Invasive pneumococcal disease in Australia, 2005

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Abstract

Enhanced surveillance for invasive pneumococcal disease (IPD) was carried out in all Australian states and territories in 2005 with comparative data available since 2001. There were 1,680 cases of IPD notified to the National Notifiable Diseases Surveillance System in Australia in 2005; a notification rate of 8.3 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 (41 cases per 100,000 population) and in 1-year-old children (36.5 cases per 100,000 population). Enhanced data provided additional information on 1,015 (60%) of all notified cases. The overall rate of IPD in Indigenous Australians was 8.6 times the rate in non-Indigenous Australians. There were 126 deaths attributed to IPD resulting in an overall case fatality rate of 7.5%. While the rate of IPD in the Indigenous under 2-year-old population decreased from 219 cases per 100,000 population since targeted introduction of the 7-valent conjugate pneumococcal vaccine (7vPCV) in 2001, the rate in 2005 (94 cases per 100,000 population) was significantly greater than in non-Indigenous children (20.4 cases per 100,000 population). Rates of disease in all children aged less than 2 years, caused by serotypes in the 7vPCV decreased by 75% between 2004 and 2005 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. There is no evidence of replacement disease with non-vaccine serotypes. Serotypes were identified in 90% of all notified cases, with 61% of disease caused by serotypes in the 7vPCV and 88% caused by serotypes in the 23-valent polysaccharide pneumococcal vaccine (23vPPV). Reduced penicillin susceptibility remains low and reduced susceptibility to 3rd generation cephalosporins is rare. *Commun Dis Intell* 2007;31:86–100.

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Introduction

While the 23-valent polysaccharide pneumococcal vaccine (23vPPV) was available for older children and adults for many years, it was the anticipation of a conjugate vaccine for infants and young children that prompted national notification and enhanced surveillance of invasive pneumococcal disease (IPD) in Australia. In 2000, the most comprehensive reporting of the nationwide burden of IPD to date was assembled[1] and the call for IPD to be nationally notified was realised in 2001. Since then, enhanced data has been collected and analysed from all states and territories and published annually. Australia is fortunate to be able to provide country-wide surveillance data for IPD that includes the vaccination status for all cases aged less than 5 years and the majority of adult cases. Serotype information has been available in past reports for up to 86% of all isolates notified.[2] The 2004 report, following 3½ years after the introduction of the 7-valent conjugate pneumococcal vaccine (7vPCV) for at-risk (including all Indigenous) children, showed the rate of IPD in Indigenous children was reduced to that of non-Indigenous children (91.5 and 93.6 cases per 100,000 population, respectively).[2] In January 2005, universal 7vPCV for infants and children was introduced. Ninety-one per cent of Australian children were reported as having received 3 doses of 7vPCV vaccine by 12 months of age between January and September 2005 (Australian Childhood Immunisation Register). The impact of this vaccine is reported in this report, as well as on-going surveillance of IPD in all ages. In addition, while some jurisdictions had funded the 23vPPV for older adults, 2005 was the first year it was federally funded for all those aged 65 years or older (Table 1).

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

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 5 years later* Aboriginal and Torres Strait Islander people aged 50 years or over to receive a single dose of vaccine with a booster 5 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 IPD (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†† 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 persons aged15 years or over in the Northern Territory from 1999.

§ Targeted funded programs for high risk persons aged over 2 years in north Western Australia and the Northern Territory from 1986.

‖ Recommended nationally for persons aged over 2 years (pre-July 2001) and aged over 5 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.

National Notifiable Diseases Surveillance System (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 2005 comprised core data, which is a set of data collected on all cases of all notifiable diseases as well as 'enhanced' data specific to IPD.

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, (< 37 weeks gestation), congenital or chromosomal abnormality, anatomical or functional asplenia, being immunocompromised, chronic illness, childcare attendee, previous episode of IPD, other (e.g. a smoker), and unknown. 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.

Populations under surveillance

There were different populations under enhanced surveillance in jurisdictions in 2005 (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 2005, was used as the denominator in rate calculations. 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 and proportions was calculated using the Chi-square test with Yates correction.

Results

There were 1,680 notifications of IPD to NNDSS in 2005; a 30% decrease compared to the number of notifications in 2004 with declines in all jurisdictions of between 21 and 46%. 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 (35 cases per 100,000 population) while Victoria had the lowest (6 cases per 100,000 population).

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 winter months with the peak number of notifications in July (226 notifications). The effect of season was more evident in the distribution of cases aged 5 years or more, compared with younger children (Figure 1).

The highest rates of IPD disease in 2005 were among the elderly aged 85 years or over (41 cases per 100,000 population) and children aged 1 year (36.5 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).

In 2005, the highest rates of IPD continue to be at the extremes of age (those 85 years or older and those aged 1 year (12–23 months). Between 2004 and 2005, the rate fell by 57% in the under 5 years age group (from 55.4 to 24 cases per 100,000 population) and by 69% specifically, in children aged 1 year (from 119 to 36.5 cases per 100,000 population) reflecting the impact of the introduction of universal 7vPCV at 2, 4 and 6 months with a catch-up program for

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 aged at 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; and • 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 IPD surveillance data collection, 2005, by state or territories

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

children up to 2 years of age. There was also a 24% reduction in the rate in the 65 year or over age group (from 25 to 19 cases per 100,000 population).

In 2005, the proportion of children aged 12 months of age immunised with 3 doses of 7vPCV was 91.1%. The proportion of children who are fully vaccinated against pneumococcal disease has increased steadily since 2001 (Figure 3).

An examination of trends in rates of IPD in different age groups from 2002 to 2005 is shown in Figure 4. The rates in children aged under 2 years declined by 68% ($p < 0.0001$) and declined in adults aged 65 years or more by 30% ($p < 0.0001$). Rates of IPD in other age groups not specifically targeted for pneumococcal immunisation also declined—there was a 52% ($p < 0.0001$) reduction in the

Table 4. Notifications, rates and demographics of IPD cases, Australia, 2005, by state or territory

	State or territory								
	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Australia
Notifications	30	636	71	325	134	45	299	140	1,680
Rate per 100,000	9.2	9.4	35.0	8.2	8.7	9.3	6.0	7.0	8.3
Male:female ratio	0.9:1	1.3:1	1.3:1	1.3:1	1.1:1	1.8:1	1.3:1	1.1:1	1.3:1
Notifications by age									
<5 years	6	137	10	57	19	10	42	21	302
5 to 64 years	13	289	55	182	66	22	151	87	865
≥65 years	11	210	6	86	49	13	106	32	513
Notifications by indigenous status									
Indigenous	1	13	59	36	7	0	7	41	164
Non-Indigenous	10	438	12	218	125	34	280	99	1,216
Unknown	19	185	0	71	2	11	12	0	300

Figure 1. Notifications of invasive pneumococcal disease, Australia, 2005, by month of report and age group

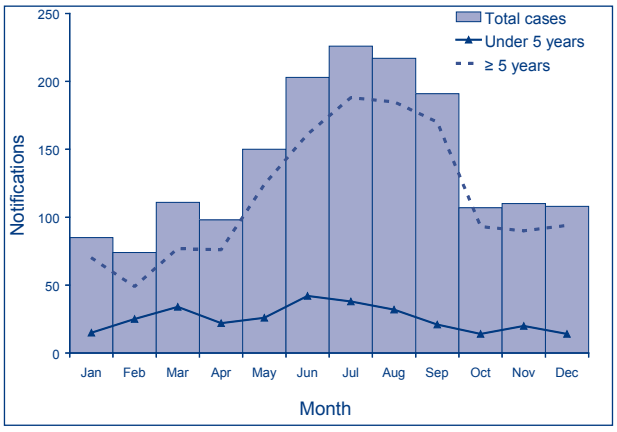


Figure 2. Notification rates of invasive pneumococcal disease, Australia, 2005, by age group and sex

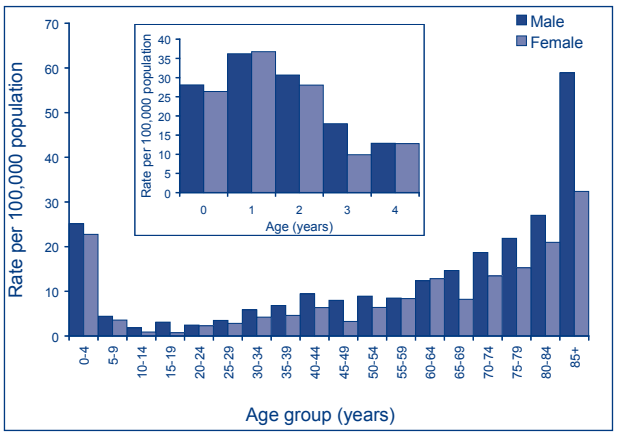


Figure 3. The proportion of children aged 12 months fully vaccinated with 7vPCV, Australia, 2001 to 2005, by indigenous status

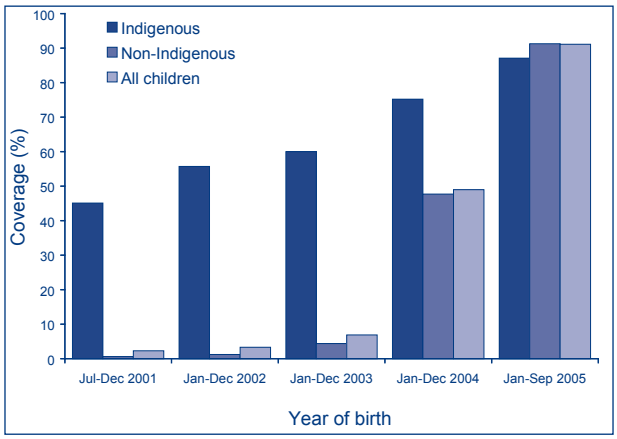
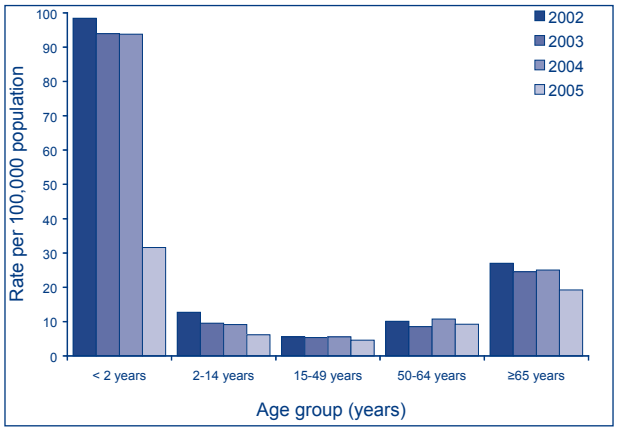
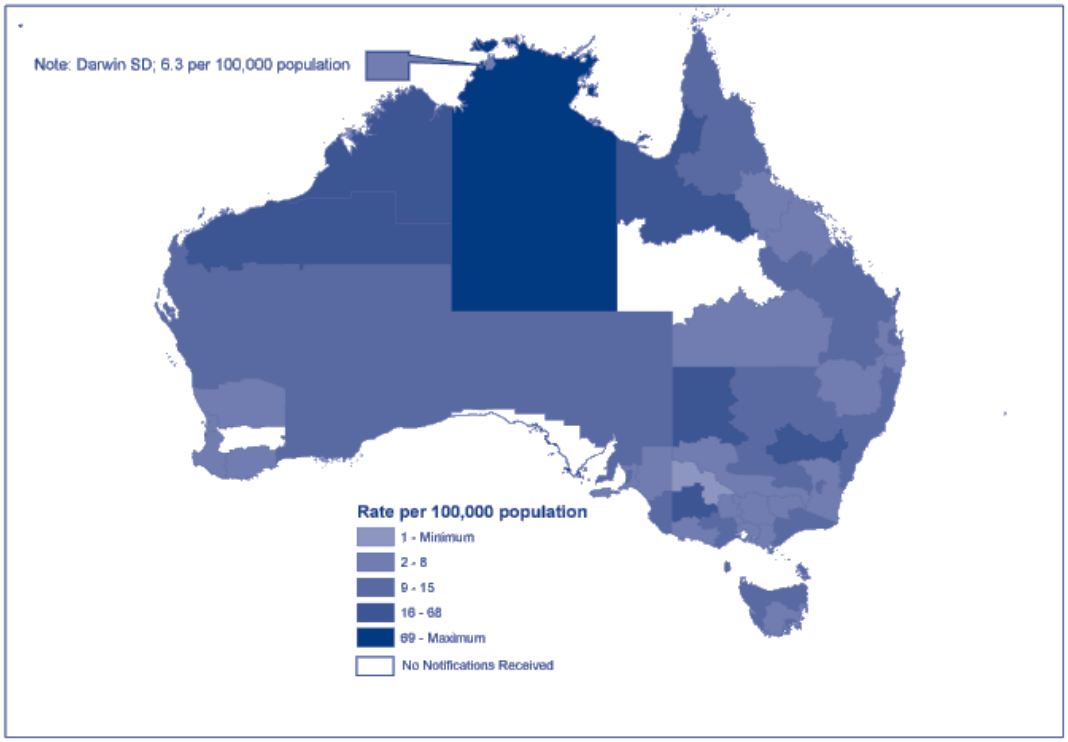


Figure 4. Pneumococcal disease notification rate, Australia 2002 to 2005, by age group



Map. Notification rates of invasive pneumococcal disease, Australia, 2005, by Statistical Division of residence



2–14 year age range; an 18% ($p < 0.05$) decline in the 15–49 year age range and a 9% decline ($p = ns$) in the 50–64 year age range.

Rates in Indigenous people

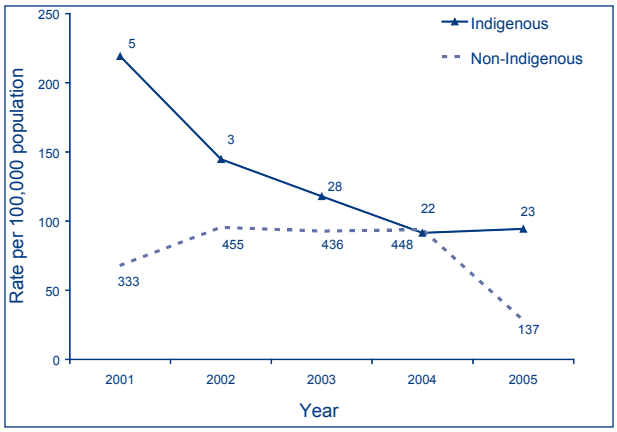
In 2005, indigenous status was reported for 1,380 (82%) notifications. There were 164 cases of IPD among Indigenous people (9.7% of all cases). This represents a rate of 66 cases per 100,000 in the Indigenous population—a rate 8.6 times that seen in the non-Indigenous population (7.6 cases per 100,000 population).

Rates in children

In 2005, rates remained similar to those in 2004 in Indigenous children, at 94 cases per 100,000 population, while a large decline to 28.7 cases per 100,000 population was recorded in non-Indigenous children in 2005 (Figure 5).

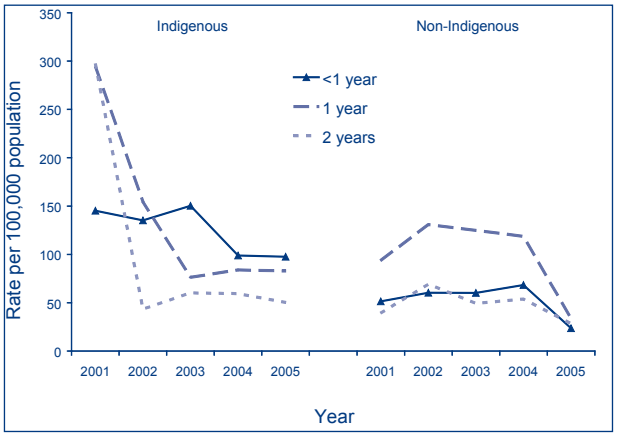
Figure 6 shows the annual rates in single year age groups in children aged less than 2 years. In 2005, the rates of IPD in Indigenous children aged less than 1 year (0–11 months) and in 1-year-olds (12–23 months) was similar to the rates in 2004 (97 versus 98) and (82 versus 84 cases per 100,000 population, respectively, both $p = ns$). Rates in Indigenous 2-year-old (24–35 months) children

Figure 5. Notification rates of invasive pneumococcal disease in Indigenous and non-Indigenous children aged less than 2 years, Australia, 2001 to 2005



fell from 59 to 50 cases per 100,000 population in 2005 ($p = ns$). Between 2004 and 2005, rates fell in non-Indigenous children aged less than 1 year, from 68 to 23 cases per 100,000 population, ($p < 0.0001$); in the 1 year age group from 118 to 34 cases per 100,000 population ($p < 0.0001$) and in the 2 years age group from 53 to 28 cases per 100,000 population ($p < 0.0001$, Figure 6).

Figure 6. Rates of invasive pneumococcal disease 2001 to 2005 in children aged 2 years and under, by indigenous status and single year age group



Clinical presentations of invasive pneumococcal disease

Enhanced surveillance including data on clinical presentation and risk factors were available for 1,015 (60%) of all cases. Clinical presentation was reported in 783 (77%) of enhanced notifications of which 483 (61%) were pneumonia, 242 (31%) were bacteraemia and 46 (5.8%) were meningitis, with the remainder being other presentations (n = 12).

The clinical presentations of IPD in Indigenous and non-Indigenous children aged less than 2 years were examined over the period 2001 and 2005. There was a decline in the proportion of Indigenous IPD cases presenting with pneumonia (from 22 cases in 2001 to 4 cases in 2005) making the proportions of cases presenting as pneumonia similar in Indigenous (27%) and non-Indigenous children (22%) in 2005 (Figure 7). Conversely, the proportion of Indigenous children with bacteraemia increased from 2001 to 2005, when the proportion (73%) was similar to that seen in non-Indigenous children (70%). Meningitis was a rare presentation in both groups and in all years, with the 'peak' in 2004 in Indigenous children representing only 2 cases.

Deaths in invasive pneumococcal disease cases

There were 128 deaths recorded among IPD cases in Australia in 2005, a case fatality rate of 7.6% (Table 5). The case fatality rate in those aged 65 years or older (16.4%) was significantly higher than in children aged less than 5 years (2.6 %, $p < 0.0001$). The case fatality rate was lower but not significantly different in Indigenous (5.5%) compared to non-Indigenous cases (9.6%). Of the 8 children whose deaths were associated with

Figure 7. Changes in clinical presentations of invasive pneumococcal disease cases aged less than 2 years, 2001 to 2005, by indigenous status

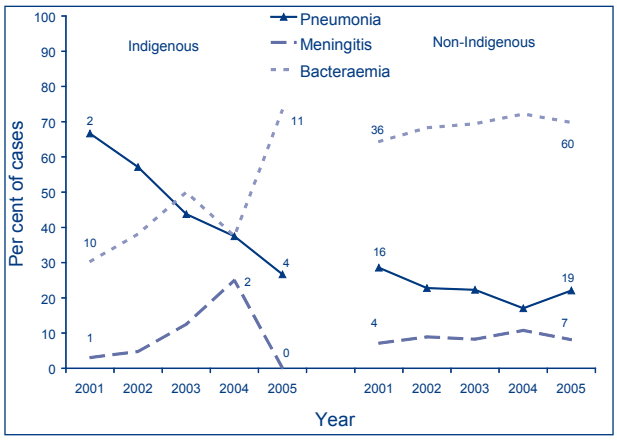


Table 5. Case fatality rates for invasive pneumococcal disease, Australia, 2005, by age, indigenous status and state or territory

	State or territory								
	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Aust
Cases	30	636	71	325	134	45	299	140	1,680
Deaths	2	64	4	4	7	2	31	14	128
Case fatality rate	6.7	10.1	5.6	1.2	5.2	4.4	10.4	10.0	7.6
Deaths in under 5 years	0	2	0	2	1	0	2	1	8
Case fatality rate <5 years	0.0	1.4	0.0	3.5	5.3	0.0	4.9	4.8	2.6
Deaths in ≥65 years	2	53	0	1	3	1	19	5	84
Case fatality rate ≥65 years	18.2	25.2	0.0	1.2	6.1	7.7	17.9	15.6	16.4
Deaths in Indigenous people	0	1	4	0	1	0	2	1	9
Case fatality rate – Indigenous	0.0	7.7	6.8	0.0	14.3	0.0	28.6	2.4	5.5
Deaths in non-Indigenous people	2	62	0	4	6	2	29	13	118
Case fatality rate – non-Indigenous	6.9	14.2	0.0	1.8	4.8	5.9	10.4	13.1	9.6

IPD, one was infected at birth, a second within the first month; three more within the first year; the remaining three were aged between 18 months and 2 years. Seven of the 8 cases had serotype information and of these seven, 3 were infected with 7vPCV serotypes (2 with 19F, 1 with 23F); 3 with serotypes in the 23vPPV (1, 10A, 19A) and the remaining case was infected with a non-vaccine strain (23B). Two of the 8 cases were recorded as fully vaccinated (Table 2) and both were infected with a non-7vPCV serotype (10A and 23B). Of the three 7vPCV serotype deaths, one was unvaccinated (serotype 23F), and the 2 cases due to 19F serotype disease were only partially vaccinated. One child was too young for the third dose of vaccine but was fully vaccinated for age while the other child was overdue for the third vaccine dose.

Risk factors for pneumococcal disease

Recognised risk factors were collected in 686 (67.5%) cases in the enhanced dataset. The most commonly reported risk factor was chronic disease (376 cases, 54.8%), which included chronic respiratory, cardiac and renal disease, and diabetes.

The frequency of risk factors for IPD in Indigenous and non-Indigenous people are shown in Table 6. While 29% of Indigenous children with IPD had predisposing risk factors, this was not significantly different when compared with 12% of non-Indigenous children. Chronic disease was a significantly more common risk factor for IPD in older Indigenous children and adults than in non-Indigenous cases in the same age range ($p < 0.005$).

Pneumococcal serotypes causing disease in Australia

Pneumococcal serotypes were identified for isolates from 1,507 (89.7%) of all notified cases in 2005. Of these, 916 (60.8%) were serotypes in the 7vPCV and 1,331 (88.3%) were serotypes in the 23vPPV (Table 7).

The proportion of 7vPCV serotypes in cases of IPD in the Northern Territory (12.1%) and Western Australia (49.6%) were significantly lower than the proportion in the national total (60.8%). The propor-

Table 6. The frequency of risk factors for invasive pneumococcal disease, Australia, 2005, by age group and indigenous status

Risk factor	Cases aged less than 5 years			Cases aged 5 years or more		
	Indigenous n=34	Non-Indigenous n=269	Significance of difference	Indigenous n=130	Non-Indigenous n=1,247	Significance of difference
Premature birth	3	13	NS	NA	NA	–
Congenital abnormality	1	7	NS	NA	NA	–
Asplenia	1	0	NS	1	10	NS
Immuno-compromised	1	2	NS	14	105	NS
Chronic illness	4	10	NS	43	260	p<0.005

NS Not significant.

NA Not applicable.

Table 7. Number and proportion* of pneumococcal serotypes in cases of invasive pneumococcal disease covered by the 7-valent and 23-valent pneumococcal vaccines, Australia, 2005, by state or territory

	State or territory								
	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Australia
7v serotypes	15	347	8†	182	90	22	186	66‡	916
(%)*	(62.5)	(63.7)	(12.1)	(62.1)	(68.7)	(73.3)	(65.3)	(49.6)	(60.8)
23V serotypes	22	488	41†	252	121	28	265	114	1,331
(%)*	(91.7)	(89.5)	(62.1)	(86.0)	(92.4)	(93.3)	(93.0)	(85.7)	(88.3)
Total serotyped	24	545	66	293	131	30	285	133	1,507

* As a proportion of serotyped isolates.

† Significantly lower proportion of 7vPCV and 23vPPV serotypes compared with the national total ($p<0.0001$).

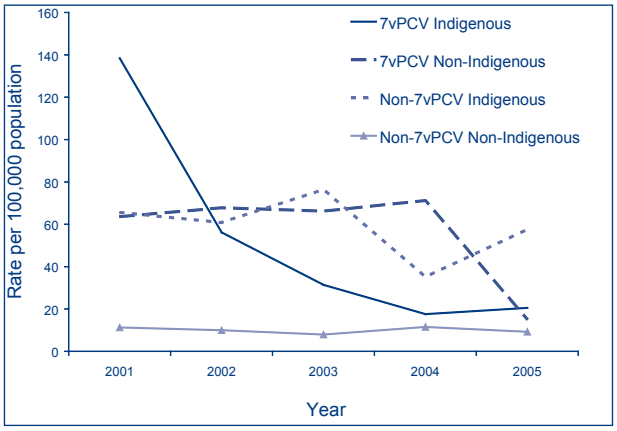
‡ Significantly lower proportion of 7vPCV serotypes compared with the national total ($p<0.05$).

tion of 23vPPV serotypes in the Northern Territory (62.1%) was also significantly lower than the proportion in the national total (88.3%, Table 7).

As in previous years, the proportion of 7vPCV serotypes causing disease in Indigenous children aged less than 2 years (23%) was significantly lower than in non-Indigenous children in the same age group (55%, $p < 0.0001$). Similarly the proportion of 23vPPV serotypes causing disease in Indigenous cases aged 2 years or over was significantly lower (62%) than in non-Indigenous cases in the same age group (84%, $p < 0.0001$).

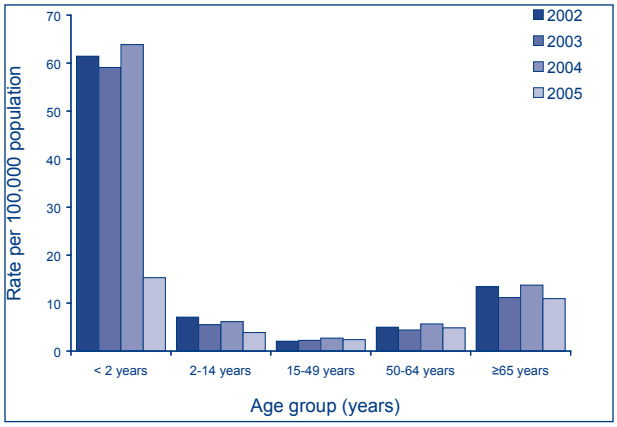
An examination of the rates of IPD disease caused by 7vPCV and non-7vPCV serotypes and indigenous status in children aged less than 2 years, showed a decline in rates in Indigenous children (from 138 to 20 cases per 100,000 population) between 2001 and 2005. Rates of disease caused by non-7vPCV serotypes also decreased in the same period but not significantly (65.5 in 2001 to 57.5 cases per 100,000 population in 2005). In non-Indigenous children, rates of 7vPCV serotype disease fell from 71 cases per 100,000 population to 15 cases per 100,000 population between 2004 and 2005, while rates of disease caused by non-vaccine serotypes in the same period were little changed (11.5 cases per 100,000 population in 2004 and 9.3 cases per 100,000 population in 2005, Figure 8).

Figure 8. Notification rates of 7-valent and non-7-valent serotypes causing cases of invasive pneumococcal disease in children aged less than 2 years, 2001 to 2005, by indigenous status



The total population rates of IPD caused by 7-valent vaccine serotypes fell 75% between 2002 and 2005 in children aged under 2 years (61.4 to 15.3 cases per 100,000 population), 45% in the 2–14 year age range (7.1 to 3.9 cases per 100,000 population) and 18% in the 65 years or over age group (13.4 to 10.9 cases per 100,000 population). All these declines were statistically significant. There was no significant change in the rates in the 15–49 years age range (2.1 to 2.4 cases per 100,000 population) or the 50–64 year age range (5 to 4.9 cases per 100,000 population, Figure 9).

Figure 9. Rates of invasive pneumococcal disease caused by 7-valent pneumococcal vaccine serotypes, 2002 to 2005, by age group



Rates of IPD due to 23vPPV serotypes in Indigenous adults aged 50 years or over declined from 71 to 28 cases per 100,000 population ($p < 0.005$) between 2001 and 2005. In the same period, rates of disease caused by non-23vPPV serotypes increased from 3 to 21 cases per 100,000 population, but this increase was not statistically significant. Rates of 23vPPV serotype disease in non-Indigenous adults aged 65 years or over showed little change over the period 2001 and 2005 (Figure 10).

Figure 10. 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), 2001 to 2005

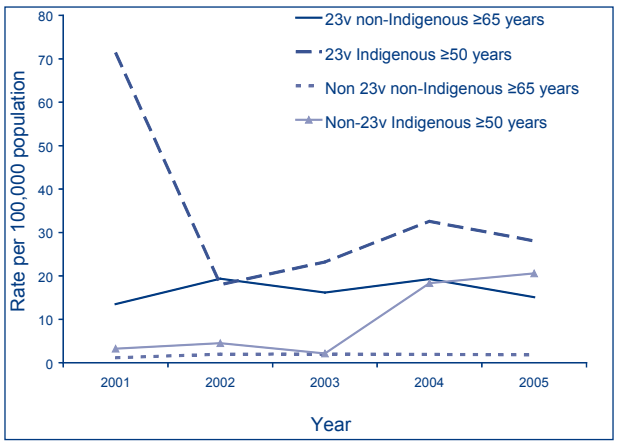


Table 8. *Streptococcus pneumoniae* susceptibility to penicillin and ceftriaxone/cefotaxime, Australia, 2005, by state or territory

Antibiotic	Description	State or territory								Australia
		ACT	NSW	NT	Qld	SA	Tas	Vic*	WA	
Penicillin	Resistant	0	32	1	18	2	1	6	3	63
	Intermediate	6	45	1	18	9	1	15	18	113
	Susceptible	24	507	68	220	105	42	228	111	1,305
	Total tested	30	584	70	256	116	44	249	132	1,481
	% reduced susceptibility	20.0	13.2	2.9	14.1	9.5	4.5	8.4	15.9	11.9
Ceftriaxone/cefotaxime	Resistant	0	7	0	1	0	1	1	0	10
	Intermediate	0	26	0	4	2	1	0	1	34
	Susceptible	25	397	52	251	27	42	188	131	1,113
	Total tested	25	430	52	256	29	44	189	132	1,157
	% reduced susceptibility	0.0	7.7	0.0	2.0	6.9	4.5	0.5	0.8	3.8

More complete data from Victoria found slightly higher prevalences of reduced susceptibility to penicillin (12.6%) and third-generation cephalosporins (1.7%).

Antibiotic resistance in invasive pneumococcal disease

The penicillin susceptibility was tested in 1,481 isolates and ceftriaxone/cefotaxime susceptibility was tested in 1,157 isolates (Table 8).

A total of 176 (11.9%) isolates had reduced susceptibility to penicillin, which was lower than the number and proportion of isolates with reduced penicillin susceptibility in 2004 (250 isolates, 13.5%). Forty-four (3.8%) isolates had reduced susceptibility to ceftriaxone/cefotaxime in 2005, which was similar to the number and proportion in 2004 (42 isolates, 3.7%).

Of the 176 isolates with reduced susceptibility to penicillin, 149 were serotyped. One hundred and eighteen (80%) isolates with reduced penicillin susceptibility were serotypes in the 7vPCV and 137 (92%) were serotypes in the 23vPPV. Of the penicillin insensitive isolates, 45 were serotype 9V, 24 were serotype 14 and 19 were serotype 19F, accounting for 75% of isolates with known serotypes. There was no significant difference in the prevalence of serotypes with reduced penicillin susceptibility between children less than 5 years and adults aged 65 years or over.

Vaccination status

Data on vaccination status was available for 1,127 (67%) of all IPD cases in 2005. Of the 1,127 cases with a vaccination history, the majority (781, 69%) were reported as unvaccinated. IPD due to 7vPCV serotype disease was reported in 7 cases who were fully vaccinated with the 7vPCV and IPD due to 23vPPV serotype disease was reported in 165 cases who were fully vaccinated with the 23vPPV.

Of the 7 fully vaccinated cases of IPD due to 7vPCV serotype disease, 3 had received 3 scheduled doses and 4 had received 1 or 2 doses as per the recommended catch up schedule (Table 9). All cases were aged less than 5 years and none of the cases were Indigenous. The serotypes causing disease in the 3 children who received 3 doses of conjugate vaccine were 19F, 6B and 23F. The serotypes in the 4 children that developed 7vPCV serotype disease following 7vPCV catch up vaccination (1 or 2 vaccine doses) were 9V, 14, and 19F (2 children).

Of the cases of IPD with 23vPPV serotype disease that were fully vaccinated with the 23vPPV, 21 were Indigenous, 142 non-Indigenous and the indigenous status of the remaining 2 cases was unknown. Risk factor information was available on 163 of the 165 (99%) 23vPPV failures. Seventy-nine cases had one risk factor recorded, 44 had 2 risk factors recorded and 15 had 3 or more risk factors recorded (Table 9).

Discussion

This report shows an overall 30% reduction of IPD from 2004 to 2005 with the highest rates still remaining in the extremes of age (those 85 years or older and those aged 1 year (12–23 months). The Northern Territory, the jurisdiction with an Indigenous population of 30% compared to 3% nationally, continued to have the highest notification rate. The major reduction over this time was in children under 5 years (57%) and more specifically in the 1-year-olds (69%) reflecting the impact of the introduction of universal 7vPCV at 2, 4 and 6 months with a catch-up program for children aged up to 2 years.

Table 9. Vaccination reporting and vaccine failure in cases of invasive pneumococcal disease, Australia, 2005, by state or territory

All cases	State or territory								
	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Australia
Vaccination history									
Received at least one vaccine ever	0	128	43	37	24	10	78	26	346
Never vaccinated	11	317	28	78	80	32	173	62	781
No vaccine data collected	19	191	0	210	30	3	48	52	553
Vaccine failures 7-valent vaccine									
<5 years of age	0	4	0	0	1	0	2	0	7
Received 3 doses	0	2	0	0	0	0	1	0	3
Received 1 or 2 doses	0	2	0	0	1	0	1	0	4
23-valent failures									
≥5 years of age	0	64	13	18	16	5	38	11	165
1 risk factor recorded	0	43	2	6	7	4	12	5	79
2 risk factors recorded	0	10	6	7	2	1	18	0	44
3 or more risk factors recorded	0	3	5	1	0	0	6	0	15
No risk factor data collected	0	0	0	2	0	0	0	0	2

Immunisation of young children may have contributed to a decline in rates of IPD in other age groups. The rates of IPD in Australia overall declined from 12.6 per 100,000 to 8.3 per 100,000 between 2002 and 2005. In the same period, there was a 75% decrease in 7vPCV serotype disease (and 68% decrease in total IPD rates) in children aged less than 2 years, who were eligible for immunisation with the 7vPCV. Over the same period the 2-14 year age group (most of whom were not immunised) and those aged more than 65 years (who were eligible for23vPPV immunisation) also showed significant decreases in 7vPCV serotype IPD rates (45% and 18% respectively) as well as for all IPD serotypes (52% and 30% respectively). The 15–49 years age range showed a significant reduction in all IPD rates but not specifically when analysing the 7vPCV serotypes. These changes in the epidemiology of IPD in Australia for children and adults are similar to those seen in the United States of America (USA) after the introduction of the 7-valent vaccine there in 2000,[3,4] however the early reduction noted in the Australian 2–14 year age range was not initially seen in the USA and is more striking than that recently reported in the USA.[5] Poehling et al[6] have reported that in the years following the introduction of the 7vPCV in the USA, neonate and infants too young to receive 7vPCV or a full course are also benefiting from a herd immunity effect. This is encouraging and the 0–90 day age group in Australia will be a group to further evaluate in coming years.

Indigenous adults (50 years or over) and non-Indigenous adults (65 years or over) have been eligible for free immunisation with the 23vPPV since 1999 and 2005 respectively. The reduction in IPD in the 65 years or over age group from 2004 to 2005 was 24%—possibly reflecting some contribution from the universal 23vPPV funded program in this age group, as well as herd effect from the 7vPCV. However, the specific impact of each vaccine will be better assessed following a second year of the programs. Of note, comparing 2001 to 2005, disease due to 23vPPV serotypes has changed little in the non-Indigenous adults aged 65 years or over, the majority age group eligible for the now funded 23vPPV program (Figure 10).

Current recommendations for immunisation with the 23vPPV in Australia include 'at risk' groups of any age (Table 1) as well as all those 65 years or over (50 years or over for Indigenous adults). An assessment of targeted populations for 23vPPV immunisation in the USA compared the proportions of vaccine preventable disease in the 50–64 year age range with that preventable in persons of any age with current risk factors. Increasing coverage in eligible age groups and with recognised risk factors would prevent more disease than expanding eligible age groups or list of existing risk factors.[7] In 2004, only an estimated 51% of 65 years or older Australians had received 23vPPV vaccination, but whether the vaccine was within the last 5 years was not determined.[8] The development and provision of a whole-of-life immunisation register to inform strategies to improve uptake and achieve better vaccine coverage in Australian adults may be more beneficial.

A recent review of vaccine preventable diseases and vaccination policies in Indigenous people in Australia, New Zealand, Canada and the United States of America, noted that despite significant

reductions in pneumococcal disease, higher rates persist in Indigenous populations as a result of differences in circulating serotypes, heavy rates of nasopharyngeal colonisation and a higher prevalence of risk factors.[9]

The decline in rates of IPD in non-Indigenous children in 2005 as a result of the universal 7vPCV immunisation program has re-opened the gap between Indigenous and non-Indigenous children aged less than 2 years. Rates of IPD in the vaccine eligible Indigenous children in 2004 were similar to those in the vaccine non-eligible non-Indigenous children. In 2005, the rate in Indigenous children remained relatively unchanged, while the rate in non-Indigenous children fell from 94 to 28.7 cases per 100,000 population making the rate of IPD in Indigenous children 3-times that in non-Indigenous children aged less than 2 years. There were however, only 23 cases reported in Indigenous children in this age group in 2005. Of these children only 5 had disease caused by a 7vPCV serotype, suggesting as already reported from north Queensland,[10] that rates in this age group may not fall much further if relying on the current 7-valent vaccine. It was well recognised prior to the 7vPCV vaccine programs that Indigenous children under 2 years had a significantly smaller proportion of serotypes contained in the 7vPCV (55%) than non-indigenous children (86% $p < 0.005$).[11] Of note, at least 40% of the Indigenous children had one or more pre-disposing risk factors for IPD with most being chronic or at risk conditions that are mainly preventable and therefore efforts for their control offer other strategies for IPD reduction while awaiting vaccines with broader serotype coverage.

The 7vPCV has been shown to protect against nasopharyngeal colonisation with vaccine serotypes. Two studies of the impact of the 7vPCV in high endemic Indigenous communities in North America demonstrated that paediatric vaccination was associated with a decline in colonisation with vaccine serotypes in vaccinees[12] and in unvaccinated adults.[13] However, the reduction in colonisation in 7vPCV vaccine recipients was offset by an increase in colonisation with non-vaccine pneumococcal serotypes. While recognising that not all serotypes are equally invasive, the potential of colonising serotypes to become invasive serotypes has been a concern, especially if there is a shift to non-7vPVC serotypes. Post 7vPVC introduction surveillance studies vary on the impact of serotype replacement on IPD. Reporting from the Intermountain Health Care region in the USA, Byington[14] found significant increases in the proportion of cases due to non-7vPCV serotypes. Other studies have found only modest increases in non-7vPCV serotypes.[3,4,5] In a matched case control study a small increase in IPD from non-7vPCV serotypes was observed, particularly from the vaccine-associated serotype 19A, as well as vaccinated children having a higher risk of disease from serotype 22F, a 23vPPV serotype.[15] A study from an large urban USA city found no statistical increase in strictly non-7vPCV serotypes but a significant increase in 7vPCV-associated serotypes, specifically again, 19A, as well as 6A.[16] Poehling et al,[6] in studies covering portions of 8 USA states, showed no evidence of non-7vPCV replacement. The impact of pneumococcal immunisation on nasopharyngeal colonisation in Australian children will be an important area for further research.

In 2005, the largest proportion (90%) of isolates from notified cases in Australia to date have serotype results providing extensive information to assess the possibility of serotype replacements following vaccine introduction, as well as other serotype linked associations. There is no evidence in children aged 2 or under of non-7vPCV serotype replacement causing IPD in either Indigenous children who have been eligible for 7vPCV since mid-2001 or non-Indigenous children who have been eligible since January 2005. The low rates of non-23vPPV serotypes causing IPD in non-Indigenous adults remained stable from 2001 to 2005, and rates in Indigenous adults aged 50 years or over have increased, but not significantly. Continued monitoring for serotype replacement is essential and the ability to look for emerging trends in incidence of disease, clinical presentations and drug resistance patterns associated with specific serotypes is valuable and may serve to shape future vaccines.

The change in clinical presentations seen among Indigenous children aged less than 2 years from a marked predominance of pneumonia to that of bacteremia following the introduction of the 7vPCV, is remarkable. The level of bacteremia is now of similar proportions to non-Indigenous same-age children. Whether this reflects the 7vPCV serotypes causing more pneumonia is unclear. The proportion of clinical presentations in non-Indigenous children one year following 7vPCV introduction remained unchanged.

Completeness of data for indigenous status continues to be problematic particularly in New South Wales, the Australian Capital Territory and parts of Queensland. Those with unknown indigenous status are mainly in the ages 5–49 years or 64 years, where enhanced data is not collected and reflects the capture of indigenous status in other notifiable diseases. A group working on the 'Improving Indigenous Identification in Communicable Disease Reporting Project' have recently finalised a report and a way forward to try to remove some of the barriers to more complete reporting.

As drug susceptibility results from this surveillance are uniformly not from reference laboratories, but from the treating institutions, these results are viewed as indicative of drug resistance trends. The number and proportion of pneumococci with reduced susceptibility to penicillin (11.8%) or ceftriaxone (3.8%) remained low in 2005. The reduced susceptibility for both drugs varied among the jurisdictions. The Australian Group on Antimicrobial Resistance (AGAR) also reported on antimicrobial resistance (AMR) in invasive and non-invasive isolates of *S. pneumoniae* in 2005.[17] AGAR has been monitoring AMR in pneumococcal infections since 1989 in all Australian states and territories except the Northern Territory and Tasmania. Penicillin resistance in pneumococcal infections in Australia increased rapidly between 1994 and 1999, and more slowly since, with lower rates than in many other countries. Rates of penicillin non-susceptibility in the 2005 AGAR survey for invasive isolates were slightly higher (16.5%) than in this study and, as expected, the AGAR non-invasive isolate rates were significantly higher (30.6%). Non-invasive isolate information is not gathered by this working party. The AGAR result of 14.9% cefotaxime/ceftriaxone non-susceptibility is only on penicillin non-susceptible isolates and therefore, though useful, is not comparable to this study.

Pneumococcal vaccination has been demonstrated to reduce the prevalence of antibiotic insensitive pneumococcal disease. In the USA, there was a 57% decline in penicillin non-susceptible strains of pneumococci between 1999 and 2004.[18] While large reductions were reported in children aged less than 2 years (81%), an increase in disease caused by a penicillin insensitive serotype 19A (a 23vPPV strain) was noted in the same age group. An increase in 19A serotypes has not been seen in Australia and to date there has been no emergence of a predominant penicillin insensitive non-vaccine pneumococcal serotype causing disease. Additionally, in contrast to previous years,[2,19] there was no significant difference in the prevalence of serotypes with reduced penicillin susceptibility in children aged between less than 5 years and adults aged 65 years or over. With 80% of isolates with reduced penicillin susceptibility covered by the 7vPCV and 92% covered by the 23vPPV the prospect of reducing penicillin resistance in the future is encouraging.

The initial year of the universal 7vPCV program has been remarkable for the reduction in IPD in those targeted for the vaccine as well as other age groups. There is no evidence to date to suggest any increase from non-7vPCV serotype disease is occurring. Continued surveillance of pneumococcal disease is essential to measure the effectiveness of the government funded universal pneumococcal immunisation programs and to guide other strategies for IPD control.

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