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Vaccine Preventable Diseases and Vaccination Coverage in Aboriginal and Torres Strait Islander People, Australia, 1999 to 2002

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Vaccine Preventable Diseases and Vaccination Coverage in Aboriginal and Torres Strait Islander People, Australia, 1999 to 2002

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Executive summary

This report complements the format of the Vaccine Preventable Diseases and Vaccination Coverage reports produced biannually since 2000 by the National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases in association with the Australian Institute of Health and Welfare. It integrates the available sources of routinely collected data relevant to the current status of vaccine preventable diseases and vaccine coverage in Aboriginal and Torres Strait Islander people in Australia. It aims to better inform Indigenous communities, Indigenous health care providers and planners of immunisation services of the current status and future needs for vaccine prevention in Indigenous people.

The vaccine preventable diseases (VPDs) presented include only those for which sufficient data are available, with the addition of measles because of its importance in national programs. Table 1 summarises the main findings, showing the reported incidence per 100,000 total population in Indigenous and other (presumed non-Indigenous) people and the ratio of incidence in Indigenous to other (presumed non-Indigenous) people. The estimates of incidence in Indigenous people are based on incomplete ascertainment of Indigenous status and can be considered as minimum estimates. Table 1 illustrates the large burden (incidence) and relative burden (rate ratio) of almost all VPDs in Indigenous people. When measured across all age groups in the Indigenous population, pertussis, influenza and pneumococcal disease have the highest incidence, though the differential burden, as measured by the rate ratio, is highest for *Haemophilus influenzae* type b (Hib) disease and hepatitis A. It is important to note that the Indigenous population is significantly younger than the non-Indigenous population and that both the absolute and relative burdens are greatest in the youngest age groups for most VPDs.

Invasive disease due to Hib has the highest rate ratio. This is because, although the total number of cases has decreased markedly since vaccination began in 1993, the decline has plateaued in Indigenous children, who now account for almost 50 per cent of the total cases occurring under the age of five years. Vaccination for Hib has been very successful, but progress has slowed for Aboriginal and Torres Strait Islander children. More information is needed on the reasons for the widening discrepancy between disease rates in Indigenous and other people, which has also been seen in North America.

Table 1. Summary of notification or hospitalisation rates of vaccine preventable diseases in Australia, 2000 to 2002*

Disease	Notification or hospitalisation rates — all ages†			Indigenous age group with peak incidence	
	Indigenous	Other‡	Incidence rate ratio	Age group	Notification or hospitalisation rate
Invasive Hib disease	1.2	0.1	9.7	0–4	10.0
Hepatitis A	9.1	3.1	2.9	0–4	37.1
Hepatitis B	7.2	1.6	4.4	15–24	14.1
Influenza§	49.3	17.1	2.9	0–4	127.3
Measles	0.2	0.4	0.6	–	–
Meningococcal disease	7.2	3.4	2.1	0–4	50.7
Pertussis	41.8	46.9	0.9	0–4	89.7
Pneumococcal disease	44.7	9.9	4.5	0–4	87.0

* Notifications (New South Wales, Northern Territory, South Australia and Western Australia only) where the date of onset was between 1 January 2000 and 31 December 2002, except for pneumococcal disease, which is from 1 January 2001 to 31 December 2002.

† Notifications per 100,000 population (unless otherwise specified), age standardised to the Australian Bureau of Statistics Australian estimated population 2001.[2]

‡ Includes records where Indigenous status was not stated.

§ Influenza data are hospitalisations (all states and territories) where the month of separation was between 1 July 1999 and 30 June 2002.

The pattern of hepatitis A shows much higher rates of disease notifications and, importantly, an even greater differential for hospitalisations, in Indigenous children aged 0–4 years. By the age of 15 years, this discrepancy has largely disappeared. These data, particularly the high hospitalisation rates in Indigenous children, and one death in the most recent 3-year period, contradict the assertion that hepatitis A is always a mild disease in children. In Far North Queensland, routine hepatitis A vaccination of Indigenous children from 18 months of age was introduced in 1999 in response to high numbers of outbreaks, reported deaths and cases of severe disease. The success of that initiative mirrors that in other high-incidence populations overseas. The Australian Technical Advisory Group on Immunisation will examine the use of hepatitis A vaccination for children, particularly in relation to Indigenous children, in 2004.

The low rates of hepatitis B disease in Indigenous and other children demonstrate the success of universal childhood immunisation. However, amongst adolescents and adults the hospitalisation and notification rates in Indigenous people are much higher, as is the discrepancy between Indigenous people and others.

With respect to influenza, at present vaccination is recommended and funded through the National Indigenous Pneumococcal and Influenza Immunisation (NIPII) program for Indigenous adults aged 15–49 years with risk factors, and for all Indigenous adults aged 50 years or more. However, there are particularly high rates of hospitalisation for influenza in age groups not currently targeted for vaccination—Indigenous children aged 0–4 years and adults aged 25 years or more. Vaccination of children has recently been recommended in the United States of America and an evaluation of the impact and reach of the NIPII program is currently under way. Following this, options to further decrease this high disease burden should be considered.

Similarly, vaccination to prevent invasive pneumococcal disease is funded nationally for protein-conjugate vaccine for Indigenous children aged 0–2 years (0–5 years in Central Australia), and for polysaccharide vaccine in adults aged 15–49 years with risk factors and all Indigenous adults aged 50 years or more. The data show the highest relative burden of invasive pneumococcal disease in the age group not targeted for routine vaccination—Indigenous adults aged 25 years or more.

There has been very little measles infection in Australia in recent years, in either Indigenous or other people. The successful control of measles and other vaccine preventable diseases such as diphtheria, poliomyelitis, rubella and tetanus, underlines the success and importance of universal vaccination programs to Indigenous health.

Meningococcal disease notifications show disproportionately high rates in Indigenous children aged 0–4 years. The limited data on serogroups suggest that serogroup B, for which there is currently no vaccine, is predominant. While the recently introduced serogroup C vaccine will have significant benefits for Aboriginal and Torres Strait Islander children, vaccines for serogroup B are likely to be particularly important in future. However, any new serogroup B vaccine will need to be effective against a wider range of subtypes than the vaccine currently being evaluated in New Zealand.

Pertussis is the least successfully controlled vaccine preventable disease in Australia, of those which have long been a part of the immunisation program. The overall notification rate of pertussis in Aboriginal and Torres Strait Islander people is no higher than in other people. However, in the age group with the most severe symptoms (0–4 years), the notification rate is 1.7 times higher in Indigenous children and the rate of hospitalisation is relatively higher in all Indigenous age groups. Vaccination coverage data indicate that delayed vaccination of Aboriginal and Torres Strait Islander infants may be an important contributor to this higher rate; this is the next challenge now that coverage at 24 months appears to be close to that in non-Indigenous children.

Vaccination coverage data are available nationally for Aboriginal and Torres Strait Islander children from the Australian Childhood Immunisation Register (ACIR) and the 2001 National Health Survey (NHS). They use different methods and provide probable upper and lower estimates of true vaccine coverage. The highest estimates for Indigenous children come from the ACIR: they show that 82 per cent of 1-year-old children recorded as Indigenous are fully vaccinated, a rate nine per cent below that for other children. By two years of age, coverage in Indigenous children has increased to 90 per cent, only one per cent lower than for other children. The lower estimate from the NHS shows coverage for Indigenous children aged 2–6 years to be between nine per cent and 17 per cent lower than non-Indigenous children for individual vaccines. For adults, data are only available from the NHS for those aged 50 years or more. Coverage is higher in Indigenous compared to non-Indigenous adults for influenza vaccine for those aged 50–64 years and for pneumococcal vaccine for those aged 50 years or more. These data show some impact of the NIPII program, as there is no corresponding funded program for non-Indigenous adults. However, the coverage estimates for Aboriginal and Torres Strait Islander adults aged 50

or more years of 51 per cent for influenza and 25 per cent for pneumococcal disease show considerable room for improvement. Higher vaccination coverage in Aboriginal and Torres Strait Islander people in remote areas compared to urban areas is also a fairly consistent finding from the NHS and regional Australian studies. Further investigation of reasons for this and of effective ways to improve access to and use of services by Indigenous people in urban areas is needed.

In conclusion, the data presented here demonstrate that vaccination programs have had a significant impact on the health of Aboriginal and Torres Strait Islander people. Several areas are highlighted for further development of vaccination policy recommendations, in particular high rates of preventable hepatitis A and B, influenza and pneumococcal disease. Areas where more research is needed include means to more accurately monitor vaccination status, the applicability of meningococcal serogroup B vaccines when available, and effective ways of increasing vaccination coverage and timeliness of vaccination. Such issues need to be considered and implemented in full cooperation with Aboriginal and Torres Strait Islander people.

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The Health Insurance Commission, for vaccination coverage data from the Australian Childhood Immunisation Register.

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Abbreviations

ABS	Australian Bureau of Statistics
ACIR	Australian Childhood Immunisation Register
AIHW	Australian Institute of Health and Welfare
ASVS	Australian Standard Vaccination Schedule
HIC	Health Insurance Commission
MCC	Measles Control Campaign
NACCHO	National Aboriginal Community Controlled Health Organisation
NAGATSIHID	National Advisory Group on Aboriginal and Torres Strait Islander Health Information and Data
NHMRC	National Health and Medical Research Council
NHS	National Health Survey
NIC	National Immunisation Committee
NIPII	National Indigenous Pneumococcal and Influenza Immunisation Program
NNDSS	National Notifiable Diseases Surveillance System
VPD	Vaccine preventable disease

Introduction

Rationale

Aboriginal and Torres Strait Islander people experience a greater burden of both communicable and non-communicable diseases compared to the non-Indigenous population.[2] Specific information on vaccination coverage and vaccine preventable diseases (VPDs) in Aboriginal and Torres Strait Islander people has been limited, with most published data coming from studies in certain regions or occasional jurisdictional reports. While national data on other Aboriginal and Torres Strait Islander health issues have been published utilising existing administrative data collections,[2] this report is the first comprehensive descriptive analysis of vaccination coverage and vaccine preventable diseases in Aboriginal and Torres Strait Islander people at the national level. The report and its rationale have the support of the National Aboriginal Community Controlled Health Organisation (NACCHO).

Social and economic context

The relationship between socioeconomic status and health is well documented. A gradient is observable with lower rates of death and most illnesses as socioeconomic position improves.[3] Aboriginal and Torres Strait Islander people are disadvantaged in terms of most socioeconomic indices (income, education, employment, housing) compared to other Australians.[2] In particular, the disproportionate exposure to overcrowded living conditions and inadequate essential infrastructure which Aboriginal and Torres Strait Islander people experience is known to facilitate the spread of many infectious diseases.[2]

Demographic context

The Aboriginal and Torres Strait Islander population has a significantly younger age profile than the Australian population as a whole. Comparisons between Indigenous and other populations must take age into consideration, either through age standardisation or stratification by age group.[2]

Approach

This report presents data on notifications of VPDs and on hospitalisations and deaths coded as being related to VPDs for the years 1999 to 2002. The completeness of identification of Aboriginal and Torres Strait Islander people varies between Australian jurisdictions. In accordance with previous practice,[4] the data for notifications, hospitalisations and deaths are presented in different combinations of states and territories, as outlined below in the methods section.

Methods

Vaccine preventable diseases data

Three sources of routinely collected data were used for this report. Notification data were obtained from the National Notifiable Diseases Surveillance System (NNDSS), hospitalisation data from the Australian Institute of Health and Welfare (AIHW) National Hospital Morbidity Database, and mortality data from the AIHW Mortality Database.

Notifications

The NNDSS database includes information about cases of VPDs reported by laboratories and health workers to state and territory authorities under public health legislation. State and territory notification criteria were based on the National Health and Medical Research Council (NHMRC) surveillance case definitions[5] in most jurisdictions. The case definitions presented for each disease in the results section are those of the NHMRC[5] with the exception of pneumococcal disease, which is taken from Roche, *et al*.[6] New standard national surveillance case definitions have recently been developed and were adopted in some jurisdictions during the period covered by this report. However, any changes in case definitions are unlikely to have a significant impact on the notification rates presented.

Notifications with an onset between 1 January 2000 and 31 December 2002 were analysed for this report. The variables extracted for analysis were: disease, date of disease onset, age at onset, Indigenous status and state or territory where the notification originated. Following an assessment of completeness of the Indigenous status field (see below), notifications were included from New South Wales, the Northern Territory, South Australia and Western Australia. Detailed data are presented for *Haemophilus influenzae* type b (Hib) disease, hepatitis A, acute hepatitis B, measles, meningococcal disease, pertussis, and pneumococcal disease. Notification data are not presented for VPDs with few or no notifications in the period (diphtheria, mumps, polio, rubella, tetanus), or for varicella, for which a vaccine was not widely used during this period. Summary data for these are provided in the Appendix. Data are not provided for influenza notifications due to the low level of completeness of the Indigenous status field.

Hospitalisations

The AIHW National Hospital Morbidity Database receives administrative, demographic and clinical information about patients admitted to public and private hospitals in Australia. Data are received by financial year of hospital separation. The three most recent years for which data were available (1999/00, 2000/01 and 2001/02) were examined. Data for 2001/02 are provisional because, at the time of publication, New South Wales data were under revision. The variables extracted for analysis were: date of separation, age at admission, state or territory of hospitalisation, Indigenous status and diagnoses. Diagnoses included principal and other with up to 31 diagnoses for each admission, coded using the International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Australian Modification, 1st Edition (ICD–10–AM). Eligible separations were those with the code of interest listed in any diagnosis field except for hepatitis B, where only principal diagnoses were included. Detailed data are presented for hepatitis A, acute hepatitis B, influenza and pneumonia, measles, meningococcal disease, pertussis, and pneumococcal disease. Separation data are not presented in the results section for those VPDs with few or no separations during the period (diphtheria, mumps, polio, rubella, tetanus), with no specific ICD10 code (Hib disease), or for which a vaccine was not widely used during this period (varicella). Summary data for these diseases are provided in the Appendix.

Deaths

Death data were obtained from the AIHW Mortality Database. These data are supplied annually to the AIHW by the Australian Bureau of Statistics (ABS). Analysis was by year of registration for the three most recent years for which data were available (2000 to 2002). The variables extracted were: age, state or territory of registration, Indigenous status, and underlying cause of death, coded using the International Classification of Disease, 10th Revision (ICD–10). Deaths where the disease of interest was recorded as the underlying cause are used in this report. Following previous practice,[2] mortality data for those jurisdictions considered to have the most complete coverage of Aboriginal and Torres Strait Islander deaths (Queensland, South Australia, Western Australia and the Northern Territory) were combined. For diseases included in the results section, numbers of deaths are presented by age group where appropriate, and as summary data. For those VPDs not included in the results section (diphtheria, mumps, polio, rubella, tetanus and varicella), summary data are provided in the Appendix.

Calculations

Incidence rates in Aboriginal and Torres Strait Islander people were calculated using ABS estimates of Indigenous populations as at mid-2001.[1] Incidence rates for other (presumed non-Indigenous) persons were calculated using as the denominator the total ABS estimated resident population as at mid-2001, minus the relevant Indigenous population. Rates for all ages combined were age standardised to the ABS Australian population estimates for 2001,[1] for both those categorised as Indigenous and other. Rate ratios for Indigenous versus other persons were calculated for each disease, with age-specific rate ratios where appropriate. All rates are presented as average annual rates per 100,000 total population or population by age group, as appropriate.

Report structure for individual diseases

For each disease, data are presented in the following format:

- description of salient clinical and epidemiological features;
- case definitions (NHMRC 1994 unless otherwise specified);
- distribution by Indigenous status (and age where appropriate); and
- comment on the data presented.

Vaccination coverage data

Data on coverage for various vaccines at the national level were provided by the Health Insurance Commission (from the Australian Childhood Immunisation Register [ACIR]) and the Australian Bureau of Statistics (from the 2001 National Health Survey).

The ACIR is administered by the Health Insurance Commission (HIC) for the Australian Government Department of Health and Ageing, and records the vaccination service details of children aged less than seven years from data supplied by vaccine providers. Vaccination coverage estimates derived from ACIR data have been reported in *Communicable Diseases Intelligence* since early 1998. A complete description of the method for calculating coverage estimates by age cohorts is given elsewhere.[7] National data on coverage in children recorded as Aboriginal and Torres Strait Islander have not been published previously.

The 2001 National Health Survey included a supplementary survey of 3,198 Aboriginal and Torres Strait Islander adults and children in order to improve the precision of estimates of Indigenous people. The sample covered all areas of Australia, including sparsely settled areas. When combined with the main survey, the total Indigenous sample size was 3,681.[8] This survey provided national data on the immunisation status of Aboriginal and Torres Strait Islander people for the first time in Australia. This report includes more detailed tabulations not previously published. Immunisation status was collected by face-to-face interview for both adults and children. Respondents were asked to consult written records if available. Vaccinations were regarded as given if at least a date of vaccination was supplied. Children were regarded as vaccinated appropriately for age if the vaccine was administered up to one month after the recommended age. Thus, data from the National Health Survey are not directly comparable with the ACIR due to differences in both the methods of data collection and calculation of vaccination status.

Data quality and notes on interpreting data

As a consequence of differences in data quality and availability, the time periods and states and territories included in this report differ between data collections. Comparing data from the different collections is therefore problematic and should take account of the various factors outlined below.

Indigenous identification

The quality of Indigenous health statistics depends on both the accuracy of Indigenous population estimates and the level of completeness and accuracy of reporting achieved in the collection of Indigenous status for the condition of interest.[2] Considerable work has been done in recent years on assessing and improving the quality of Indigenous statistics in national and state and territory administrative data collections.[2] More work is needed to improve the quality of the data, as large variations in quality exist between data collections, between States, and over time. For this report, data and analyses chosen for inclusion are in most instances similar to previous publications on those data collections.[2] This is not the case where there have been changes in data quality since the last publication, or no previous assessment has been carried out, as specified below.

Notification data

Indigenous identification

The proportion of notifications lacking identification of Indigenous status were analysed by state, year and disease. Adequate levels of completeness of Indigenous status identification between 2000 and 2002 were defined as at least 60 per cent for a substantial majority of the diseases analysed. This level of completeness was achieved for New South Wales, South Australia, Western Australia and the Northern Territory. After first establishing that the notification incidence estimates were not dominated by any one of these four States for all diseases of interest (data not shown), estimates are presented for the four jurisdictions combined. Although a previous presentation of notifications for the period 1998–2000[4] excluded New South Wales, data completeness for this State between 2000 and 2002 was found to be comparable to that of South Australia and Western Australia. As a high proportion of influenza notifications lacked identification of Indigenous status in all states and territories, other than the Northern Territory, influenza was excluded from further analysis.

Overall, estimated Indigenous notification rates can be considered underestimates, due to the incomplete recording of Indigenous status.

Other issues

A major consideration in interpreting notification data is that they represent only a proportion of the total cases occurring in the community. This proportion is usually unknown and may vary between diseases, with infections diagnosed by a laboratory test more likely to be notified. Data accuracy may also vary between states and territories, due to the use of different case definitions for surveillance and varying reporting requirements by medical practitioners, laboratories and hospitals. In addition, data accuracy may change over time as new diagnostic tests are introduced or surveillance practices change.

Hospitalisation data

Indigenous identification

Although the overall proportion of hospitalisations lacking identification of Indigenous status was low (less than 5%) from 1999/00 to 2001/02, variability in completeness and in accuracy of identification have been previously documented.[4,9] The proportion of Aboriginal and Torres Strait Islander people correctly identified in hospital records has varied between 44 per cent and 100 per cent in studies conducted in various jurisdictions since 1997.[9] Following previous practice,[2] hospital separations are presented for all jurisdictions combined. Indigenous hospitalisation rates can also be considered underestimates due to the incomplete identification of Aboriginal and Torres Strait Islander people.

Other issues

There are limitations associated with the use of ICD–10–AM codes to identify cases. Hospital coding errors have been reported to occur more commonly for diseases that the coder was less familiar with and for admissions with multiple diagnoses.[10] Assignation of codes is based on information in medical records, as recorded by clinicians, without strict case definitions. This is in contrast with the more stringent case definitions used for notification data. Indigenous hospitalisations where the code of interest was in any diagnosis field were included, and the relative importance of these cannot be gauged. For acute hepatitis B, cases were only included where the code of interest was the principal diagnosis, as previous studies have found a substantially lower proportion of principal diagnoses compared to other diseases.[11,12]

It should also be noted that the hospitalisation database contains a record for each admission, which means that there are separate records for each readmission or inter-hospital transfer. This is unlikely to have a major impact on the numbers reported for most diseases reviewed, as they are acute illnesses, but may inflate the numbers of hospitalisations where inter-hospital transfer is more frequent, either because of remote residence or the severity of the illness.

Death data

Indigenous identification

The accuracy of reporting Indigenous status on deaths has been previously evaluated by comparing the reported number with an expected, or predicted, number of Indigenous deaths.[2] Reporting was found to be acceptable for deaths in 1997–1999 in Queensland, South Australia, Western Australia and the Northern Territory. Following previous practice,[2] reported deaths from these four States only have been presented in this report. These combined rates may still underestimate Indigenous death rates due to under-reporting.

Other issues

Mortality data were analysed by year of registration rather than by year of death. Approximately six per cent of deaths in a particular calendar year are registered in the subsequent year, mostly deaths in the previous December. Issues associated with the accuracy of the ICD codes used for hospital separations may also apply to mortality data.

Vaccination coverage data

Indigenous identification

The completeness of reporting of Indigenous status on the ACIR was analysed by comparing the number of children recorded as Aboriginal or Torres Strait Islander on the ACIR with ABS 2001 Census data. Indigenous status is currently either not routinely reported or not transferred to the ACIR from the Australian Capital Territory, Queensland and Tasmania, so these jurisdictions were not included in this report. For New South Wales, the Northern Territory, South Australia, Victoria and Western Australia, 61 per cent of the estimated cohort of Aboriginal or Torres Strait Islander children aged 12–18 months and 65 per cent of the estimated cohort aged 24–30 months were recorded as Aboriginal or Torres Strait Islander on the ACIR. The accuracy of the information recorded in the Indigenous status field was assessed by comparison of Hib vaccines received, adapting a method developed by Hull, *et al*.[13] Until May 2000, different Hib vaccines were recommended for Indigenous (Hib vaccine conjugated to outer membrane protein of *Neisseria meningitidis*, Pedvax) and non-Indigenous (Hib vaccine conjugated to a mutant diphtheria toxin, HibTiter) children. Children born between 1 January and 30 April 2000 and recorded on the ACIR as receiving a Hib vaccine and being Aboriginal or Torres Strait Islander were 27 times more likely to have received a dose of Pedvax. Children recorded as receiving a dose of Pedvax were nine times more likely to be recorded as Aboriginal or Torres Strait Islander than children who received other Hib vaccines. These data suggest an acceptable level of correlation between the recording of Indigenous status and the receipt of a vaccine recommended only for Aboriginal and Torres Strait Islander children.

Other issues

General limitations of data available from the ACIR must be considered when used to estimate vaccination coverage. A study conducted in 2001 found that the ACIR underestimated overall Australian immunisation coverage by 2.7 per cent at 12 months of age and five per cent at 24 months.[14] However, for Aboriginal and Torres Strait Islander children these estimates may not be valid, as there is the issue of both under-reporting of vaccinations given to the ACIR and incomplete identification of Indigenous children. This means that ACIR coverage estimates could overestimate or underestimate coverage, depending on whether those children not identified as Aboriginal and Torres Strait Islander have higher or lower than average vaccination coverage. The ACIR holds records only for children up to seven years of age. Coverage is calculated only for children registered on Medicare; however, current data show that by the age of 12 months practically all Australian children have been registered with Medicare (personal communication, Kathi Williams, Health Insurance Commission, April 2004).

Indigenous population estimates

Estimation of the size and age composition of the Aboriginal and Torres Strait Islander population is difficult. Increases in census counts of Aboriginal and Torres Strait Islander people between 1966 and 1996 are far greater than can be explained by simple demographic factors (births minus deaths).[15] Other factors thought to be important include changes in: the propensity to identify as Indigenous in the Census; the proportion of children with only one Aboriginal and Torres Strait Islander parent identified as Indigenous; and Census enumeration procedures.[4,15]

In this report, Australian Bureau of Statistics estimates of Aboriginal and Torres Strait Islander population figures, based on 2001 Census data,[1] are used.

Results

Haemophilus influenzae type b disease

Haemophilus influenzae is a fastidious Gram-negative bacterium, which occurs in both encapsulated and unencapsulated forms. Before Hib vaccines became available, one encapsulated serotype, type b (Hib), caused at least 95 per cent of invasive infections due to *H. influenzae* (those associated with isolation of the organism from a normally sterile site) in children.[16,17] The most common manifestation of invasive Hib disease was meningitis, with children aged less than 18 months most at risk.[17–19] Aboriginal children had a particularly high risk of Hib meningitis, with a recorded incidence among children living in Central Australia among the highest in the world and an earlier age of onset than non-Indigenous children.[20] Survivors of Hib meningitis commonly had neurological sequelae such as deafness and intellectual impairment. Epiglottitis, a potentially fatal inflammation of the epiglottis obstructing breathing, was the other major category of infection, but was rare in Aboriginal and Torres Strait Islander children.[20] Less common manifestations of invasive Hib disease include a range of focal infections (cellulitis, septic arthritis, pneumonia, pericarditis, osteomyelitis) and septicaemia without focus.

Haemophilus influenzae type b disease

Case definitions

Notifications

a) A clinically compatible illness (meningitis, epiglottitis, cellulitis, septic arthritis, osteomyelitits, pneumonia, pericarditits or septicaemia) *and* either:

isolation of *Haemophilus influenzae* type b from blood *or*

detection of Hib antigen (in a clinically compatible case) *or*

detection of Gram-negative bacteria of characteristic appearance where the organism fails to grow in a clinical case

or

b) A confident diagnosis of epiglottitis by direct vision, laryngoscopy or X-ray.

Hospitalisations and deaths

Hospitalisations and deaths were not analysed as there are no ICD–10–AM/ICD–10 codes which specify Hib as a causative organism, as opposed to *Haemophilus influenzae* (type unspecified).

Distribution by age and Indigenous status

In 2000–2002, there were a total of 47 notifications of invasive Hib disease in the jurisdictions with adequate data, 24 in children 0–4 years, of whom 11 (46%) were identified as Aboriginal and Torres Strait Islander (Table 2). The notification rate of 10 per 100,000 in Aboriginal and Torres Strait Islander children under five years of age gave a rate ratio of 15 for this age group, compared to four in persons five years and over. Cases in Aboriginal and Torres Strait Islander children were not wholly or predominantly reported from any one jurisdiction.

A similar number of notifications were received for persons 0–4 years and five years of age and over. Among 0–4 year olds, there was a striking difference in the annual notification rates for Aboriginal and Torres Strait Islander (10 per 100,000) and other children (0.7 per 100,000).

Table 2. *Haemophilus influenzae* type b notifications, selected Australian States,* 2000 to 2002, by Indigenous status

Age group (years)	Indigenous status	Notifications (2000–2002)		
		n	Rate†	Rate ratio
0–4	Indigenous	11	10.0	14.7
	Other	13	0.7	
5 and over	Indigenous	2	0.3	3.6
	Other	21	0.1	
All ages‡	Indigenous	13	1.2	9.7
	Other	34	0.1	

* New South Wales, Northern Territory, South Australia and Western Australia only, where the date of onset was between 1 January 2000 and 31 December 2002.

† Average annual age-specific rate per 100,000 population.

‡ Rates for all ages combined are age standardised to the Australian Bureau of Statistics Australian population estimates for 2001.[1]

Comment

The Hib immunisation program in Australia commenced in April 1993, with catch-up immunisation for children up to five years of age from July 1993. Until June 2000, Aboriginal and Torres Strait Islander children were scheduled to receive a different Hib vaccine (conjugated to the outer membrane of *Neisseria meningitidis* type C, PRP–OMP) than other children who received a vaccine conjugated to a mutant diphtheria toxin (CRM197). Since June 2000, all Australian children have received PRP–OMP vaccine.

Following the introduction of Hib vaccination in 1993, children aged up to 15 years and children born since the introduction of the program up to 10 years of age by July 2003 were eligible to receive it. Indigenous status was poorly reported in the National Notifiable Diseases Surveillance System until the late 1990s, but an enhanced surveillance scheme for invasive Hib disease, established in 1993, included Indigenous status.[21] Vaccination has had a striking impact on the incidence of Hib disease in the age groups targeted by immunisation programs, among both Indigenous and non-Indigenous children.[21] Compared to an incidence of 35–40 per 100,000 in the general population and up to 280 per 100,000 in Aboriginal and Torres Strait Islander children living in the Northern Territory,[22] notification rates presented in this report (0.7 and 10.0 respectively in 2000–2002) represent a reduction of almost 98 per cent since vaccination was introduced.

Although the number of cases has decreased markedly, the proportion of total Hib disease cases occurring in Aboriginal and Torres Strait Islander people has increased from around seven per cent before 1993 to 15 per cent in 2000.[21] This report shows a further increase in the differential between Aboriginal and Torres Strait Islander people and others to a rate ratio of 10 overall and 15 among children under five years of age. However, the point estimate for incidence in Aboriginal and Torres Strait Islander children under five years of 10.0 per 100,000 compares favourably with that among American Indian children in 1998–2000.[21] A similar pattern of increasing disparity in Hib disease rates has also been observed between Maori-Pacific Islander children and other children in New Zealand.[23] The available data indicate that Hib immunisation rates are acceptable in Aboriginal and Torres Strait Islander children in some geographic areas.[22] However, the role of regional variations in immunisation coverage should be examined as a likely reason for this increasing disparity. Crowded living conditions may also be a factor, being associated with high levels of Hib colonisation in the nasopharynx. In the meantime, the experience of similar Indigenous populations in Alaska[24] suggests that continued use of a Hib vaccine which is immunogenic after the first dose is appropriate in Aboriginal and Torres Strait Islander children.

Hepatitis A

Infection with the hepatitis A virus (HAV), a picorna virus, produces symptoms with a wide range from subclinical hepatitis to acute hepatitis with jaundice and, in the most severe cases, fulminant hepatitis leading to death. The single most important factor in determining the outcome of HAV infection is age. In symptomatic adult cases, onset of clinical symptoms is usually abrupt with fever, anorexia, malaise, nausea and abdominal discomfort followed by jaundice. In contrast, over 90 per cent of infections acquired before the age of five years are clinically silent. In adults, the proportion of infected individuals showing symptoms is thought to be around 90 per cent.[25,26]

Hepatitis A

Case definitions

Notifications

a) Detection of anti-hepatitis A virus IgM antibody, in the absence of recent vaccination

or

b) A clinical case of hepatitis (jaundice ± elevated aminotransferase levels, without a non-infectious cause) *and* an epidemiological link to a serologically confirmed case.

Hospitalisations and deaths

The ICD–10–AM/ICD–10 codes B15 (hepatitis A) were used to identify hospitalisations and deaths.

Distribution by Indigenous status and age

Of the total of 1,012 notifications of hepatitis A recorded in the relevant jurisdictions, 113 (11%) were identified as occurring in Aboriginal and Torres Strait Islander people, as were 82 (6%) of the 1,309 hospitalisations recorded nationally. The overall rate ratio of cases identified as Indigenous to those presumed to be non-Indigenous was three for notifications and two for hospitalisations. Both hospitalisation (16 per 100,000) and notification (37 per 100,000) rates were highest among children 0–4 years identified as Indigenous, with the absolute number of cases higher than in other children (Table 3) and rate ratios of 57 and 22 respectively. This excess morbidity falls sharply with age, with smaller but substantial Indigenous versus other rate ratios among children 5–14 years of age (8 for notifications, 7 for hospitalisations), decreasing to two or less from the age of 15 years. Figures 1 and 2 illustrate the striking difference between young children and others when comparing both notifications and hospitalisations for Indigenous and other people.

Comment

The data in this report show a high burden of hepatitis A among Aboriginal and Torres Strait Islander children, with a progressive decrease in incidence with increasing age. The high rate ratio for hospitalisations due to hepatitis A in children under the age of five years is particularly noteworthy, indicating that higher rates of disease are reflected in significantly higher levels of morbidity in Aboriginal and Torres Strait Islander children. One death was coded as due to hepatitis A in an Aboriginal and Torres Strait Islander child in the reporting period, and other such deaths have been reported recently in North Queensland.[27]

Table 3. Hepatitis A notifications, hospitalisations and deaths, Australia, 1999 to 2002,* by age group and Indigenous status

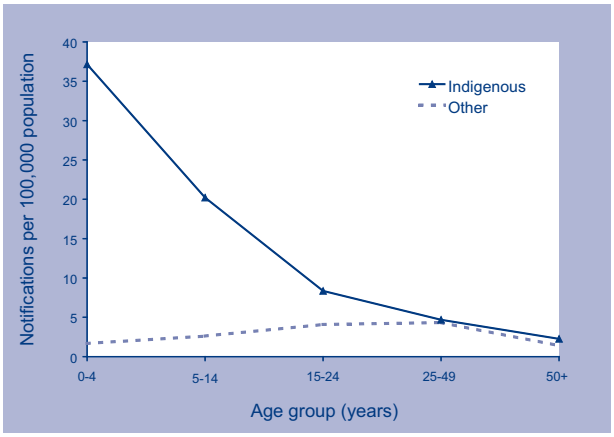
Age group (years)	Indigenous status	Notifications (2000–2002)			Hospitalisations (July 1999–June 2002)			Deaths (2000–2002)
		n	Rate†	Rate ratio	n	Rate†	Rate ratio	n
0–4	Indigenous	41	37.1	22.2	28	15.5	56.8	1
	Non-Indigenous	32	1.7		10	0.3		0
5–14	Indigenous	44	20.2	7.7	16	4.5	7.1	0
	Other	105	2.6		49	0.6		0
15–24	Indigenous	13	8.4	2.0	10	4.0	1.9	0
	Other	163	4.1		161	2.1		0
25–49	Indigenous	13	4.7	1.1	28	6.3	2.3	0
	Other	479	4.3		585	2.8		0
50+	Indigenous	2	2.3	1.6	0	0.0	0.0	0
	Other	120	1.4		422	2.5		2
All ages‡	Indigenous	113	9.1	2.9	82	4.5	2.1	1
	Other	899	3.1		1,227	2.1		2

* Notifications (New South Wales, Northern Territory, South Australia and Western Australia only) where the date of onset was between 1 January 2000 and 31 December 2002; hospitalisations (all States) where the date of separation was between 1 July 1999 and 30 June 2002; deaths (Queensland, Northern Territory, South Australia, Western Australia) where the date of death was recorded between 1 January 2000 and 31 December 2002.

† Average annual age-specific rate per 100,000 population.

‡ Includes cases with unknown ages. Rates for all ages combined are age standardised to the Australian Bureau of Statistics Australian population estimates for 2001.[1]

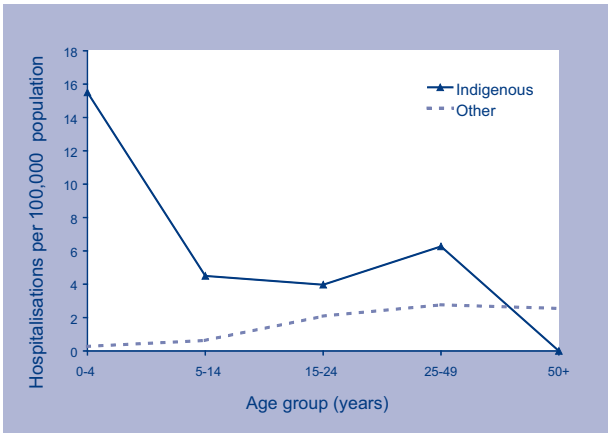
Figure 1. Hepatitis A notification rate, selected Australian States,* 2000 to 2002,† by age group and Indigenous status



* New South Wales, South Australia, Western Australia and the Northern Territory.

† Notifications where the date of onset was between 1 January 2000 and 31 December 2002.

Figure 2. Hepatitis A hospitalisation rate, Australia, 1999 to 2002,* by age group and Indigenous status



* Hospitalisations where the date of separation was between 1 July 1999 and 30 June 2002.

The pattern of acquisition of hepatitis A is known to vary substantially according to living standards. More advantaged communities have delayed or no exposure to hepatitis A, with the majority seronegative even in middle age, while communities living in crowded and/or less hygienic circumstances acquire infection and immunity to hepatitis A at an early age. In the Northern Territory in 1994, a serosurvey in rural Aboriginal populations found hepatitis A to be hyperendemic, with acquisition of the virus predominantly in the first five years of life,[28] as is characteristic of disadvantaged living conditions. It was argued that, in such circumstances, immunisation is of little benefit and may produce a cohort whose immunity could subsequently wane.[28] Although case-fatality and hospitalisation rates are low in children, with a high rate of infection some serious outcomes can be expected. In comparable Indigenous populations in the United States of America (USA), with similar high infection rates and age distribution, community-wide hepatitis A immunisation was recommended[29] and has resulted in dramatic reductions in the incidence of hepatitis A.[30] The recommendations have been expanded more recently to include the routine vaccination of children in areas where the rate of hepatitis A exceeds 20 per 100,000 population.[29]

In Australia, an immunisation program for hepatitis A was commenced among children from 18 months of age in North Queensland in 1999, in response to two deaths in Far North Queensland Aboriginal and Torres Strait Islander children from fulminant hepatitis A.[27] Early results from this program indicate that despite targeting only Aboriginal and Torres Strait Islander children, substantial reductions in hepatitis A across all sectors of the population groups have occurred.[31] Currently, no funded hepatitis A immunisation program exists in Australia outside of north Queensland. The favourable experience with hepatitis A immunisation programs in north Queensland, and in high incidence areas of the United States of America, is in accord with experience in other highly endemic areas.[32] The Australian Technical Advisory Group on Immunisation will examine the use of hepatitis A vaccination for children, particularly in relation to Indigenous children, in 2004.

Hepatitis B (acute)

Acute infection with hepatitis B virus (HBV), a hepadnavirus, may produce a range of conditions from subclinical hepatitis to acute hepatitis with jaundice and, rarely, fulminant hepatitis. Only a small proportion of HBV infections are clinically recognised, with less than 10 per cent of children and 30–50 per cent of adults experiencing clinical symptoms.[33] Onset of illness, when it occurs, is usually insidious with anorexia, vague abdominal discomfort, nausea and vomiting and sometimes arthralgia and rash, often progressing to jaundice. The principal cause of morbidity and mortality from hepatitis B is chronic infection, which may occur irrespective of symptoms. Chronic infection can lead to cirrhosis of the liver and hepatocellular carcinoma, usually over a prolonged period.[34] The risk of chronic infection is greatest in those infected as infants, particularly if infected in the perinatal period. Accordingly, preventive efforts have been focussed, in both the Indigenous and non-Indigenous community in Australia, on preventing maternal-infant transmission.

Hepatitis B (acute)

Case definitions

Notifications

People who have a positive hepatitis B surface antigen (HBsAg) *and* one of the following:

hepatitis B core antibody (Anti-HBc) IgM

or

demonstration of a clinical illness consistent with acute viral hepatitis (jaundice, elevated aminotransferase levels).

Hospitalisations

ICD–10–AM code B16 (acute hepatitis B) was used to identify hospitalisations.

As in previous reports,[12] hospitalisations were included only where the relevant ICD code was the principal diagnosis (which was in 30% of all hospitalisations which included acute hepatitis B). This is a much lower proportion than for the other diseases but similar to previous analyses of hepatitis B hospitalisations.[33]

Deaths

ICD–10 code B16 (acute hepatitis B) was used to select deaths from acute hepatitis B.

Distribution by Indigenous status and age

Of the total of 526 notifications of acute hepatitis B recorded in the relevant jurisdictions, 57 (11%) were identified as occurring in Aboriginal and Torres Strait Islander people, as were 30 (6%) of the 463 hospitalisations recorded nationally. The overall rate ratio for cases identified as Indigenous compared to those presumed to be non-Indigenous was four for both notifications and hospitalisations (Table 4). In contrast to hepatitis A, no notified or hospitalised cases of hepatitis B were recorded as Indigenous among children 0–4 years. Notification rates for acute hepatitis B then increased progressively among Aboriginal and Torres Strait Islander people, reaching a peak among 15–24 year olds and continuing to show a higher incidence in absolute and relative terms compared with other groups at all ages, maximal in those over 50 years (Figure 3). This was also reflected in hospitalisations (Figure 4). The highest notification rates per 100,000 were seen in both Indigenous and other populations in the 15–24 years (14 versus 4) and 25–49 years (10 versus 2) age groups. The highest hospitalisation rates per 100,000 were seen in 25–49 year old cases identified as Indigenous (5 per 100,000) with a rate ratio of four. Of the 10 deaths recorded, two were in persons identified as Indigenous, both aged 25–49 years.

Table 4. Acute hepatitis B notifications, hospitalisations and deaths, Australia, 1999 to 2002,* by age group and Indigenous status

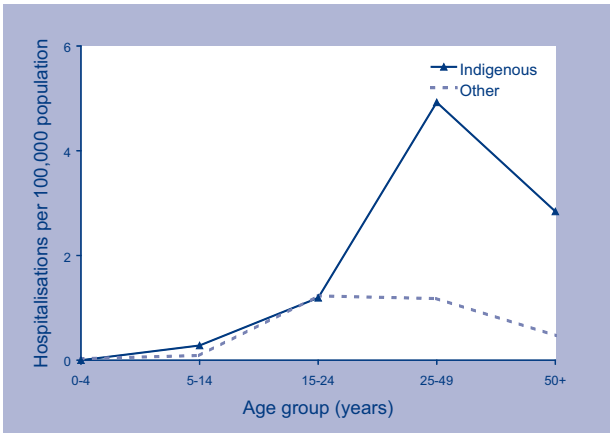
Age group (years)	Indigenous status	Notifications (2000–2002)			Hospitalisations (July 1999–June 2002)			Deaths (2000–2002)
		n	Rate†	Rate ratio	n	Rate†	Rate ratio	n
0–4	Indigenous	0	0.0	0.0	0	0.0	0.0	0
	Other	3	0.2		1	0.0		0
5–14	Indigenous	3	1.4	5.5	1	0.3	3.1	0
	Other	10	0.2		7	0.1		0
15–24	Indigenous	22	14.1	3.5	3	1.2	1.0	0
	Other	162	4.1		98	1.3		2
25–49	Indigenous	29	10.4	4.6	22	4.9	4.2	2
	Other	249	2.3		250	1.2		1
50+	Indigenous	3	3.4	6.8	4	2.8	6.0	0
	Other	43	0.5		77	0.5		5
All ages‡	Indigenous	57	7.2	4.4	30	2.8	3.7	2
	Other	469	1.6		433	0.8		8

* Notifications (New South Wales, Northern Territory, South Australia and Western Australia only) where the date of onset was between 1 January 2000 and 31 December 2002; hospitalisations (all States) where the date of separation was between 1 July 1999 and 30 June 2002; deaths (Northern Territory, South Australia, Queensland, Western Australia) where the date of death was recorded between 1 January 2000 and 31 December 2002.

† Average annual age-specific rate per 100,000 population.

‡ Includes cases with unknown ages. Rates for all ages combined are age standardised to the Australian Bureau of Statistics Australian population estimates for 2001.[1]

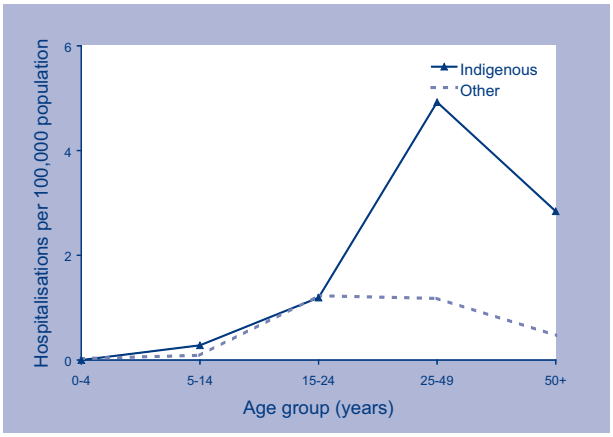
Figure 3. Acute hepatitis B notification rate, selected Australian States,* 2000 to 2002,† by age group and Indigenous status



* New South Wales, South Australia, Western Australia and the Northern Territory.

† Notifications where the date of onset was between 1 January 2000 and 31 December 2002.

Figure 4. Acute hepatitis B hospitalisation rate, Australia, 1999 to 2002,* by age group and Indigenous status



* Hospitalisations where the date of separation was between 1 July 1999 and 30 June 2002.

Comment

The mortality and morbidity from hepatitis B among Aboriginal and Torres Strait Islander people has been recognised for at least two decades and led to childhood hepatitis B vaccination programs being introduced in the Northern Territory in the 1980s.[33] Aboriginal and Torres Strait Islander newborns were also targeted for risk-based hepatitis B immunisation programs, along with children born to hepatitis B surface antigen positive mothers or parents born in countries with a high incidence of hepatitis B from this time. In contrast to hepatitis A, the greatest differential morbidity from hepatitis B is in the age groups over 15 and particularly over 25 years. This is consistent with some impact from immunisation programs, as the oldest cohorts of children targeted for immunisation would now be around 15 years of age.

The highest incidence of acute hepatitis B and the greatest differential between Indigenous and other hepatitis B incidence has always been in adolescents and young adults,[33] and remains so in these data. Hepatitis B immunisation could be considered for adolescents and young adults, including prison populations, until birth cohorts eligible for hepatitis B vaccine reach adulthood. While providing information on acute disease, these data do not reflect the significant chronic disease burden from hepatitis B for Aboriginal and Torres Strait Islander people, including liver cancer.

Influenza and pneumonia

Influenza is an acute respiratory illness caused by influenza type A or B viruses. Onset of clinical symptoms is typically abrupt with fever, cough, myalgia and prostration. Outbreaks of variable severity occur almost every winter in Australia and are associated with significant morbidity and mortality, particularly in the elderly and chronically ill. The most common complication of influenza is pneumonia. It is generally believed that hospitalisations and deaths coded as influenza significantly underestimate disease burden, with excess all-cause pneumonia and influenza combined, during the influenza season, being a better indicator of true disease burden.[35]

Influenza and pneumonia

Case definitions

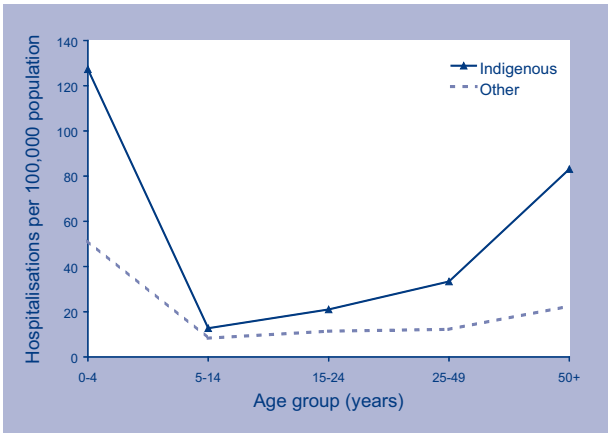
Hospitalisations and deaths

The ICD–10–AM/ICD–10 codes J10 and J11 (influenza) were used to identify hospitalisations and deaths from influenza. The ICD–10–AM/ICD10 codes J10 to J18 were used to identify hospitalisations and deaths from influenza and all-cause pneumonia combined.

Distribution by Indigenous status and age

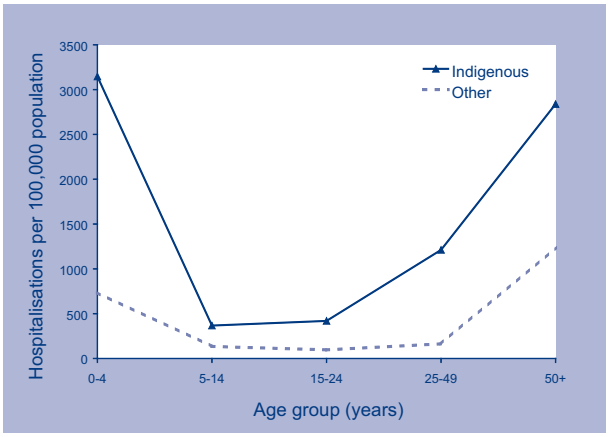
Rates of hospitalisation were higher in all Indigenous age groups for both influenza and influenza and pneumonia combined, with the highest rate ratio (7) for influenza and pneumonia combined in the 25–49 years age group (Table 5). While rates of influenza and pneumonia combined are substantially higher than for influenza alone, the pattern of distribution by age group is very similar (Figures 5 and 6, allowing for different scales). The rate ratio for deaths was highest in those aged 25–49 (28), 15–24 (15) and 0–4 years (17).

Figure 5. Hospitalisation rate for influenza, Australia, 1999 to 2002,* by age group and Indigenous status



* Hospitalisations where the date of separation was between 1 July 1999 and 30 June 2002.

Figure 6. Hospitalisation rate for influenza and all pneumonia combined, Australia, 1999 to 2002,* by age group and Indigenous status



* Hospitalisations where the date of separation was between 1 July 1999 and 30 June 2002.

Table 5. Influenza and pneumonia hospitalisations and deaths, Australia 2000 to 2002,* by age group and Indigenous status

Age group (years)	Indigenous status	Hospitalisations (July 1999–June 2002)						Deaths (2000–2002)			
		Influenza			Influenza and pneumonia			Influenza	Influenza and pneumonia		
		n	Rate†	Rate ratio	n	Rate†	Rate ratio	n	n	Rate†	Rate ratio
0–4	Indigenous	230	127.3	2.5	5,682	3,146	4.3	0	18	10.0	17.4
	Other	1,877	51.2		26,885	733		3	21	0.6	
5–14	Indigenous	45	12.7	1.5	1,304	367	2.7	0	1	0.3	10.9
	Other	643	8.3		10,471	135		0	2	0.0	
15–24	Indigenous	53	21.0	1.8	1,056	419	4.4	0	1	0.4	15.3
	Other	883	11.4		7,383	96		1	2	0.0	
25–49	Indigenous	149	33.4	2.7	5,416	1,212	7.4	0	34	7.6	27.8
	Other	2,591	12.2		34,536	163		3	58	0.3	
50+	Indigenous	117	83.1	3.7	3,997	2,838	2.3	2	76	54.0	2.6
	Other	3,725	22.5		204,601	1,236		54	3,486	21.0	
All ages‡	Indigenous	594	49.3	2.9	17,455	1,580	3.2	2	130	19.1	3.1
	Other	9,719	17.1		283,876	495		61	3,569	6.2	

* Hospitalisations (all States) where the date of separation was between 1 July 1999 and 30 June 2002; deaths (Queensland, Northern Territory, South Australia and Western Australia) where the date of death was recorded between 1 January 2000 and 31 December 2002.

† Average annual age-specific rate per 100,000 population.

‡ Includes cases with unknown ages. Rates for all ages combined are age standardised to the Australian Bureau of Statisitcs Australian population estimates for 2001.[1]

Comment

The relatively high morbidity from influenza and related conditions in older Aboriginal and Torres Strait Islander adults led to a specific program for influenza and pneumococcal vaccine being funded nationally for Indigenous adults over 50 years in 1999 and those aged 15–49 years with risk factors.[36] This is in contrast to the non-Indigenous population, for whom influenza vaccine is funded only from age 65 years and pneumococcal vaccine is funded only in Victoria for this age group. Young children also experience high morbidity from influenza, with minimal estimates, such as those in this report based on hospital coding data, still showing a high incidence of hospitalisation under five years of age. Although only five per cent of deaths coded as attributable to influenza nationally were in persons under five years and none in Aboriginal and Torres Strait Islander children, there was a twofold differential in the influenza hospitalisation rate between Indigenous and other children.

The importance of young children, both in terms of their own high morbidity from influenza and their role in transmission of influenza to adults, has been increasingly appreciated in recent years.[37] This has led to a recommendation in the United States of America that all children between six and 24 months of age receive influenza vaccine.[38] This recommendation is particularly pertinent to Aboriginal and Torres Strait Islander children in Australia, where influenza may contribute significantly to overall respiratory morbidity in children and adults they are in contact with, especially in crowded living conditions. Evaluation of the reach and impact of the current National Indigenous Pneumococcal and Influenza Immunisation (NIPII) program in adults is currently underway and the potential role of influenza immunisation in children or universally in at least some communities of Aboriginal and Torres Strait Islander people is needed. Subsequently, consideration of the role of influenza immunisation in young Aboriginal and Torres Strait Islander children would be appropriate.

Measles

Measles is an acute and highly communicable disease caused by a morbillivirus. The clinical picture includes a prodromal fever, rash, conjunctivitis, coryza, cough and Koplik spots on the buccal mucosa. Complications include otitis media, pneumonia and encephalitis. Subacute sclerosing panencephalitis occurs very rarely as a late sequel.[35]

Measles

Case definitions

Notifications

An illness characterised by all the following features:

a generalised maculopapular rash lasting three or more days, *and*

a fever (at least 38ºC if measured), *and*

cough or coryza or conjunctivitis or Koplik spots

or

Demonstration of measles specific IgM antibody

or

A fourfold or greater rise in measles antibody titre between acute and convalescent phase sera obtained at least two weeks apart, with tests preferably conducted at the same laboratory

or

Isolation of measles virus from a clinical specimen

or

A clinically compatible case epidemiologically related to another case.

Hospitalisations and deaths

The ICD–10–AM/ICD–10 code B05 (measles) was used to identify hospitalisations and deaths. Subacute sclerosing panencephalitis was not included in these analyses.

Distribution by Indigenous status

Only 113 notifications and 172 hospitalisations recorded as being associated with measles were seen in the relevant jurisdictions or Australia respectively during the reporting period examined. Of these, only 3 (2.6%) notifications and 2 (1.1%) hospitalisations were recorded as Indigenous, with equivalent incidence in Indigenous and other persons (Table 6). No deaths were recorded in the reporting period.

Comment

Two significant milestones in measles control occurred in Australia in 1998; the Measles Control Campaign (MCC), involving catch-up immunisation of 1.3 million children aged 5–12 years, and the moving of the second dose of measles-mumps-rubella (MMR) vaccine from 12 to four years.[39] This reporting period follows the MCC and is in a period when transmission of measles in Australia is believed to have been largely limited to introduction of virus from overseas, with limited local transmission among age-groups with high levels of immunity from immunisation (under 15 years) or past infection (over 35 years).[40] Measles outbreaks have been almost entirely confined to children who were unimmunised, either because of young age or refusal to vaccinate, and to young adults aged 18–30 years.[41]

Table 6. Measles notifications, hospitalisations and deaths, Australia, 1999 to 2002,* by age group and Indigenous status

Age group (years)	Indigenous status	Notifications (2000–2002)			Hospitalisations (July 1999–June 2002)			Deaths (2000–2002)
		n	Rate†	Rate ratio	n	Rate†	Rate ratio	n
All ages‡	Indigenous	3	0.2	0.6	2	0.1	0.4	0
	Other	110	0.4		170	0.3		0

* Notifications (New South Wales, Northern Territory, South Australia and Western Australia only) where the date of onset was between 1January 2000 and 31 December 2002; hospitalisations (all States) where the date of separation was between 1 July 1999 and 30 June 2002; deaths (Queensland, Northern Territory, South Australia and Western Australia) where the date of death was recorded between 1 January 2000 and 31 December 2002.

† Average annual rate per 100,000 population.

‡ Includes cases with unknown ages. Rates are age standardised to the Australian Bureau of Statistics Australian population estimates for 2001.[1]

Measles was associated with high levels of morbidity among Aboriginal and Torres Strait Islander children in the past, prompting the Northern Territory to introduce immunisation at nine months of age, with a subsequent booster, for Aboriginal children.[42] This program ended in the Northern Territory in 1998[43] and no excess morbidity from measles is evident in this or other Australian jurisdictions. The successful control of measles in Aboriginal and Torres Strait Islander people is a reflection of the almost total success of immunisation in preventing measles transmission, in contrast to other VPDs such as pertussis or Hib disease. It illustrates the importance of universal programs, across all relevant age groups in the population, in disease prevention in both Indigenous and non-Indigenous people.

Meningococcal disease

Clinical manifestations of meningococcal disease include meningitis, meningococcaemia without meningitis (which varies in presentation from fulminant to chronic) and septic arthritis.

Meningococcal disease

Case definitions

Notifications

Isolation of *Neisseria meningitidis* from a normally sterile site

or

Detection of meningococcal antigen in joints, blood or cerebrospinal fluid

or

Detection of Gram-negative intracellular diplococci in blood or cerebrospinal fluid.

Hospitalisations and deaths

The ICD–10–AM/ICD–10 code A39 (meningococcal infection) was used to identify hospitalisations and deaths.

Distribution by Indigenous status and age

Notification and hospitalisation rates (per 100,000 population) showed a progressive decrease with increasing age in both Indigenous and other persons (Table 7). The notification rate fell from a peak of 51 in the 0–4 age group for Indigenous and 15 in other children, to eight and four respectively in 5–14 year olds, with the lowest rates in 25–49 year olds in both groups (Figure 7). Overall, the rate ratio for notifications comparing Indigenous versus others was two, but was close to unity among 15–49 year olds, differing only at the extremes of age. The pattern for hospitalisations was similar, with again the lowest hospitalisation rates among Aboriginal and Torres Strait Islander people aged 15–49 years, although one of the five Indigenous deaths recorded occurred in this age band (Figure 8).

Serogroup distribution by Indigenous status and age

Serogroup data were not available for hospitalisations and were missing for 63 per cent of Indigenous and 45 per cent of other notifications, so conclusions about serogroup distribution are subject to significant limitations. In notifications where serogroup was known, a higher proportion of cases identified as Indigenous were serogroup B (73% compared to 59% in other cases) with a lower proportion due to serogroup C (27% compared to 38%).

Comment

The available data on meningococcal disease were limited by lack of serogroup information, which is important given the introduction of conjugate meningococcal C vaccine into the Australian Standard Vaccination Schedule (ASVS) for all children 1–19 years in 2002. The overall pattern of invasive meningococcal disease shown here indicates a secondary peak in notifications and hospitalisations among 15–24 year olds presumed non-Indigenous persons not evident in Indigenous people. In both groups, the age-specific incidence is highest among 0–4 year olds, being about tenfold higher in Indigenous 0–4 year olds (51) than in 15–24 year olds (5) and twofold higher in the comparable (presumed) non-Indigenous age groups. In keeping with this, the greatest differential disease burden was in 0–4 year olds, with a rate ratio of Indigenous to other notifications of 3.5. Indigenous deaths accounted for 13 per cent of the total, similar to the proportion of notifications (9%), but four of five these deaths (80%) occurred in 0–4 year olds compared with 12 (36%) of other deaths.

Table 7. Meningococcal disease notifications, hospitalisations and deaths, Australia, 1999 to 2002,* by age group and Indigenous status

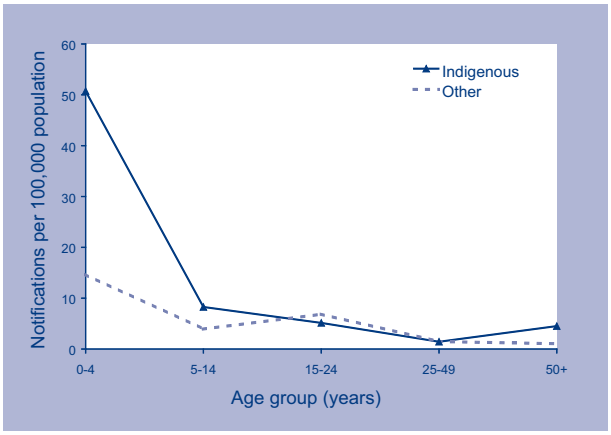
Age group (years)	Indigenous status	Notifications (2000–2002)			Hospitalisations (July 1999–June 2002)			Deaths (2000–2002)
		n	Rate†	Rate ratio	n	Rate†	Rate ratio	n
0–4	Indigenous	56	50.7	3.5	76	42.1	2.1	4
	Other	280	14.6		731	20.4		12
5–14	Indigenous	18	8.3	2.1	29	8.2	1.7	0
	Other	158	3.9		364	4.8		3
15–24	Indigenous	8	5.1	0.7	7	2.8	0.3	1
	Other	273	6.9		756	9.5		5
25–49	Indigenous	4	1.4	1.0	5	1.1	0.7	0
	Other	162	1.5		349	1.6		8
50+	Indigenous	4	4.5	4.3	4	2.8	1.9	0
	Other	91	1.1		240	1.5		5
All ages‡	Indigenous	92	7.2	2.1	121	5.5	1.3	5
	Other	975	3.4		2,440	4.3		33

* Notifications (New South Wales, Northern Territory, South Australia and Western Australia only) where the date of onset was between 1 January 2000 and 31 December 2002; hospitalisations (all States) where the date of separation was between 1 July 1999 and 30 June 2002; deaths (Queensland, Northern Territory, South Australia and Western Australia) where the date of death was recorded between 1 January 2000 and 31 December 2002.

† Average annual age-specific rate per 100,000 population.

‡ Includes cases with unknown ages. Rates for all ages combined are age standardised to the Australian Bureau of Statistics Australian population estimates for 2001.[61]

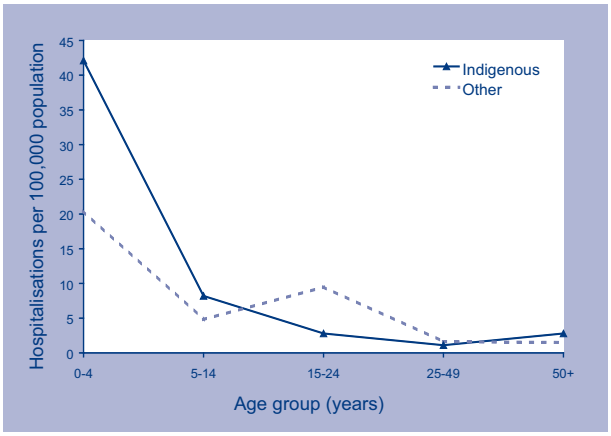
Figure 7. Meningococcal disease notification rate, selected Australian States*, 2000 to 2002,† by age group and Indigenous status



* New South Wales, South Australia, Western Australia and the Northern Territory.

† Notifications where the date of onset was between 1 January 2000 and 31 December 2002.

Figure 8. Meningococcal disease hospitalisation rate, Australia, 1999 to 2002,* by age group and Indigenous status



* Hospitalisations where the date of separation was between 1 July 1999 and 30 June 2002.

Historically, the incidence of meningococcal disease has been disproportionately higher among Aboriginal and Torres Strait Islander Australians, with well-recorded outbreaks in Central Australia[44] and north-west Queensland due to type A and type C disease.[45] The current pattern appears, from the limited data available, to be more one of serogroup B disease in the youngest children, similar to that seen in Maori and Pacific Islander children in New Zealand,[46] in whom living conditions have been shown to be an important disease risk factor.[47] Vaccines protecting against serogroup B disease will be an important consideration for Aboriginal and Torres Strait Islander children in the future, but will need to be effective against a wider range of serogroup B subtypes than the vaccine currently being evaluated in New Zealand.[48]

Pertussis

Pertussis (whooping cough) is an acute illness, caused by the *Bordetella pertussis* bacterium, involving the respiratory tract. The typical illness begins with an irritating cough that gradually becomes paroxysmal and lasts for 1–2 months or longer. Paroxysms are characterised by repeated violent coughs, followed by a characteristic crowing or high-pitched inspiratory whoop. Infants less than six months old, adolescents and adults often have fewer classical symptoms without paroxysms or whoop.[49]

Pertussis

Case definitions

Notifications

Isolation of *Bordetella pertussis* from a clinical specimen

or

Elevated *B. pertussis*-specific IgA in serum *or* the detection of *B. pertussis* antigen in a nasopharyngeal specimen using immunofluorescence with history of a clinically compatible illness

or

An illness lasting two weeks or more with one of the following:

paroxysms of coughing, *or*

inspiratory whoop without other apparent causes, *or*

post-tussive vomiting.

or

An illness characterised by a cough lasting at least two weeks in a patient who is epidemiologically linked to a laboratory confirmed case.

Hospitalisations and deaths

The ICD–10–AM/ICD–10 code A37 (whooping cough) was used to identify hospitalisations and deaths.

Distribution by Indigenous status and age

The age-specific pattern of notifications among Indigenous and other people differed substantially, even though the overall notification rates were almost identical at 42 and 47 respectively per 100,000. For Aboriginal and Torres Strait Islander people, there was an almost twofold higher notification rate among 0–4 year olds and over 50 year olds, with relatively lower notification rates in those aged 5–49 years (Figure 9). In contrast, there was a relative excess of hospitalisations for Aboriginal and Torres Strait Islander people in all age groups, except 25–49 year olds, with an overall rate ratio of two (Figure 10). Hospitalisations were predominantly in those aged 0–4 years (130/150, 87%) of those recorded as Indigenous and (957/1478, 62%) of other children.

In view of the large differential in rates for 0–4 year olds and relatively large case numbers, incidence in the under one year age group was also examined. The notification rate (per 100,000 population) was substantially higher in Indigenous (308) compared to other infants (120), with a rate ratio twice that seen in the 0–4 years age group. However, while hospitalisation rates under 12 months were more than threefold higher than the overall 0–4 years age group at 196 per 100,000 Indigenous and 89 per 100,000 other, there was no difference between the rate ratios at 0–11 months and 12–59 months of age. Seven deaths were recorded as due to pertussis during the reporting period, five in presumed non-Indigenous children under 12 months of age and two in presumed non-Indigenous adults over 50 years.

Table 8. Pertussis notifications, hospitalisations and deaths, Australia, 1999 to 2002,* by age group and Indigenous status

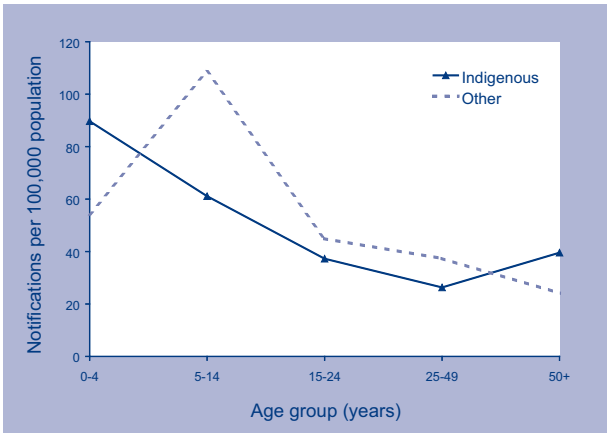
Age group (years)	Indigenous status	Notifications (2000–2002)			Hospitalisations (July 1999–June 2002)			Deaths (2000–2002)
		n	Rate†	Rate ratio	n	Rate†	Rate ratio	n
0–4	Indigenous	99	89.7	1.7	130	72.0	2.8	0
	Other	1,038	54.3		957	26.1		5
5–14	Indigenous	133	61.1	0.6	10	2.8	1.3	0
	Other	4,372	108.6		167	2.2		0
15–24	Indigenous	58	37.3	0.8	4	1.6	3.1	0
	Other	1,798	44.9		40	0.5		0
25–49	Indigenous	73	26.3	0.7	3	0.7	0.9	0
	Other	4,130	37.3		150	0.7		0
50+	Indigenous	35	39.6	1.6	3	2.1	2.2	0
	Other	2,083	24.1		164	1.0		2
All ages‡	Indigenous	408	41.8	0.9	150	6.2	2.4	0
	Other	13,528	46.9		1,478	2.6		7

* Notifications (New South Wales, Northern Territory, South Australia and Western Australia only) where the date of onset was between 1 January 2000 and 31 December 2002; hospitalisations (all States) where the date of separation was between 1 July 1999 and 30 June 2002; deaths (Queensland, Northern Territory, South Australia and Western Australia) where the date of death was recorded between 1 January 2000 and 31 December 2002.

† Average annual age-specific rate per 100,000 population.

‡ Includes cases with unknown ages. Rates for all ages combined are age standardised to the Australian Bureau of Statistics Australian population estimates for 2001.[1]

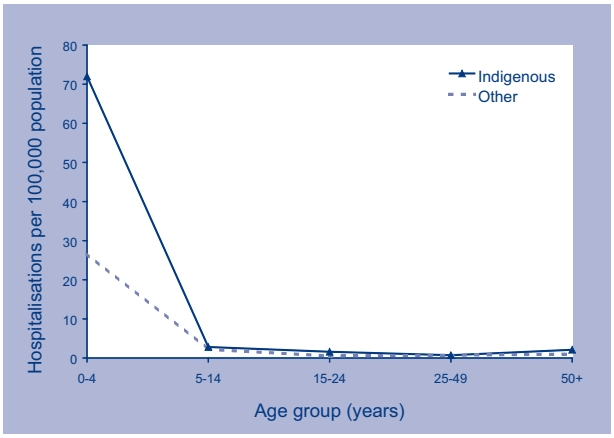
Figure 9. Pertussis notification rate, selected Australian States,* 2000 to 2002,† by age group and Indigenous status



* New South Wales, South Australia, Western Australia and the Northern Territory.

† Notifications where the date of onset was between 1 January 2000 and 31 December 2002.

Figure 10. Pertussis hospitalisation rate, Australia, 1999 to 2002,* by age group and Indigenous status



* Hospitalisations where the date of separation was between 1 July 1999 and 30 June 2002.

Comment

Pertussis is the disease least well controlled of all the diseases with long-standing, well-established vaccination programs. It has the highest notification rate for all ages for the total Australian population[12] and, with the exception of influenza, meningococcal and pneumococcal diseases and varicella, the highest hospitalisation rates. The data in this report are the first to examine this in relation to Indigenous status nationally, although data have been reported previously from the Northern Territory.[50] Interpretation of the data is complex, because of the marked differences between age groups in immunisation history and disease severity as measured by hospitalisation and deaths. Despite this, the relatively large number of cases compared with other VPDs among Aboriginal and Torres Strait Islander people allows some interesting conclusions.

First, the greatest relative excess of pertussis is in 0–4 year olds, most marked in infants under 12 months of age and in hospitalisations. Second, the relatively lower notification rates and rate ratios seen between five and 49 years of age are not reflected in hospitalisation data. This could be artefactual, due to diagnostic practice or lack of access to laboratory facilities in more remote areas, or a real phenomenon, perhaps related to greater exposure to pertussis and more long-lasting immunity in Aboriginal and Torres Strait Islander adults and older children. Even in presumed non-Indigenous children, the age group 5–14 years is a diverse one in relation to vaccination history, as an additional dose of pertussis vaccine was included in the ASVS from 1994. More detailed analysis shows a progressive cohort effect among this age group, shown by high rates in the oldest members of the cohort and low rates among the younger ones, similar that of 1–4 year olds.[51] From the beginning of 2004, an additional dose of a pertussis-containing vaccine will replace diphtheria-tetanus vaccine for all Australian 15–17 year olds.[52] It will be important to monitor trends following this change according to Indigenous status to fully examine its impact.

Pneumococcal disease

Pneumococcal disease is caused by the bacterium *Streptococcus pneumoniae* (pneumococcus). Pneumococci are frequently isolated from the upper respiratory tract and can spread directly from the nasopharynx to cause infection in other parts of the respiratory tract (otitis media, sinusitis, pneumonia) or enter the bloodstream. Manifestations include meningitis, pneumonia and infection at a number of less common sites, as well as septicaemia without focal infection. Invasive pneumococcal disease (IPD) is defined as a sterile site isolate of *Streptococcus pneumoniae*, usually from blood. In the absence of a sterile site isolate, a presumptive diagnosis of pneumococcal pneumonia may be based on a sputum isolate of *Streptococcus pneumoniae* and/or clinical features such as the chest X-ray appearance and prompt response to antibiotic therapy. Invasive pneumococcal disease has been notifiable in Queensland and the Northern Territory since 1997. From January 2001, invasive pneumococcal disease became notifiable Australia-wide.

Pneumococcal disease

Case definitions

Notifications

Isolation from, or detection in, blood, cerebrospinal fluid or other sterile site, of *Streptococcus pneumoniae.*

Hospitalisations

The ICD–10–AM codes used to identify hospitalisations were: G00.1, pneumococcal meningitis; A40.3, pneumococcal septicaemia (together considered to be a proxy for invasive pneumococcal disease); and J13, pneumococcal pneumonia.

Deaths

ICD–10 codes G00.1 and A40.3 were used (together considered to be a proxy for invasive pneumococcal disease) to select deaths from IPD.

Distribution by Indigenous status and age

Notification and hospitalisation rates for invasive pneumococcal disease were higher for all Indigenous age groups with an overall Indigenous: other rate ratio of five for notifications and hospitalisations (Table 9). Rates per 100,000 population were highest in both Indigenous and other populations for the 0–4 years age group (notifications 87 versus 49; hospitalisations 45 versus 26) and 50+ years age group (notifications 59 versus 14; hospitalisations 29 versus 8). Importantly, the incidence of IPD began to increase significantly in the 25–49 years Indigenous age group to an incidence of 48 per 100,000 compared with four per 100,000 in other persons. The incidence rate ratios remained significantly higher at approximately three even for the lowest incidence age group of 5–24 years, with the notification rate among Aboriginal and Torres Strait Islander young people remaining 10 per 100,000, equivalent to that seen among other people over 50 years of age (Figure 11). The age distribution was similar for notifications of IPD and for hospitalisations. For hospitalisations coded as pneumococcal pneumonia, without septicaemia or meningitis, a similar pattern was also found, but was accentuated among those over 50 years and showed a much lower hospitalisation rate for 0–4 year olds (Figures 12 and 13). Death was recorded as due to IPD in 21 cases in the reporting period, 24 per cent of whom were Aboriginal and Torres Strait Islander. In 0–4 year olds, 2/8 deaths (25%) were in Aboriginal and Torres Strait Islander children, 2/3 (67%) among 5–49 year olds and 1/10 (10%) of deaths occurring in over 50 year olds.

Table 9. Invasive pneumococcal disease notifications, hospitalisations and deaths, Australia, 1999 to 2002*, by age group and Indigenous status

Age group (years)	Indigenous status	Notifications† (2001–2002)			Hospitalisations‡ (July 1999–June 2002)			Deaths (2000–2002)
		n	Rate§	Rate ratio	n	Rate§	Rate ratio	n
0–4	Indigenous	64	87.0	1.8	81	44.8	1.7	2
	Other	620	48.6		944	25.7		6
5–14	Indigenous	15	10.3	2.7	24	6.8	4.0	0
	Other	102	3.8		130	1.7		1
15–24	Indigenous	10	9.6	3.7	15	6.0	8.2	1
	Other	70	2.6		58	0.8		0
25–49	Indigenous	89	48.1	11.9	108	24.2	13.4	1
	Other	297	4.0		384	1.8		0
50+	Indigenous	35	59.4	4.3	41	29.1	3.7	1
	Other	800	13.9		1,290	7.8		9
All ages‖	Indigenous	214	44.7	4.5	269	22.0	4.5	5
	Other	1,926	9.9		2,806	4.9		16

* Notifications (New South Wales, Northern Territory, South Australia and Western Australia only) where the date of onset was between 1 January 2001 and 31 December 2002; hospitalisations (all States) where the month of separation was between 1 July 1999 and 30 June 2002; deaths (Queensland, Northern Territory, South Australia and Western Australia) where the date of death was recorded between 1 January 2000 and 31 December 2002.

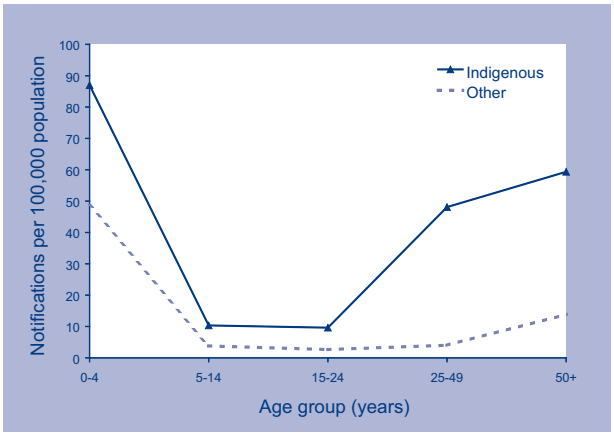
† Notifications are presented for two years only as invasive pneumococcal disease became nationally notifiable in January 2001. Completeness of the Indigenous status data field was suboptimal for New South Wales data in 2001.

‡ Using hospitalisations for pneumococcal meningitis and pneumococcal septicaemia as a proxy for invasive pneumococcal disease.

§ Average annual age-specific rate per 100,000 population.

‖ Includes cases with unknown ages. Rates for all ages combined are age standardised to the Australian Bureau of Statistics Australian population estimates for 2001.[6]

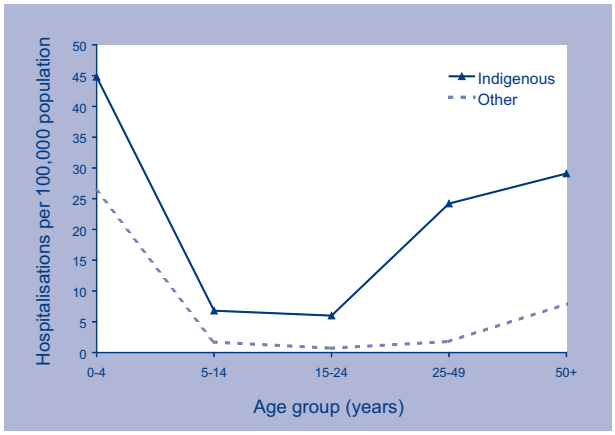
Figure 11. Invasive pneumococcal disease notification rate, selected Australian States,* 2001 to 2002,† by age group and Indigenous status



* New South Wales, South Australia, Western Australia and the Northern Territory.

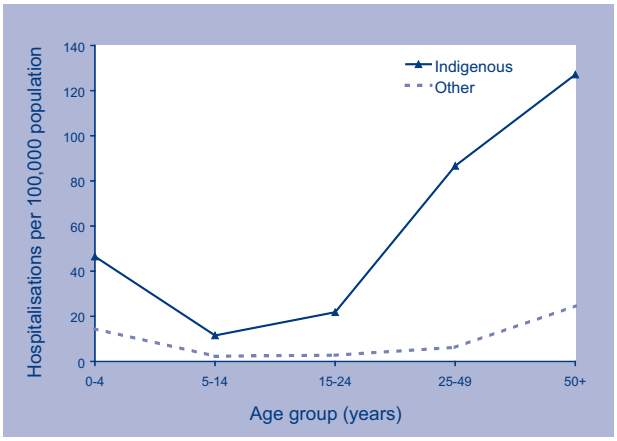
† Notifications where the date of onset was between 1 January 2001 and 31 December 2002.

Figure 12. Hospitalisation rate for pneumococcal meningitis and septicaemia, Australia, 1999 to 2002,* by age group and Indigenous status



* Hospitalisations where the date of separation was between 1 July 1999 and 30 June 2001.

Figure 13. Hospitalisation rate for pneumococcal pneumonia (not coded as meningitis or septicaemia), Australia, 1999 to 2002,* by age group and Indigenous status



* Hospitalisations where the date of separation was between 1 July 1999 and 30 June 2002.

Comment

Invasive pneumococcal disease is well recognised as causing a significant disease burden among Aboriginal and Torres Strait Islander people, especially in Northern and Central Australia.[53,54] The data presented in this report reinforce the importance of IPD as a priority for vaccine prevention in Aboriginal and Torres Strait Islander people of all ages. In particular, the data indicate that IPD has an incidence in younger Aboriginal and Torres Strait Islander adults (25–49 years) almost as high as in the age group currently targeted for pneumococcal vaccine, those over 50 years. It should be noted that the pattern of age-specific incidence seen for IPD is almost identical to that seen for influenza and pneumonia.

Currently, IPD is targeted for vaccine prevention among Aboriginal and Torres Strait Islander children 0–2 years of age, except in Central Australia and adjacent areas, where the conjugate pneumococcal vaccine program is extended to five years. From the age of 15 years, only adults with risk factors for IPD are included in recommendations for funding for polysaccharide vaccine, with the exception of the Northern Territory, where all Aboriginal and Torres Strait Islander adults aged 15 years or more are eligible. From the age of 50 years, funded vaccine is provided for all Aboriginal and Torres Strait Islander adults.

It is too early for definitive data to be available on the impact of the conjugate vaccine program among Aboriginal and Torres Strait Islander infants, but available data indicate that vaccine coverage is sub-optimal, particularly in the south-east of Australia. For adults, data from the program in North Queensland indicate that, in a setting where high coverage with pneumococcal polysaccharide vaccine has been achieved, substantial disease reductions have been observed.[55] However, recent data from the USA in Navajo populations suggest sub-optimal efficacy of pneumococcal polysaccharide vaccine, particularly in adults with underlying medical conditions such as alcoholism.[56] Based on the data presented here on disease rates, and assuming that vaccine effectiveness is adequate, a universal pneumococcal polysaccharide vaccination program for 25–49 year old Aboriginal and Torres Strait Islanders may be justified and should be further examined.

Vaccination coverage

Australian Standard Vaccination Schedule 1998 to 2003

The Australian Standard Vaccination Schedule for children aged 0–6 years changed in the second half of 1998, in mid 2000 and in January and September 2003. In 1998, the second dose of measles-mumps-rubella vaccine (previously given at 12–13 years) was moved to four years. For children born after May 2000, full vaccination at 12 months of age required immunisation against hepatitis B as well as three doses of diphtheria-tetanus-pertussis vaccine (DTP) and oral poliomyelitis (OPV) vaccines. Full immunisation against *Haemophilus influenzae* type b disease at 12 months required, from 2000, two doses of PRP–OMP (*Haemophilus influenzae* type b polysaccharide conjugated to the outer membrane protein of *Neisseria meningitidis*) vaccine for all children. The neonatal dose of hepatitis B vaccine (scheduled for all newborns since May 2000) is not accounted for in ACIR coverage estimates. In the second year of life, a dose of MMR vaccine is scheduled at 12 months of age as well as booster doses of DTP (at 18 months) and Hib vaccine (at 12 months); the 18 month dose of (DTP) was removed in September 2003. The 7-valent pneumococcal conjugate vaccine (7vPCV) was introduced for children at high risk of invasive pneumococcal disease (including all Aboriginal and Torres Strait Islander children) in June 2001. The meningococcal C conjugate vaccine (MenCCV) was introduced for all children in January 2003. The current ASVS is shown in Table 10.

Specific recommendations for Aboriginal or Torres Strait Islander people

There are several differences between the vaccines recommended for Indigenous and non-Indigenous Australians, mainly due to differences in disease incidence. The Australian Standard Vaccination Schedule contains recommendations specifically for Aboriginal and Torres Strait Islander people for influenza, pneumococcal disease and Hib disease. There are also additional recommendations for Aboriginal and Torres Strait Islander people for tuberculosis and hepatitis A vaccines, which are limited to some geographical regions.

The 23-valent pneumococcal polysaccharide vaccine is recommended for all Aboriginal and Torres Strait Islander people aged 50 years and over, and for those aged 15–49 years who have high-risk underlying conditions. In the Northern Territory, vaccination is recommended for all Aboriginal and Torres Strait Islanders aged 15 years or more. A single re-vaccination is generally recommended five years later (see the *Australian Immunisation Handbook* 8th edition for more details).[57] Annual influenza vaccination is also recommended for Aboriginal and Torres Strait Islander adults aged 50 years and over, and for those aged 15 to 49 years with high-risk underlying conditions. These vaccines are funded under the National Indigenous Pneumococcal and Influenza Immunisation Program. The recommendations for non-Indigenous adults differ in that vaccination for these two diseases is recommended from 65 years of age instead of 50. Influenza vaccine is provided for non-Indigenous adults aged 65 or more years under the National Immunisation Program. Pneumococcal vaccine is not publicly funded for non-Indigenous adults except in Victoria, although it is subsidised on the Pharmaceutical Benefits Scheme.

The 7-valent pneumococcal conjugate vaccine is recommended for all children at two, four and six months of age. It is provided free under the National Immunisation Program for all Aboriginal and Torres Strait Islander children and for non-Indigenous children with high risk conditions. Aboriginal and Torres Strait Islander children living in high incidence areas (Northern Territory, South Australia, Western Australia, Queensland) should also receive a dose of 23-valent vaccine at 18–24 months. Catch up vaccination is recommended for unvaccinated children up to five years of age in Central Australia and up to two years of age in other areas.

PRP-OMP (purified polysaccharide conjugated to an outer membrane protein carrier) Hib vaccine is immunogenic at an earlier age and therefore requires fewer doses than other Hib vaccines. For PRP-OMP vaccine, doses are recommended at two, four and 12 months of age, while other Hib vaccines require an extra dose at six months. Since Hib vaccine was first introduced onto the ASVS in 1993, PRP–OMP has been recommended for Aboriginal and Torres Strait Islander children, due to their higher risk of disease under six months of age. Other Hib vaccines were recommended for non-Indigenous children until May 2000. Since then, either PRP–OMP or PRP–T/HbOC vaccines are recommended for non-Indigenous children.

Table 10. The Australian Standard Vaccination Schedule[57]

Age	Vaccine								
Birth	Hepatitis B*								
2 months	Hepatitis B*	DTP_a	Hib‡	IPV‖			7vPCV**		
4 months	Hepatitis B*	DTP_a	Hib‡	IPV‖			7vPCV**		
6 months	Hepatitis B*	DTP_a	Hib§	IPV‖			7vPCV**		
12 months	Hepatitis B*		Hib‡		MMR			MenCCV	
18 months						VZV¶	23vPPV††		
2 years									
4 years		DTP_a		IPV‖	MMR				
10–13 years	Hepatitis B†					VZV¶			
15–17 years		dTp_a							
50 years and over		dT					23vPPV‡‡		Influenza (annual)‡‡
65 years and over							23vPPV		Influenza (annual)

Note: Vaccines currently funded under the National Immunisation Program are shaded in Table 10 above. Vaccines lightly shaded are funded for targeted, at-risk populations only.

* Four doses of hepatitis B vaccine recommended for each child, the timing of doses varies according to the vaccine formulation used.

† Two or three catch up doses recommended for children not previously immunised.

‡ Three doses of PRP–OMP recommended for all children.

§ A 4-dose schedule of PRP–T or HbOC may be given to non-Indigenous children as an alternative.

‖ IPV is recommended but not funded by the National Immunisation Program; OPV is funded as an alternative.

¶ Only for children with a negative history of disease or vaccination.

** Recommended for all children, provided free only to: all Aboriginal and Torres Strait Islander children aged up to two years, Indigenous children in Central Australia aged up to five years, non-Indigenous children in Central Australia aged up to two years, and all children under five years with medical risk factors that predispose them to high rates or high severity of pneumococcal infection.

†† Aboriginal and Torres Strait Islander children only.

‡‡ Aboriginal and Torres Strait Islander adults only, vaccines provided under the National Indigenous Pneumococcal and Influenza Immunisation Program.

Vaccine key

Hepatitis B	Hepatitis B vaccine	MMR	Measles-mumps-rubella vaccine
DTPa	Diphtheria-tetanus-acellular pertussis infant/child formulation	VZV	Varicella-zoster vaccine
dTpa	Adult diphtheria-tetanus-pertussis vaccine	7vPCV	7-valent pneumococcal conjugate vaccine
Hib	*Haemophilus influenzae* type b (Hib) vaccine (PRP–OMP, as monovalent or in combination)	23vPPV	23-valent pneumococcal polysaccharide vaccine
IPV	Inactivated poliomyelitis vaccine (in combination)	MenCCV	Meningococcal C conjugate vaccine
OPV	Oral poliomyelitis vaccine	Influenza	Influenza vaccine

Since 1999, hepatitis A vaccine has been provided for all Aboriginal and Torres Strait Islander children in North Queensland at 18 and 24 months of age. Catch-up vaccination is provided to children up to six years of age.

Vaccination with BCG (Bacille Calmette-Guérin) vaccine for tuberculosis is recommended for all Aboriginal and Torres Strait Islander neonates in high incidence areas.

Vaccination for Japanese encephalitis virus is recommended for all residents of the outer Islands of the Torres Strait aged over one year of age, and non-residents staying at least 30 days during the wet season.

Calculating vaccination coverage estimates from the ACIR

The methodology for calculating cohort-based vaccination coverage from the ACIR was described by 0'Brien *et al*.[7] Using this method, a cohort of children is defined by date of birth in 3-month groups; the first cohort was born between 1 January 1996 and 31 March 1996. To minimise duplicate records, the cohort includes only children enrolled with Medicare. The vaccination status of each cohort is assessed at the two key milestones of 12 months and 24 months of age. Coverage is measured several months after the due date for completion of each milestone, to allow for delayed notification to the ACIR. It is assumed that notification of receipt of a later vaccine dose implies receipt of earlier doses, even if no earlier vaccination is recorded ('third dose assumption').[58]

A child is now defined as 'fully vaccinated' at 12 months of age if he or she has received a third dose of DTPa and poliomyelitis vaccine (oral or inactivated), a second dose of Hib vaccine (PRP–OMP), and either a second or a third dose of hepatitis B vaccine. At 24 months of age a child is defined as fully vaccinated if he or she has received the third dose of DTPa, OPV and Hib, either a third or fourth dose of hepatitis B and a first dose of MMR. ACIR coverage estimates have been reported in *Communicable Diseases Intelligence* since 1998.[7] Coverage estimates for Aboriginal and Torres Strait Islander children are not published separately except in those jurisdictions where agreement has been reached with the relevant jurisdictional organisation(s).

The completeness of data on Indigenous status was assessed by State and Territory. As a result, data were included only for New South Wales, Northern Territory, South Australia, Victoria and Western Australia. See Methods for more information.

Vaccination coverage estimates from the ACIR for Indigenous versus other children

Coverage estimates from the ACIR for Aboriginal and Torres Strait Islander children and children not identified as Indigenous aged one and two years are shown in Table 11. For Aboriginal and Torres Strait Islander children, 82.2 per cent of one year olds and 90.1 per cent of two year olds were fully immunised. The proportion fully immunised at 12 months of age was considerably higher for children not identified as Indigenous (9% higher than Indigenous children) and less so at two years of age (1% higher).

Coverage at 12 months of age was lower for Aboriginal and Torres Strait Islander children for each single vaccine. However, at two years of age, the differences in coverage for individual vaccines between Indigenous and other children were less marked. Coverage was higher in Aboriginal and Torres Strait Islander two year olds for hepatitis B (Indigenous 97.9%, other 95.5%), DTP (Indigenous 96.7%, other 95.7%), OPV (Indigenous 95.3%, other 94.5%) and MMR (Indigenous 94.2%, other 93.1%).

It should be noted, however, that coverage estimates for Aboriginal and Torres Strait Islander children include only those who are registered on the ACIR and identified on it as Indigenous. Children so identified may not be representative of all Aboriginal and Torres Strait Islander children, and so estimates based on these could either overestimate or underestimate coverage among young Indigenous children.

Table 11. Coverage estimates from the Australian Childhood Immunisation Register for Indigenous and other children 'fully vaccinated' at age 1 and 2 years*

Vaccine	Indigenous status	1 year	2 years
Hepatitis B	Indigenous	94.0	97.9
	Other	94.8	95.5
DTP	Indigenous	84.8	96.7
	Other	92.7	95.7
OPV	Indigenous	84.1	95.2
	Other	92.6	94.5
Hib	Indigenous	93.0	92.9
	Other	94.4	92.9
MMR	Indigenous	N/A†	94.2
	Other	N/A†	93.1
All vaccines	Indigenous	82.2	90.9
	Other	91.2	91.3

Source: Australian Childhood Immunisation Register, Health Insurance Commission.

* 3-month cohorts, age at 30 September 2003, calculated at 31 December 2003. Coverage assessment date was 12 or 24 months after the last birth date of each cohort. Includes data from New South Wales, Northern Territory, South Australia, Victoria, Western Australia only.

† Not included in coverage estimates for that age group.

Calculating vaccination coverage estimates from the National Health Survey

The methodology for calculating vaccination coverage estimates in the National Health Survey (NHS) has been published.[8] In contrast to ACIR estimates, NHS estimates for children are combined for different ages, in this case 2–6 years of age. The NHS was conducted in 2001, so for this age group, three different schedules have applied—those of 1996, 1998 and 2000. Some of the schedule changes applied only to children born after that date, while others applied to all children below a certain age, depending on the vaccine and dose concerned. The vaccination status for each child was calculated according to the number of doses received, compared to the number recommended under the schedule applying to a child in that age group. An allowance of one month was made for late vaccinations, so that at the time of interview, if a child was due for a vaccination in the previous month and had not received it, that dose was not included in the calculation of vaccination status. Adult respondents were asked whether they had been vaccinated for influenza in the last 12 months, and for pneumococcal disease in the last five years.

Vaccination coverage estimates from the National Health Survey for Indigenous versus non-Indigenous children

Coverage estimates from the National Health Survey for Indigenous and non-Indigenous children were provided by the ABS and are presented here for children aged 2–6 years in Table 12. Estimated coverage in this group was considerably lower for both Indigenous and non-Indigenous children than recorded on the ACIR for one and two year olds.

Table 12. Coverage estimates (with 95% confidence intervals) from the National Health Survey for Indigenous and non-Indigenous children 'fully immunised', aged 2–6 years*

Vaccine	Indigenous status	Coverage (%)
DTP†	Indigenous	70 (62–78)
	Non-Indigenous	82 (79–85)
OPV‡	Indigenous	76 (70–82)
	Non-Indigenous	87 (84–90)
Hib§	Indigenous	50 (41–59)
	Non-Indigenous	67 (64–70)
MMR‖	Indigenous	85 (78–92)
	Non-Indigenous	94 (92–96)

Source: Unpublished data from the National Health Survey, provided by the Australian Bureau of Statistics.

* Children living in non-remote areas only.

† Four or more doses.

‡ Three or more doses.

§ Indigenous children three or more doses, non-Indigenous children four or more doses.

‖ One or more doses.

For Aboriginal and Torres Strait Islander children in non-remote areas, estimated coverage ranged from 85 per cent for one or more doses of MMR to 50 per cent for three or more doses of Hib. Coverage for non-Indigenous children was statistically significantly higher for DTP, OPV and Hib, and almost so for MMR. Coverage for non-Indigenous children ranged from 94 per cent for one or more doses of MMR to 67 per cent for four or more doses of Hib. The vaccine with the largest difference in coverage between Indigenous and non-Indigenous children was Hib (17%), while the smallest difference was for MMR (9%). Parents of Indigenous children were less likely to have referred to immunisation cards or records (56%, 95% CI 43–69%) than parents of non-Indigenous children (80%, CI 77–83%). The proportion of parents of Aboriginal and Torres Strait Islander children who reported they either did not know whether their child was vaccinated, or did not know how many doses they had received, ranged from six per cent for MMR to 23 per cent for Hib. For parents of non-Indigenous children, the proportions ranged from six per cent for OPV to nine per cent for Hib.

Vaccination coverage estimates from the National Health Survey for Indigenous versus non-Indigenous adults

Coverage estimates for influenza and pneumococcal vaccines in age groups relevant for the fully funded vaccine programs among Indigenous and non-Indigenous adults are shown in Table 13. Pneumococcal vaccine coverage was significantly higher in Aboriginal and Torres Strait Islander adults at 50–64 years (Indigenous 20%, non-Indigenous 3%) and 65 years and over (Indigenous 47%, non-Indigenous 28%). Influenza vaccine coverage was significantly higher in Aboriginal and Torres Strait Islander adults at 50–64 years (Indigenous 47%, non-Indigenous 26%) but not when those aged 65 years and over were added (50+ years; Indigenous 51%, non-Indigenous 47%).

Data on remoteness were available for Aboriginal and Torres Strait Islander people only. For those aged 50 years and over, coverage was substantially higher in remote areas than in non-remote areas for both influenza vaccine (75% vs 45%) and pneumococcal vaccine (48% vs 19%).[59]

Table 13. Vaccination coverage estimates from the National Health Survey for Indigenous and non-Indigenous adults, by age

Vaccine	Indigenous status	50–64 years	65+ years	Total 50+ years
Influenza*	Indigenous	47 (38–56)	71 (50–92)	51 (43–59)
	Non-Indigenous	26 (24–28)	75 (74–76)	47 (46–48)
Pneumococcal†	Indigenous	20 (15–25)	47 (29–65)	25 (19–31)
	Non-Indigenous	3 (2–4)	28 (26–30)	14 (13–15)

Source: Unpublished data from the National Health Survey, provided by Australian Bureau of Statistics.

* Vaccinated in the last 12 months.

† Vaccinated in the last five years.

Other data

Previously published national data on immunisation coverage in Aboriginal and Torres Strait Islander people are largely limited to the 1996 'Wronski Report'.[60] This report estimated levels of immunisation coverage in Aboriginal and Torres Strait Islander children by surveying community controlled Aboriginal and Torres Strait Islander Health Services and regional health bodies. Of 25 services providing data, estimated coverage in two years old and five years old children varied from 14 per cent to 100 per cent, with generally higher coverage in non-urban areas compared to urban areas.[60] A more recent study[13] has estimated national immunisation coverage using Australian Childhood Immunisation Register records with receipt of PedvaxHIB immunisation as a proxy for Aboriginal and Torres Strait Islander status. Using this method, coverage in Aboriginal and Torres Strait Islanders at 12 months (72%–76%) and 24 months (64%–73%) was considerably lower than in others (90%–94% and 81%–88% respectively). As in the National Health Survey, coverage was significantly lower in children residing in 'accessible' compared to 'remote' areas.[13]

Other data on immunisation coverage in Aboriginal and Torres Strait Islander children have come largely from specific areas in particular States. Surveys of immunisation providers' records have reported rates from 36 per cent fully vaccinated for children up to 11 years of age on the North Coast of New South Wales in 1992[61] to 73 per cent by two years of age in Central Australia in 1985.[62] In Far North Queensland in 1996, coverage was estimated to be less than 42 per cent by two years of age.[63] Studies examining computerised immunisation registers in the Northern Territory have reported uptake rates of above 95 per cent for most vaccines at two years of age in remote communities in 1993.[64] Overall coverage, measured as fully immunised at six years of age, was estimated as 77 per cent for the whole Northern Territory in 1996.[65] Studies have consistently reported significantly higher coverage rates in remote communities compared to urban areas in Northern Australia[63,65,66] but the reverse was found in Northern New South Wales.[61]

Comment

Immunisation coverage from the National Health Survey is generally lower than that from the ACIR and the NHS figures show a larger discrepancy between rates in Indigenous and non-Indigenous children. There are several possible reasons for this. First, the NHS coverage estimates only include children whose vaccination status could be determined. The data above also show that parents of Aboriginal and Torres Strait Islander children were less likely to have written records to refer to. They were therefore more likely to report that they did not know the status of their child and therefore not be recorded as vaccinated. Under-reporting of vaccination to the ACIR also occurs, but it has been estimated at 2.5 per cent for the general population,[14] considerably lower than the 6–9 per cent of non-Indigenous children with unknown vaccination status in the NHS, and 8–23 per cent for Indigenous children. NHS estimates did not include children from remote areas. Given that coverage has frequently been shown to be higher in Indigenous populations in remote compared to urban areas,[59,66] this may also have contributed to underestimating Indigenous coverage.

For those children who are recorded as Indigenous on the ACIR, coverage is similar to that in the general population by two years of age. Coverage for DTP and OPV were lower than in the general population at 12 months of age, but there was little difference by two years. As there are no doses of DTP or OPV recommended between one and two years of age, this indicates that the main reason for lower coverage at 12 months for those recorded as Indigenous on the ACIR is delayed receipt of the vaccines due at 0–6 months.

Approximately 65 per cent of the estimated number of Aboriginal and Torres Strait Islander children born between June 2001 and December 2002 are recorded as Indigenous on the ACIR. To the extent that data completeness is an indicator of access to health care then these children may be more likely to be vaccinated than those whose status has not been recorded. It is likely, therefore, that the ACIR and NHS respectively provide an upper and lower limit of the coverage in Aboriginal and Torres Strait Islander children and the difference between Indigenous and non-Indigenous children. Improved reporting of Indigenous status on the ACIR in future may enable the monitoring of trends over time and geographical differences. Ideally, any future NHS examining immunisation status in an enhanced sample of Aboriginal and Torres Strait Islander children should seek to map this to the ACIR, for identification of both Indigenous and immunisation status.

In adults, coverage was higher for Aboriginal and Torres Strait Islanders for pneumococcal vaccine in those aged 50 years and over and for influenza vaccine at 50–64 years. This higher coverage is probably attributable to the provision of free vaccine through the National Indigenous Pneumococcal and Influenza Immunisation program. There was no significant difference in influenza vaccine coverage at 65 years and over, where vaccine is recommended and provided free to the general population.

Discussion

This report gives, for the first time, detailed data on VPDs and vaccine coverage in Aboriginal and Torres Strait Islander people and compares these data with those for the population not recorded as Indigenous. These data add to the more general data on communicable disease and health in the report(s) of the Australian Institute of Health and Welfare and the Australian Bureau of Statistics.[2] They have direct implications for prevention, both in considering new or expanded vaccine programs and in improving the population coverage of existing programs.

With the exception of hepatitis A, all VPDs considered in detail in the report are currently targeted by population-wide programs. Each VPD highlights different issues for consideration. For childhood programs, Hib disease, pertussis and measles provide interesting contrasts. In the case of Hib disease, great progress has been made in preventing this life-threatening infection across the population, but the residual disease burden, though much diminished, is falling disproportionately on Aboriginal and Torres Strait Islander people. More information is needed on the reasons for this, as vaccination coverage data from the NHS and ACIR do not show a consistent picture. In contrast, ACIR data show little difference in younger children aged one and two years. For pertussis, although there is little difference in incidence rates across all ages, this is not the case in the youngest children. Both Hib disease and pertussis can affect very young infants below six months of age and the data suggesting delayed immunisation in Aboriginal and Torres Strait Islander children may be particularly relevant here. In the case of measles, where early receipt of vaccine is not so critical and a recent nationwide campaign was delivered in schools, good control of equivalent degree is evident for Indigenous and non-Indigenous people.

Different issues are highlighted by examination of the data on disease incidence and vaccine coverage for hepatitis B, meningococcal disease, influenza and pneumococcal disease, all with established programs targeting a wider age group. In the case of hepatitis B, Aboriginal and Torres Strait Islander infants have been included in targeted programs since the late 1980s and the oldest will now be more than 15 years of age. In the Northern Territory, where the program was universal rather than targeted, high coverage may have been more successful than in regions with targeted programs. Certainly the data showing high incidence and significant differential incidence in the 5–14 years old age group suggest that there may have been sub-optimal coverage. Indeed, relatively high rates of hepatitis B notification for Aboriginal and Torres Strait Islander young people suggest that a program targeting this age group should be considered. A national program of meningococcal C conjugate vaccination has been in place since early 2003. Available notification data indicate that the significantly higher rates of invasive meningococcal disease in Aboriginal and Torres Strait Islander people are primarily in children under two years and are mostly type B, for which no licensed vaccine is available. It will be important to have more complete serogroup-specific data available for Aboriginal and Torres Strait Islander cases in the future.

High morbidity from influenza and pneumococcal disease in Aboriginal and Torres Strait Islander people has been targeted by a funded vaccine program for adults over 50 years since 1999. Children under two years of age have been targeted for a funded program of conjugate pneumococcal vaccine since 2001. The data presented here show that the incidence of these diseases remains high and, in the adult program, there is significant scope for increasing vaccine coverage. This is particularly the case in adults aged 50–64 years where coverage, although higher than in non-Indigenous adults for whom there is no funded program, remains low. There is also a high disease burden from influenza and pneumococcal disease in 25–49 years old Aboriginal and Torres Strait Islander adults, potentially justifying expansion of the program to all Aboriginal and Torres Strait Islander adults in this age group. However, it will be important to first identify means of achieving higher coverage in the young adult population.

In the last category is hepatitis A, where no national vaccine program exists for any population group. In north Queensland, hepatitis A has been targeted by a vaccination program for Aboriginal and Torres Strait Islander children under five years of age with dramatic falls in disease incidence extending to other age groups and the non-Indigenous population.[31] This experience, and similar experiences with hepatitis A programs in Indigenous communities in the USA, suggest that hepatitis A should also be strongly considered for a national program, at least in high incidence areas, as is done in the USA.

In summary, the data in this report reveal some important areas where increased attention is justified and consideration of expanded programs and mechanisms of enhancing existing programs should be expedited. Limitations of the available data relate both to VPD and vaccine coverage data, though the issues in each differ. For VPD data, incomplete identification of Aboriginal and Torres Strait Islander status is a problem, tending to underestimate disease burden. However, even the available data indicate a substantially higher burden from VPDs in almost all instances, with the limitation that information about Aboriginal and Torres Strait Islander people living in the southern parts of the country and in urban areas is less complete. For vaccine coverage, there is the possibility of overestimating completeness of coverage through the ACIR, depending on the characteristics of children identified as Indigenous in it. On the other hand, the range of years and small sample sizes for individual years significantly limit the interpretation of data from the National Health Survey, as does lack of availability of records. Expansion of the ACIR to include other age groups, should this occur in the future, may be able to address this problem.

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Appendix

Summary of notifications, hospitalisations and deaths for vaccine preventable diseases, Australia, 1999 to 2002,* by Indigenous status

Disease†	Indigenous status	Notifications (2000–2002)			Hospitalisations (July 1999–June 2002)			Deaths (2000–2002)		
		n	Rate‡	Rate ratio	n	Rate‡	Rate ratio	n	Rate‡	Rate ratio
Diphtheria§	Indigenous	0	–	–	0	–	–	0	–	–
	Other	1	–		2	–		0	–	
Hib disease (invasive)‖	Indigenous	13	1.2	9.7	–	–	–	–	–	–
	Other	34	0.1		–	–		–	–	
Hepatitis A	Indigenous	113	9.1	2.9	82	4.5	2.1	1	–	–
	Other	899	3.1		1,227	2.1		2	–	
Hepatitis B (acute)	Indigenous	57	7.2	4.4	30	2.8	3.7	2	–	–
	Other	469	1.6		433	0.8		8	–	
Influenza¶	Indigenous	–	–	–	594	49.3	2.9	2	–	–
	Other	–	–		9,719	17.1		61	–	
Measles	Indigenous	3	0.2	0.6	2	0.1	0.4	0	–	–
	Other	110	0.4		170	0.3		0	–	
Meningococcal disease	Indigenous	92	7.2	2.1	121	5.5	1.3	5	–	–
	Other	975	3.4		2,440	4.3		33	–	
Mumps**	Indigenous	5	0.3	0.4	9	0.4	1.8	0	–	–
	Other	270	0.9		129	0.2		1	–	
Pertussis	Indigenous	408	41.8	0.9	150	6.2	2.4	0	–	–
	Other	13,528	46.9		1,478	2.6		7	–	
Pneumonia	Indigenous	NN	NN	–	17,455	1,580	3.2	130	19.1	3.1
	Other	NN	NN		283,876	495		3,569	6.2	
Pneumococcal disease	Indigenous	214	44.7	4.5	269	22.0	4.5	5	–	–
	Other	1,926	9.9		2,806	4.9		16	–	
Poliomyelitis††	Indigenous	0	–	–	2	0.3	2.8	0	–	–
	Other	0	–		54	0.1		0	–	
Rubella‡‡	Indigenous	5	0.5	0.4	1	0.1	0.6	0	–	–
	Other	310	1.1		81	0.1		0	–	
Tetanus§§	Indigenous	1	0.3	16.2	0	–	–	0	–	–
	Other	6	0.0		80	0.1		1	–	
Varicella‖‖	Indigenous	NN	NN	–	197	8.9	1.2	0	–	–
	Other	NN	NN		4,285	7.6		10	–	

* Notifications (New South Wales, Northern Territory, South Australia and Western Australia only) where the date of onset was between 1 January 2000 and 31 December 2002; hospitalisations (all states) where the month of separation was between 1 July 1999 and 30 June 2002; deaths (Queensland, Northern Territory, South Australia and Western Australia) where the date of death was recorded between 1 January 2000 and 31 December 2002.

† See results section for case definitions. For diseases not included in Section 3, case definitions are listed below.

‡ Average annual rate per 100,000 population, age standardised to the Australian Bureau of Statistics Australian population estimates for 2001.[6]

§ Notifications: isolation of toxigenic *Corynebacterium diphtheriae*, plus either pharyngitis or laryngitis, and toxic symptoms. Hospitalisations: ICD–10 codes A36.0, A36.1, A36.2 or (A36.8 + I41.0). Deaths: A36. One notification of a cutaneous infection acquired overseas.

‖ Hospitalisations and deaths not included because there is no ICD–10 code specific to *Haemophilus influenzae* type b.

¶ Notifications not included due to low completeness of Indigenous status field.

** Notifications: Isolation of mumps virus, rise in mumps antibody, or clinically compatible illness. Hospitalisations and deaths: ICD–10 code B26.

†† Notifications: Acute flaccid paralysis without apparent cause. Hospitalisations and deaths: ICD–10 code A80. Hospitalisations include vaccine-associated polio and imported cases.

‡‡ Notifications: generalised macropapular rash, fever, epidemiological link to a confirmed case, plus arthralgia/arthritis, lymphadenopathy or conjunctivitis. Hospitalisations and deaths: ICD–10 code B06.

§§ Notifications: a clinically compatible illness without other apparent cause. Hospitalisations and deaths: ISD–10 code A35.

‖ ‖ Hospitalisations and deaths: ICD–10 code B01.

NN Not notifiable.