year (119 cases per 100,000 population). There were 472 cases in children aged less than 2 years. In all age groups there were more male than female cases (overall male to female ratio 1.4:1)

There were 174 cases of IPD among Indigenous people (6.2% of all cases). This represents a rate of 35.9 cases per 100,000 population compared with a rate of 11.2 cases per 100,000 population in non-Indigenous people. The rates were highest in Indigenous people in the Northern Territory (134 cases per 100,000 population, 80 cases).

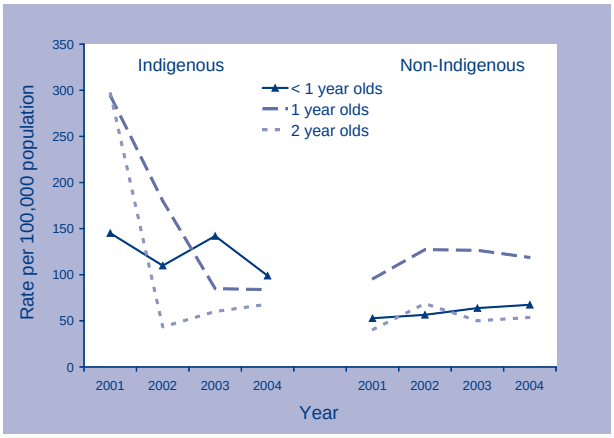
Since 2001, a 7vPCV vaccination program has provided free vaccination to Indigenous children less than 2 years of age (Table 1). The disparity in the rates of IPD between Indigenous and non-Indigenous children aged under 2 years has dropped from 2.9-fold (219.2 and 74.7 cases per 100,000 population, respectively) in 2001 to parity (91.5 and 93.6 cases per 100,000 population, respectively) in 2004 (Figure 3).

Figure 3. Notification rates of invasive pneumococcal disease in Indigenous and non-Indigenous children aged less than 2 years, Australia, 2001 to 2004



Between 2001 and 2004, the rate of IPD in Indigenous children aged one year (12 to 23 months) fell from 294 to 84 cases per 100,000 population (34 cases in 2001 to 10 cases in 2004). Similarly, the rate of IPD in Indigenous children aged 2 years (24 to 35 months) fell from 297 to 68 cases per 100,000 population (34 cases in 2001 to 8 cases in 2004, Figure 4).

Figure 4. Rates of invasive pneumococcal disease in children aged 2 years and under, 2001 to 2004, by Indigenous status and single year age group



Enhanced surveillance including data on clinical presentation and risk factors were available on 2,023 (85%) cases. Clinical presentation was reported for 1,219 (60%) enhanced notifications. Of these, 672 (55%) were pneumonia, 429 (35%) were bacteraemia, 75 (6%) were meningitis and the remainder were other presentations (n=43).

As in previous years there were significantly larger proportion of IPD cases with pneumonia among Indigenous children aged less than 5 years (45%) compared with non-Indigenous children in the same age group (22%, p<0.01). The proportion of IPD cases with bacteraemia was significantly larger in non-Indigenous (65%), than in Indigenous (45%, p<0.05) children, aged less than 5 years.

There were 154 deaths recorded among IPD cases in Australia in 2004, a case fatality rate of 7.6 per cent (Table 5). The case fatality rate in those aged 65 years and older (16%) was significantly higher than in children aged less than 5 years (2.3%, p<0.0001). The case fatality rate was not significantly different in Indigenous (4.8%) and non-Indigenous cases (7.6%). Of the 16 children under 5 years of age who died, 13 were under 2 years.

Risk factors for pneumococcal disease

The national surveillance working party defined risk factor categories for IPD. Other risk factors defined by jurisdictions were also collected. More than one risk factor could be recorded for each case. Recognised risk factors were collected in 686 (34%) enhanced cases. The most commonly reported risk factor was chronic disease (376 cases, 54.8%) which included chronic respiratory, cardiac and renal disease.

The frequency of risk factors for IPD in Indigenous and non-Indigenous people are shown in Table 6. Premature birth was a significantly more common risk factor in non-Indigenous children compared with Indigenous children. Immunocompromising conditions were recognised as a more common risk factor in older non-Indigenous children and adults than in Indigenous cases in the same age range.

Pneumococcal serotypes causing disease in Australia

Pneumococcal serotypes were identified for isolates from 1,915 (80%) of all notified cases in 2004. Of these, 72 per cent (1,373) were serotypes in the 7vPCV and 91 per cent (1,750) were serotypes in the 23vPPV (Table 7).

Table 5. Case fatality rates* for invasive pneumococcal disease, Australia, 2004, by age, Indigenous status and state or territory

	State or territory								Aust
	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	
Cases	26	585	93	477	198	56	389	199	2,023
Deaths	0	84	4	9	7	6	28	16	154
Case fatality rate (%)	0.0	14.3	4.3	1.9	3.5	10.7	7.2	8.0	7.6
Deaths in < 5 years	0	7	0	2	2	0	4	1	16
Case fatality rate in <5 years	0.0	2.6	0.0	1.3	2.6	0.0	3.6	2.1	2.3
Deaths in >65 years	0	56	2	4	4	5	17	6	94
Case fatality rate >65 years	0.0	24.3	50.0	3.6	6.1	38.5	15.0	12.0	16.0
Deaths in Indigenous people		1	3	1	0	0	0	3	8
Case fatality rate Indigenous	0	16.7	3.8	3.0	0.0	0.0	0.0	9.7	4.8
Deaths in non-Indigenous people	0	77	1	8	5	6	28	13	138
Case fatality rate non-Indigenous	0.0	13.7	7.7	1.8	2.6	10.9	7.3	7.7	7.6

* From enhanced invasive pneumococcal disease surveillance data.

Table 6. The frequency of risk factors for invasive pneumococcal disease, Australia, 2004, by age group and Indigenous status

Risk factor	Cases aged less than 5 years			Cases aged 5 years or more		
	Indigenous n=14	Non Indigenous n=85	Significance of difference	Indigenous n=98	Non-Indigenous n=489	Significance of difference
Premature birth	1 (7%)	30 (35%)	p<0.05	0	0	–
Congenital abnormality	1 (7%)	13 (15%)	ns	0	2 (0.4%)	–
Asplenia	0	2 (2%)	–	2 (2%)	10 (2%)	ns
Immunocompromised	0	9 (11%)	–	10 (10%)	152 (31%)	p<0.0001
Chronic illness	4 (28%)	16 (19%)	ns	56 (56%)	300 (61%)	ns

ns Not significant

Table 7. Proportion of pneumococcal serotypes in cases of invasive pneumococcal disease covered by the 7-valent and 23-valent pneumococcal vaccines,* Australia, 2004, by state or territory

	State or territory								Total
	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	
7v	33/46	432/565	21/88	332/454	136/187	32/46	266/356	121/173	1,373/1,915
	72%	77%	24%	73%	73%	70%	75%	70%	72%
23v	40/46	529/565	60/88	420/454	167/187	41/46	334/356	159/173	1,750/1,915
	87%	94%	68%	93%	89%	89%	84%	92%	91%

* As a proportion of serotyped isolates.

The distributions of serotypes in cases aged less than 5 years and 65 years or more, in 2004, are shown in Figure 5. Eighty-four per cent of isolates from cases of IPD aged less than 5 years were serotypes in the 7vPCV and 93 per cent were serotypes in the 23vPCV. Ninety per cent of isolates from cases of IPD aged 65 years or more were serotypes in the 23vPPV.

Figure 5a. Serotypes responsible for invasive pneumococcal disease in cases aged less than 5 years, Australia, 2004

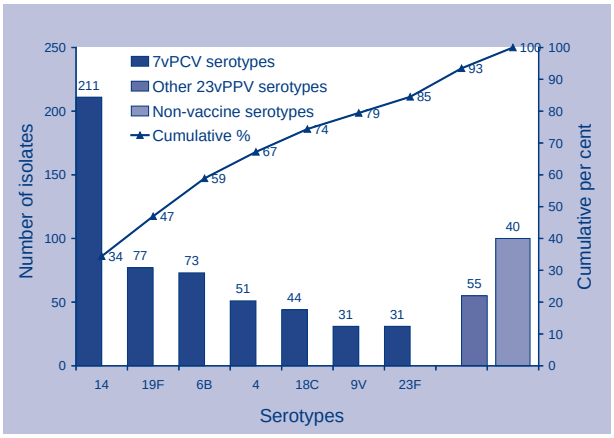
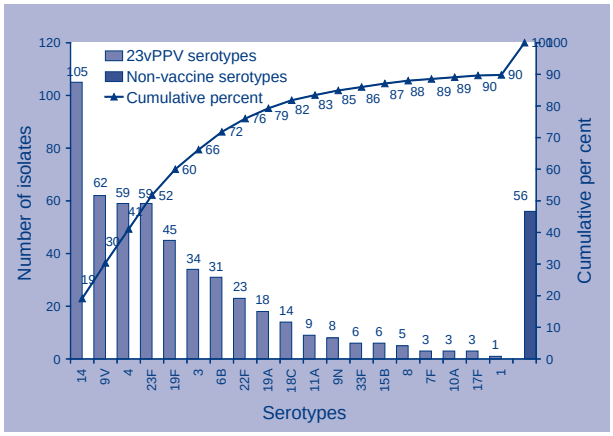


Figure 5b. Serotypes responsible for invasive pneumococcal disease in cases aged 65 years or more, Australia, 2004



The proportion of 7vPCV serotypes was significantly lower in Indigenous (18%) than in non-Indigenous (74%, p<0.0001) children, aged less than 2 years. Similarly, the proportion of 23-valent polysaccharide vaccine serotypes in Indigenous cases was significantly lower (65%) than in non-Indigenous cases (73%, p<0.05) aged 2 years and above (Table 8).

Trends in the number of 7vPCV and non-7vPCV serotypes in Indigenous and non-Indigenous cases aged under 2 years between 2002 and 2004 are shown in Figures 6a and 6b. There was a decline in the proportion of 7vPCV serotypes in Indigenous children (from 38% in 2002 to 18% in 2004) while the proportion of 7vPCV serotypes remained stable in non-Indigenous children.

The change in the rates of IPD in Indigenous children aged less than 2 years due to 7vPCV and non-7vPCV serotypes between 2001–02 and 2003–04 is shown in Table 9. Rates of disease caused by 7vPCV serotypes fell significantly (74.2%) while the increase (11.6%) in disease caused by non-7vPCV was not significant.

Vaccination status of invasive pneumococcal disease cases

Data on vaccination status was available for 1,517/2,375 (64%) cases in 2004. Of the 1,517 cases with a vaccination history, the majority (1,107, 73%) were reported as unvaccinated. IPD was reported in 15 cases who had been fully vaccinated with the 7vPCV and in 158 cases aged more than 15 years who had been fully vaccinated with the 23vPPV.

Further investigation of the 15 cases of IPD fully vaccinated with the 7vPCV showed that only three cases had evidence of vaccine failure. The three apparent vaccine failures had all received three doses of the 7vPCV, had disease caused by a 7vPCV serotype and no pre-disposing risk factors for IPD. Two of the three cases were Indigenous children.

Of the 158 cases of IPD fully vaccinated with the 23vPPV, 133 had disease caused by serotypes in the 23vPPV. These vaccine failures occurred in 69 males and 64 females aged between 17 and 95 years. Nineteen were Indigenous adults and 114 were non-Indigenous adults and all jurisdictions except the Australian Capital Territory reported vaccine failures. Of the 133 vaccine failures, 97 had predisposing risk factors for pneumococcal disease recorded.

Figure 6a. Number of 7-valent and non-7-valent vaccine serotypes causing cases of invasive pneumococcal disease in Indigenous children aged less than 2 years, 2002 to 2004

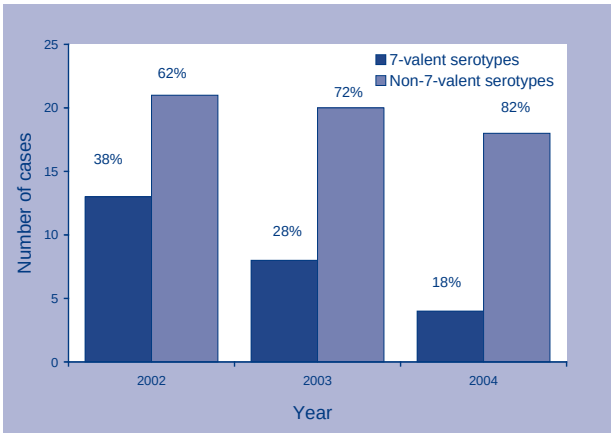


Figure 6b. Number of 7-valent and non-7-valent vaccine serotypes causing cases of invasive pneumococcal disease in non-Indigenous children aged less than 2 years, 2002 to 2004

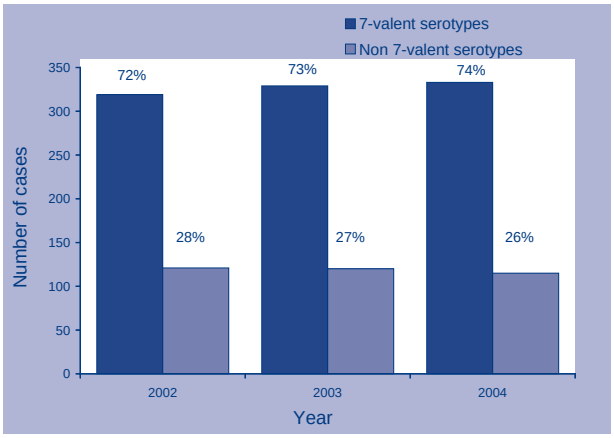


Table 8. The proportion of pneumococcal serotypes isolated from cases of invasive pneumococcal disease, which were serotypes in the 7-valent and 23-valent pneumococcal vaccines, Australia, 2004, by age and Indigenous status

	Cases aged less than 2 years with serotypes in 7-valent conjugate vaccine					Cases aged 2 years or more with serotypes in 23-valent vaccine				
	Indigenous		Non-Indigenous		Significance of difference	Indigenous		Non-Indigenous		Significance of difference
	n	%	n	%		n	%	n	%	
Total	4/22	18	333/448	74	p<0.0001	98/151	65	1,275/1,754	73	p=0.05

Table 9. Changes in estimated rates of invasive pneumococcal disease in Indigenous children under 2 years of age, 2001–02 and 2003–04, by serotype

Serotype	2001–02		2003–04		% change in rate	P value*
	Number of cases n=74	Rate per 100,000	Number of cases n=46	Rate per 100,000		
7vPCV serotypes	45	192.4	12	49.6	– 74.2	p<0.001
4	5	21.4	1	4.1	– 80.7	
14	14	59.9	2	8.3	– 86.2	
18C	3	12.8	1	4.1	– 67.8	
19F	4	17.1	6	24.8	+44.9	
23F	4	17.1	0	0.0	–100.0	
6B	11	47.0	2	8.3	– 82.4	
9V	4	17.1	0	0.0	– 100.0	
Non-vaccine serotypes	29	124.0	34	140.4	+11.6	NS

* Significance of difference in proportions between two time periods tested by Chi-square test.

NS Not significant.

Table 10. *Streptococcus pneumoniae* susceptibility to penicillin and ceftriaxone/cefotaxime, Australia, 2004, by state or territory*

Antibiotic	Description	State or territory							Total
		NSW	NT	Qld	SA	Tas	Vic†	WA	
Penicillin	Penicillin resistant	39	0	32	2	0	2	7	82
	Penicillin intermediate	45	10	43	19	2	27	22	168
	Penicillin susceptible	483	82	366	157	53	310	152	1,603
	Total tested	567	92	441	178	55	339	181	1,853
	% reduced susceptibility	14.8	10.9	17.0	11.8	3.6	8.6	16.0	13.5
Ceftriaxone	Ceftriaxone/cefotaxime resistant	NT	0	10	1	0	0	0	11
	Ceftriaxone/cefotaxime Intermediate	NT	3	15	2	0	9	2	31
	Ceftriaxone/cefotaxime susceptible	NT	71	416	56	55	305	179	1,082
	Total tested	NT	74	441	59	55	314	181	1,124
	% reduced susceptibility		4.1	5.7	5.1	0.0	2.9	1.1	3.7

* No data available from the Australian Capital Territory.

† Data from Victorian Hospitals Pathogen Surveillance System participating laboratories.

NT Not tested.

Antibiotic resistance in pneumococcal cases

The penicillin susceptibility was tested in 1,853 isolates and ceftriaxone/cefotaxime susceptibility was tested in 1,124 isolates (Table 10).

A total of 250 (13.5%) tested isolates had reduced susceptibility to penicillin which was an increase on the number and rate of isolates with reduced penicillin susceptibility in 2003 (142 isolates, 11.9%). Forty-two isolates (3.7%) had reduced susceptibility to ceftriaxone/cefotaxime in 2004, which was an increase in the number and rate compared to 2003 (9 isolates, 1.3%).

The serotypes of isolates with reduced penicillin susceptibility were examined (Table 11). Of the 250 isolates, 216 were serotyped. One hundred and eighty

Table 11. Proportions of pneumococcal isolates with reduced penicillin susceptibility, Australia, 2004, by age group and serotype

Serotype	Total	Children aged less than 5 years		Adults aged 65 years and over		Significance of difference
		n	%	n	%	
14	34	21	24.4	5	7.0	p<0.0001
11A	1	0	0.0	0	0.0	
19A	23	11	12.8	6	8.5	p<0.01
19F	45	17	19.8	13	18.3	ns
22F	1	0	0.0	1	1.4	
23F	5	1	1.2	2	2.8	
6A	2	1	1.2	1	1.4	
6B	19	14	16.3	4	5.6	ns
9V	77	17	19.8	35	49.3	p<0.005
Not typed	9	4	4.7	4	5.6	
Total	216	86	100.0	71	100.0	

ns Not significant

(83%) isolates with reduced penicillin susceptibility were serotypes in the 7vPCV and 205 (95%) were serotypes in the 23vPPV. There was no significant difference in the rate of penicillin resistance between children aged less than 5 years and adults aged 65 years or more.

When the prevalence of serotypes with reduced penicillin susceptibility was examined by age group, differences were noted between children aged less than 5 years and adults aged 65 years and above. There were a significantly higher proportion of penicillin insensitive serotypes 14 and 19A in children compared with adults and a higher proportion of penicillin insensitive serotype 9V in adults compared with children (Table 11). This pattern of penicillin resistant serotypes was different from that seen in 2003[5] when the proportions of penicillin resistant serotypes 19F and 14 were higher in older adults than young children.

Discussion

In 2004, IPD continued to have a significant impact on the health of young and old Australians. Serotypes causing IPD in 2004 were predominately vaccine serotypes in the 7vPCV in children aged less than 5 years and in the 23vPPV in the 65 years and older age group. All children under two years of age and all adults aged 65 years and older have been offered free vaccination with pneumococcal vaccines from January 2005.

This report details the impact of the Indigenous 7vPCV vaccine program in reducing the disease burden of IPD among Indigenous children. Rates of IPD in Indigenous children in the 1990s were among the highest recorded in the world. In 2004, the rates in Indigenous children aged less than 2 years had fallen to that of their non-Indigenous peers. IPD disease caused by 7vPCV serotypes in these Indigenous children under 2 years fell by 74 per cent in the period 2001–02 to 2003–04 with no significant increase in disease caused by non 7vPCV serotypes.

Despite the availability of the 23vPPV for Indigenous adults, through the National Indigenous Pneumococcal and Influenza Immunisation program, reductions in IPD in Indigenous adults have not been seen. A recent (2004) study estimated that the vaccine coverage was 25 per cent.[6] Although Indigenous adults were more likely to have disease caused by non-23vPCV serotypes than their non-Indigenous peers, two-thirds of cases reported in Indigenous adults in 2004 would have been potentially preventable by 23vPPV vaccination.

Reduced susceptibility to both penicillin and ceftriaxone/cefotaxime was evident in isolates from all age groups and jurisdictions in 2004. There was further evidence of specific penicillin resistant serotypes circulating among children and older adults. However the great majority of non-susceptible strains were 7vPCV serotypes and a significant reduction in the prevalence of antibiotic resistant IPD can be expected with the implementation of universal 7vPCV vaccination from 2005.[7]

In the USA the impact of the 7vPCV vaccine on IPD has recently been assessed.[8] Since the licensure of the vaccine in 2000, a reduction in the incidence of IPD in the vaccinated age groups has continued. In addition, it has been estimated that the vaccine has prevented twice as many cases indirectly through reductions in pneumococcal transmission

via increased herd immunity. Although increases in disease caused by non-7vPCV serotypes have been seen, these have been small relative to the declines in 7vPCV serotype disease. It has been recently estimated that the universal 7vPCV will prevent more than 80 per cent of childhood IPD and associated mortality in Australia. 7vPCV may also prevent 6 per cent of all pneumonia, 18 per cent of radiographically-defined pneumonia, 6 per cent of otitis media and 20–40 per cent of tympanostomy procedures in children under 5 years.[9] A reduction of 80 per cent may be a slight over-estimation, since IPD due to 7vPCV serotypes has accounted for only 72–74 per cent of disease in children aged under 2 years in recent years; nevertheless a significant reduction is anticipated. An analysis of the impact of the first year of the universal 7vPCV vaccination program on IPD in Australia will be provided in the next report.

Recent studies have revealed high-risk groups for IPD who could benefit from vaccination. A case control study in the USA identified asthma in persons aged 2–49 years as an independent risk factor for IPD.[10] Another USA study estimated the increased risk of IPD for specific chronic diseases, controlling for age and race.[11] Relative risks (compared to healthy adults) were 5.8 for diabetes, 6.9 for chronic lung disease, 10.4 for chronic heart disease, 11.5 for alcohol abuse, 32.2 for solid cancer, 48.8 for HIV/AIDS and 52.2 for haematological cancers. These observations support the recommendations in the *Australian Immunisation Handbook* that such high-risk groups receive the 23vPPV.[12]

The changing epidemiology of IPD in the era of pneumococcal conjugate vaccines is the subject of continuing research. Changes in serotypes causing IPD ('serotype replacement') are being measured through on-going laboratory surveillance. Despite increased prevalence of non-7vPCV serotypes in Indigenous children between 2001 and 2005, the overall rate of IPD continues to decline. Some concern has been raised about non-7vPCV serotypes causing unusual or severe presentations of IPD such as para-pneumonic empyema.[13] However, a recent review of apparent epidemiological differences between serotypes concluded that 7vPCV serotypes are the most prevalent in children aged 6 months to 2 years and in the immunocompromised and elderly adults. Continued epidemiological surveillance is required to determine whether increases in the prevalence of some non-vaccine serotypes are more significant than others.[14]

The use of 7vPCV in Indigenous children in Australia over the past three years has successfully reduced the rate of IPD to that of non-Indigenous children. There is, to date, no evidence of significant non-7vPCV serotype 'replacement' disease. Rates of pneumococcal resistance to penicillin are modest and resistance to ceftriaxone/cefotaxime remains rare. The introduction of the 7vPCV to the universal vaccination schedule in Australia in 2005 will further lower the disease burden of IPD among children and may contribute to reduction in other age groups. Continued enhanced IPD surveillance will be critical to assessing the impact of the expanding pneumococcal vaccine strategies.

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