Supplement

# Vaccine preventable diseases and vaccination coverage in Australia, 1993–1998

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June 2000

# Vaccine preventable diseases and vaccination coverage in Australia, 1993–1998

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June 2000

Supplement

Communicable Diseases Intelligence

Communicable Diseases Network Australia

ISBN 0642446628



Produced by Surveillance and Management Section, Department of Health and Aged Care, Canberra

Front Cover Photography by Renee Wilson and Alison Milton

Printed by Union Offset, Canberra

# Contents

# Executive summary

## Background

Since the introduction of childhood vaccination for diphtheria in 1932 and the widespread use of vaccines to prevent tetanus, pertussis (whooping cough) and poliomyelitis in the 1950s, deaths in Australia from vaccine preventable diseases (VPDs) have declined by more than 99%. It is important, however, that the downward trend in morbidity and mortality from VPDs is maintained and carefully monitored, and that changes are interpreted in relation to vaccination coverage.

## Aim

This report aimed to bring together three national sources of routinely collected data on the morbidity and mortality (notifications, hospitalisations and deaths) from VPDs during the period 1993–1998 for the 8 diseases then on the routine childhood vaccination schedule, and for 4 other diseases potentially preventable by childhood vaccination. It also examined vaccination coverage for the same period.

## Methods

Data sources included notifications from the National Notifiable Diseases Surveillance System (NNDSS), hospitalisation data from the Australian Institute of Health and Welfare (AIHW) National Hospital Morbidity Database, deaths from the Australian Bureau of Statistics (ABS) Causes of Death Collection and vaccination coverage according to the Australian Childhood Immunisation Register (ACIR). All data sources were expected to have some limitations, the most important being under-reporting for notifications and vaccination encounters, and coding errors in the hospital morbidity data.

## Results

Notifications for the 8 diseases covered by the routine schedule declined by 42%, from an average of 11,537 cases each year in 1993–1997 to 6700 in 1998, and hospitalisations fell by 12%, from an average of 1745 per year to 1536 in 1997/1998, while deaths remained unchanged at 7 each year over the period of review (Table 1). Tetanus caused 1 or 2 of the deaths each year. However, 6 of the 7 deaths in 1997 were in infants during a major outbreak of pertussis. Pertussis caused most of the notifications, hospitalisations and deaths during the review period. While most of these were in children, 46% of the notifications and 13% of the hospitalisations occurred in persons aged 15 years or more. There were notable declines in the numbers of notifications of invasive *Haemophilus influenzae* type b (Hib) disease in children under 5 years of age (77%), measles (87%) and rubella (75%), and there were no notifications of diphtheria or poliomyelitis.

Vaccination coverage estimated using ACIR data increased during the review period. Coverage for the first 3 doses of diphtheria, tetanus, pertussis and Hib vaccines, assessed at 1 year of age, increased from 75% to 85%, while coverage for measles-mumps-rubella (MMR) vaccine, assessed at 2 years of age, increased from 83% to 86%. It is likely that these data underestimated coverage by 5–10%, and that the increase in coverage partly reflected better reporting to the ACIR by providers.

**Table 1. Notifications, hospitalisations and deaths from diseases preventable by vaccines on the current childhood vaccination schedule, Australia, 1993–1998***

| Disease† | Notifications | | Hospitalisations | | Deaths | |
|---|---|---|---|---|---|---|
| | Average per year 1993-1997 | 1998 | Average per year July 93-June 97 | 1997/98 | Average per year 1993-1996 | 1997 |
| Diphtheria | 0 | 0 | 5 | 0 | 0 | 0 |
| Hib (aged <5 yrs) | 103‡ | 24 | 129 | 80 | 3 | 0 |
| Measles | 2418 | 313 | 517 | 156 | 2 | 0 |
| Mumps | 116§ | 181 | 55 | 51 | 1 | 0 |
| Pertussis | 5887 | 5413 | 910 | 1165 | 0 | 6 |
| Polio | 0 | 0 | 4‖ | 2‖ | 0 | 0 |
| Rubella | 3006‡ | 762 | 99 | 48 | 0 | 0 |
| Tetanus | 8 | 7 | 28 | 34 | 2 | 1 |
| Total | 11537** | 6700 | 1745** | 1536 | 7** | 7 |

* Notifications where the month of onset was between January 1993 and December 1998; hospitalisations where the month of admission was between 1 July 1993 and 30 June 1998; deaths where the date of death was recorded between 1993 and 1997.

† See Chapter 3 for case definitions.

‡ Not all States/Territories were reporting in all years (see Appendix 2 for details).

§ Only the ACT, NSW and Victoria reported mumps notifications for the entire period. For these States/Territories the average number of mumps notifications per year from 1993 through 1997 was 78 and there were 96 notifications in 1998.

‖ Principal diagnosis only. See page 27 for comment.

** Average per year for the total does not equal the sum of that for each disease, due to rounding.

## *Comment*

This is the first comprehensive report on VPDs and vaccination coverage in Australia using multiple data sources. It provides a valuable baseline for ongoing measurement of trends and the impact of interventions.

The striking features were the low rates of VPDs in 1998, and the marked decline in both Hib, related to the introduction of vaccination in 1993, and in measles and rubella, due to the introduction of the second dose of MMR vaccine in 1994 and the Measles Control Campaign in 1998. Compared with deaths in the pre-vaccination era, Hib deaths in children under the age of 5 years fell by 83%, suggesting that Hib vaccine prevented 62 deaths in this age group between 1993 and 1997. The ongoing morbidity and mortality from pertussis indicates the need for additional interventions aimed at controlling spread of this infection in both children and adults.

# Acknowledgements

We thank the Scientific Advisory Committee of the NCIRS, especially Dr Cathy Mead and Professor John Kaldor, who generated the initial ideas for this report, encouraged us during its production and commented on the draft. We also thank Dr Jill Forrest and Alison Milton, who provided invaluable advice and edited the manuscript, and Dr Raina MacIntyre, who reviewed the manuscript.

We wish to acknowledge the following organisations for provision of data for this report: The National Centre for Disease Control, for data from the National Notifiable Diseases Surveillance System; The Australian Institute of Health and Welfare, Patient Morbidity and Services Unit, for data from the National Hospital Morbidity Database; The Australian Bureau of Statistics, for data from the Causes of Death Collection.

The report was reviewed by a representative of each Australian jurisdiction from the Communicable Diseases Network of Australia and New Zealand before publication.

# 1 - Introduction

The burden of death and disease in Australia has been dramatically reduced by vaccination. The first disease to be prevented by widespread childhood vaccination was diphtheria in 1932. This was followed by vaccination against pertussis in 1942, tetanus in 1953, poliomyelitis in 1956, measles in 1970 and *Haemophilus influenzae* type b (Hib) disease in 1993. The most important and easily measured impact of vaccination for these diseases has been on deaths, which declined by more than 99%, from 9300 in the decade 1926–1935 to 64 in the decade 1986–1995, despite the Australian population increasing 2.6 fold over this time (Table 2).[1] The incidence rates for reported cases of individual diseases have also decreased by similar or greater amounts from the pre-vaccination era (Appendix 1).[2]

**Table 2. Deaths from diseases commonly vaccinated against, Australia 1926–1997***

| Period | Diphtheria | Pertussis | Tetanus | Poliomyelitis | Measles† | Population estimate |
|---|---|---|---|---|---|---|
| 1926-1935 | 4073 | 2808 | 879 | 430 | 1102 | 6,600,000 |
| 1936-1945 | 2791 | 1693 | 655 | 618 | 822 | 7,200,000 |
| 1946-1955 | 624 | 429 | 625 | 1013 | 495 | 8,600,000 |
| 1956-1965 | 44 | 58 | 280 | 123 | 210 | 11,000,000 |
| 1966-1975 | 11 | 22 | 82 | 2 | 146 | 13,750,000 |
| 1976-1985 | 2 | 14 | 31 | 2 | 62 | 14,900,000 |
| 1986-1995 | 2 | 9 | 21 | 0 | 32 | 17,300,000 |
| 1996-1997 | 0 | 8 | 1 | 0 | 0 | 18,400,000 |

* Sources: Feery B One hundred years of vaccination *Public Health Bull* 1997; 8:61-3; Feery B. Impact of immunization on disease patterns in Australia. *Med J Aust* 1981;2:172-6. Deaths recorded for 1966–1975 and 1996–1997 updated with data provided by ABS 1999.

† Excludes deaths from subacute sclerosing panencephalitits.

Indicates decade in which community vaccination started for the disease.

However, in 1991, when surveillance and reporting of vaccine preventable diseases were coordinated nationally in their present form for the first time, the incidence of measles and pertussis was high compared with many other industrialised countries.[3] Similarly, the proportion of children fully vaccinated against diseases included in the Australian Standard Vaccination Schedule appeared to be low.[3] This prompted a number of important initiatives under the *Immunise Australia* program,[4] including the implementation of the Australian Childhood Immunisation Register (ACIR) in 1996[4,5] and The Seven Point Plan in 1997.[4]

To measure the impact of these initiatives, it is important to continue monitoring the morbidity and mortality associated with vaccine preventable diseases and to estimate vaccination coverage. The Australian Institute of Health and Welfare (AIHW) report *Australia's Children* has presented these data for 0–14 year olds.[3] In addition, the annual report of the National Notifiable Diseases Surveillance System (NNDSS) gives summary data for all notifiable diseases, including vaccine preventable diseases, and reports of vaccination coverage from the ACIR.[6]

This report brings together for the first time all three national sources of routinely collected data about vaccine preventable diseases, for all age groups in Australia between 1993 and 1998, together with information about vaccination coverage. This time period was chosen because data were available from each source from 1993 onwards. The diseases covered in this report include those for which vaccines for children were funded nationally during the review period (diphtheria, *Haemophilus influenzae* type b (Hib) disease, measles, mumps, pertussis, poliomyelitis, rubella and tetanus), those for which vaccines were available but only funded or recommended for specific risk groups (hepatitis A, hepatitis B, invasive pneumococcal disease), and varicella (for which a licensed vaccine became available in Australia in 2000). This report does

not cover some other diseases for which vaccines are available, such as influenza, meningococcal infection and tuberculosis, as these are included in detailed reports available elsewhere.[7-9]

The report provides both evidence of the impact of changes in vaccination policy and practice over the six years, particularly notable for measles and Hib disease, and a baseline against which further changes can be measured.

# 2 - 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 (unpublished data), and mortality data from the Australian Bureau of Statistics (ABS) Causes of Death Collection.

### *Notifications*

The NNDSS database was established in its current form in 1991, and includes information about cases of vaccine preventable diseases reported by laboratories and health workers to State/Territory authorities under their current public health legislation. State/Territory notification criteria are based on the National Health and Medical Research Council (NHMRC) surveillance case definitions.[10] However, application of these definitions may differ between jurisdictions. Pneumococcal disease and varicella are currently not notifiable to the NNDSS.

In March 1999 we extracted unit record vaccine preventable diseases notification data from the NNDSS for cases with an onset between 1 January 1993 and 31 December 1998 (6 years). Note that 1998 data were provisional. The variables examined were disease, date of disease onset, age at onset, sex and State/Territory of residence. The fields for laboratory confirmation, vaccination status and Aboriginality were too incomplete to warrant analysis. Data from each State/Territory were included only when that jurisdiction had been reporting for a complete year (see Appendix 2, notifications by State/Territory and year, for the years in which States/Territories were reporting). Differences in surveillance systems between jurisdictions may have accounted for some of the differences in notification rates. Where there were known differences that were likely to differentially affect notification rates, these have been described under the disease of interest.

### *Hospitalisations*

The AIHW National Hospital Morbidity Database has received administrative, demographic and clinical information about patients admitted to public and private hospitals in Australia since 1993. As data are received by financial year of discharge, cases discharged between 1 July 1993 and 31 June 1998 (5 years) were examined. Cases admitted before 1 July 1993 were excluded; note also that cases admitted in 1997/1998 but discharged after 30 June 1998 are not included. The variables extracted for analysis were date of admission (reported by financial year of admission), age at admission, sex, State/Territory of hospitalisation, length of stay (LOS), and diagnosis (principal and other diagnoses — up to 26 diagnoses were recorded for each admission). Data were extracted based on the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM). The first Australian version of ICD-9-CM was used for 1995/1996 data and the second version for 1996/1997 and 1997/1998 data. The codes used are given in each disease section. Eligible cases were those with the code of interest listed in the principal (the diagnosis chiefly responsible for the admission of the patient to hospital) or other diagnosis levels. The proportion of cases for which the diseases were coded as the principal diagnosis is reported for each disease. For hepatitis B, only principal diagnosis cases were included. Limited data were available for children less than one year old. For diseases where it was considered important to report on this age group, available data were used. State/Territory of residence was not available for all records, therefore State/Territory of hospitalisation was used. These would be the same for the majority of cases. Where the ICD-9-CM code for a disease specifies a complication directly resulting from the infection (eg, meningitis) the number and type of complications were reported.

### Deaths

Summary death data were obtained from the ABS Causes of Death Collection for those deaths coded with the ICD-9 codes of interest. The Causes of Death Collection classifies records based on the underlying cause of death. Data were available for deaths registered from 1993 to the end of 1997 (5 years). The variables extracted were disease, age at death, year death was reported, sex, State/Territory in which death was recorded, and number of deaths.

### Calculations

All rates were calculated using ABS mid-year estimated resident populations, and are presented as annual rates or average annual rates per 100 000 total population or population in age, sex or geographic subgroups, as appropriate. Average annual rates were calculated by dividing the total number of cases for the period of investigation by the sum of each year's population for the same period. For hospitalisation data, the mid-year population estimate for the first half of the financial year was used as the denominator, eg, the 1993 mid-year population estimate was used to calculate rates for 1993/1994. For notification data, the denominator population for each year included only jurisdictions notifying cases for that entire year. Averages were calculated for rates of notifications and hospitalisations, and for bed days per year. Medians and ranges, rather than averages, were used to describe the distribution of notifications and hospitalisations per month, and length of stay per admission, as these data were not normally distributed.

### Report structure for individual diseases

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

- secular trends — describing the pattern of notifications and hospitalisations over time, with reference to seasonality and outbreaks;
- severe morbidity and mortality — presents hospital bed days, length of stay, complications and mortality by age group in standard categories;
- age and sex distribution — presents data by age and sex groups as relevant for each particular disease;
- geographical distribution — case numbers and rates by State/Territory, as shown in Appendices 2 and 3, are discussed;
- comment — discussion of the data presented.

## Vaccination coverage data

During the review period of this report, there were two sources of data about national vaccination coverage: the Australian Bureau of Statistics' survey in 1995 and the Australian Childhood Immunisation Register (ACIR). The ACIR commenced in January 1996 and is administered by the Health Insurance Commission for the Department of Health and Aged Care. The ACIR records details, as supplied by vaccination providers, about the vaccination status of children aged less than 7 years. 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.[11] In this report we have described trends in vaccination coverage for all vaccines on the current childhood schedule, and make comparisons with the 1995 ABS national immunisation survey.[12,13] This survey sampled the Australian population using a stratified multistage cluster design and was conducted as a face-to-face interview relying on parental recall of vaccination status.[13] It is the most recent comprehensive benchmark available for comparison with the ACIR.[5]

# Notes on interpreting data

## *Vaccine preventable diseases data*

Comparisons between the notification, hospitalisation and death data bases should be made with caution as they differ in their purpose, reporting mechanisms and accuracy. To provide the most recent information available and to account for the varied reporting formats, different time periods have been reviewed for each data set. As there were no unique identifying codes to link records for the same individual across data bases and because of differences in the accuracy of each data base, it was not possible to analyse deaths and hospitalisations as a subset of notifications.

The rates presented here are crude rates and may be confounded by differences in the population structure (ie, age, ethnicity and population density) between jurisdictions. It is also important to note that jurisdictions with small populations may have high rates even with low absolute numbers of cases, so that a small change in numbers results in a large change in rates.

### Notification data

A major limitation of the notification data is that they only represent a proportion of the total cases occurring in the community. This proportion may vary between diseases, with infections diagnosed by a laboratory test more likely to be notified. Data accuracy may also vary between States/Territories due to the use of different surveillance methods. In addition, data accuracy may change over time as new diagnostic tests are introduced or surveillance practices change. In interpreting the geographical distribution of notification data it is of note that Western Australia, while receiving some laboratory notifications, is the only State/Territory that does not have legislation for mandatory laboratory notification.

### Hospitalisation data

Comparisons over time and between jurisdictions should be more valid for hospitalisation data than for notification data, because methods of collecting hospitalisation data are more uniform. However, some variation in hospital access, admission practices and record coding may occur between regions and over time. There are also limitations associated with the use of ICD-9-CM codes to identify cases. Hospital coding errors have been reported to occur at a frequency of at least 40%, and more commonly for diseases that the coder was less familiar with (eg, rare diseases) and for admissions with multiple diagnoses.[14] Assignation of codes is based on information in medical records, as recorded by clinicians, and there are no strict case definitions. For some diseases, such as *Haemophilus influenzae* type b infection, the ICD-9-CM code lacks specificity. This is in contrast to the more stringent case definitions used for notification data. It must also be noted that the hospitalisation data base contains a record for each admission, which means that there are separate records for each readmission or interhospital transfer. This is unlikely to have a major impact on case numbers for most diseases reviewed in this report, as they are acute illnesses. This limitation may, however, have impacted on the numbers of polio and acute hepatitis B hospitalisations. For hospitalisations where the code of interest was not the principal diagnosis, the code of interest will have been recorded as a co-morbidity (additional or secondary diagnosis), the relative importance of which cannot be gauged.

## *Death data*

The problems associated with using ICD-9-CM codes to select hospitalisations may also apply to the causes of death data held by the Australian Bureau of Statistics. However, unlike hospitalisations, only a single underlying cause of death was recorded until 1997. Hence some deaths for which an ICD-9 code for a vaccine preventable disease was recorded may be missed if this code was not recorded as the underlying cause of death. Also, the death data ICD-9 codes are limited to 4 digits, unlike hospitalisation ICD-9-CM codes. This was a problem for hepatitis B data, as the 5$^{th}$ digit level of coding is required to distinguish acute from chronic infection, so deaths from both acute and chronic hepatitis B infection were reported.

### *Vaccination coverage data*

Limitations of data available from both the ACIR and the 1995 ABS national immunisation survey must be considered when they are used to estimate vaccination coverage. The ABS survey relied on parental recall of vaccination status which may overestimate coverage.[5] On the other hand, the ABS survey was a random sample, representative of the Australian population, unlike the ACIR which is incomplete due to under-reporting by providers.[5] Hence vaccine coverage estimates calculated using ACIR data, even for children born after the ACIR commenced in 1996, should be considered minimum estimates due to under-reporting.[5,12] Another limitation of ACIR data is that records are only held for children aged up to 7 years. Also, coverage is calculated only for children registered on Medicare; however, by the age of 12 months it is estimated that over 98% of Australian children have been registered with Medicare.[11]

# 3 - Diseases preventable by vaccines on the routine childhood schedule 1998

## Diphtheria

Diphtheria is an acute bacterial infection caused by *Corynebacterium diphtheriae*. The major manifestation is a membranous inflammation of the upper respiratory tract. Damage to other organs including the myocardium, nervous system and kidneys, caused by the organism's exotoxin, may also occur.[15,16]

### *Case definitions*

#### Notifications

Isolation of toxigenic *Corynebacterium diphtheriae* and one of the following:

- pharyngitis *and/or* laryngitis (with or without membrane) *or* toxic (cardiac or neurological) symptoms.

#### Hospitalisations

The ICD-9-CM codes used to identify cases were: 032.0, faucial diphtheria; 032.1, nasopharyngeal diphtheria; 032.3, laryngeal diphtheria; 032.82, diphtheritic myocarditis.

#### Deaths

The ICD-9 code 032 (diphtheria) was used to identify deaths.

### *Notifications, hospitalisations and deaths*

There were no notifications of, or deaths due to, diphtheria between 1993 and 1998. However, during the review period 20 persons were recorded as being hospitalised: 6 were recorded as laryngeal, 2 as faucial, 5 as nasopharyngeal and 7 as myocardial diphtheria. Twelve patients were male. Numbers of hospitalisations declined annually from 7 in 1993/1994 to 6 in 1994/1995 and 1995/1996, 1 in 1996/1997 and 0 in 1997/1998. Ten of the 20 hospitalisations (50%) had diphtheria recorded as their principal diagnosis. Seven of the 10 cases with diphtheria as a secondary diagnosis had a principal diagnosis apparently unrelated to diphtheria. Adults aged at least 15 years accounted for most of the hospitalisations (65%) and numbers of hospital bed days (67%). Hospitalisations for diphtheria were recorded in all jurisdictions except the Australian Capital Territory (Appendix 3).

### *Comment*

The epidemiology of diphtheria in Australia is similar to that described for other industrialised countries. Diphtheria hospitalisations in Australia between 1993/1994 and 1997/1998 declined and were predominantly amongst adults. Numbers of diphtheria notifications have also been decreasing since mass vaccination programs became established in 1936 (Appendix 1), and the three most recently notified cases (identified over a 15-year period) have been adults. This is similar to the picture in the USA,[17] and many Western European countries.[18] Adult cases also predominated during the early and late phases of an outbreak in the Newly Independent States of the former Soviet Union in the 1990s.[19]

Without reviewing the hospital records, one cannot determine why there were 20 hospitalisations during the review period, even though there were no notifications. The discrepancy may be due to under-notification of cases with hospitalisations representing true cases of diphtheria. If this is so, notification data cannot be used to accurately measure the burden of diphtheria in Australia. On the other hand, numbers of hospitalisations may overestimate the number of cases because hospitalisation codes lack specificity. A hospitalisation code for diphtheria can be given to unconfirmed cases, while notification criteria for diphtheria are more strict, requiring laboratory confirmation of a toxigenic strain. It is also possible that some of the diphtheria hospitalisations reported here were coding errors. The decline in numbers of hospitalisations over the review period may be due to improved coding practices.

## *Haemophilus influenzae* type b (Hib) disease

*Haemophilus influenzae* is a fastidious Gram-negative bacterium which occurs in both encapsulated and unencapsulated forms. One encapsulated serotype, type b (Hib), caused 95% of infections due to *H. influenzae* in children less than five years of age before Hib vaccines became available.[20] Prior to the introduction of Hib vaccination the most common manifestation of invasive Hib disease was meningitis, with children aged less than 18 months most at risk. Survivors of Hib meningitis commonly had neurological sequelae such as deafness and intellectual impairment. Epiglottitis was the other major category of infection, most often occurring in children over the age of 18 months. Less common manifestations of Hib disease included cellulitis, septic arthritis, pneumonia, pericarditis, osteomyelitis and septicaemia.

### *Case definitions*

#### Notifications

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

- the isolation of *Haemophilus influenzae* type b (Hib) from blood *or*
- detection of Hib antigen (in a clinically compatible case) *or*
- detection of Gram-negative bacteria 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

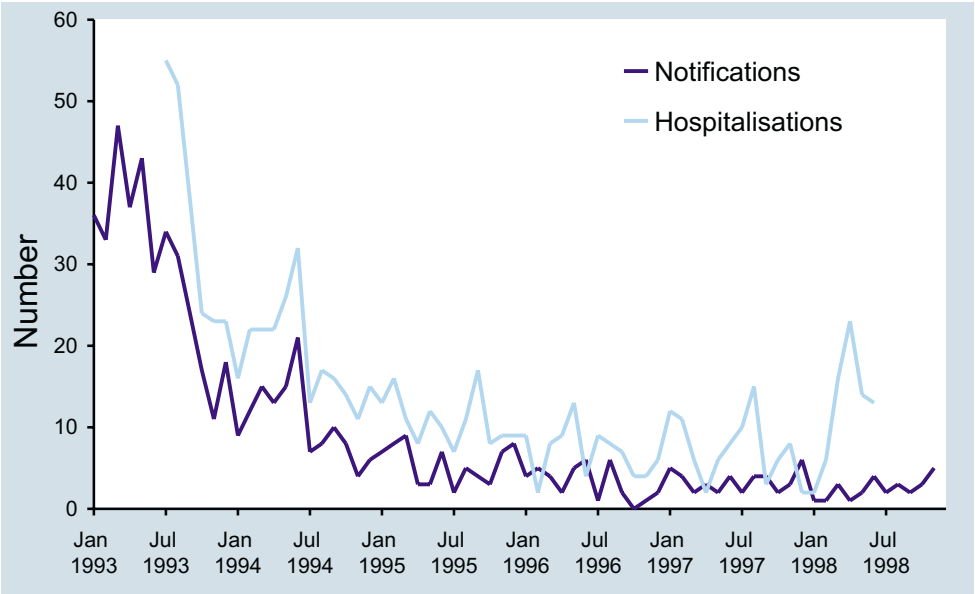
There were no ICD-9/ICD-9-CM codes which specified Hib as a causative organism. Prior to the introduction of routine Hib vaccination in late 1993 most cases of *H. influenzae* meningitis and acute epiglottitis were presumed to be caused by Hib. In the post-vaccination era this assumption may no longer be valid. Two ICD-9/ICD-9-CM codes were used to identify presumed Hib cases: 320.0, *Haemophilus influenzae* meningitis; and 464.3, acute epiglottitis. The ICD-9/ICD-9-CM codes 482.2 (*H. influenzae* pneumonia), 038.41 (*H. influenzae* septicaemia) and 041.5 (*H. influenzae* infection) were not included.

Only notification, hospitalisation and death data for children 0–14 years of age have been included in this report for two reasons. Firstly, Hib vaccines are targeted at reducing disease in children; secondly, the diagnostic codes selected are thought to be more specific for Hib infection in this age group.

### *Secular trends*

There were 634 Hib notifications (average annual notification rate 2.8 per 100,000) during the review period for children aged 0–14 years (Table 3). A median of 5 cases (range 0–44) were notified per month (Figure 1). There were 818 hospitalisations (average annual rate 4.2 per 100,000) for presumed Hib, a median of 11 cases (range 2–55) hospitalised per month. Numbers of notifications and hospitalisations were highest in 1993-1994, with 462 notifications (73%) and 441 hospitalisations (54%) recorded in these two years.

**Figure 1. H. influenzae type b notifications and presumed Hib hospitalisations* by month of onset or admission for children aged 0–14 years, Australia 1993–1998†**




* Hospitalisations for *H. influenzae* meningitis and acute epiglottitis.

† Notifications where the month of onset was between January 1993 and December 1998, hospitalisations where the month of admission was between 1 July 1993 and 30 June 1998.

## *Severe morbidity and mortality*

The number and rate of hospitalisations were higher than for notifications (Table 3). Four thousand and thirty-one hospital bed days (average of 806 days per year) were recorded for patients with presumed Hib. Children 0–4 years of age had a longer median length of stay and a higher mortality than older children. For 728 (89%) of the hospitalisations *H. influenzae* meningitis or epiglottitis was the principal diagnosis. Meningitis was the cause of 13 (87%) deaths and 327 (40%) hospitalisations.

**Table 3. *Haemophilus influenzae* type b notifications, presumed Hib hospitalisations* and deaths for children 0–14 years of age, Australia 1993–1998†**

| Age group (years) | Notifications 1993-1998 | | Hospitalisations July 1993-June 1998 | | LOS‡ per admission (days) | Deaths 1993-1997 | |
|---|---|---|---|---|---|---|---|
| | No. | Rate§ | Total (^) | Rate§ (^) | Median | No. | Rate§ |
| 0-4 | 535 | 7.0 | 594 (528) | 9.2 (8.2) | 4.0 | 13 | 0.2 |
| 5-14 | 99 | 0.6 | 224 (200) | 1.7 (1.5) | 1.5 | 2 | 0.0 |
| 0-14 | 634 | 2.8 | 818 (728) | 4.2 (3.7) | 3.0 | 15 | 0.1 |

* Hospitalisations for *H. influenzae* meningitis and acute epiglottitis.

† Notifications where the month of onset was between January 1993 and December 1998; hospitalisations where the month of admission was between 1 July 1993 and 30 June 1998; deaths where the date of death was recorded between 1993 and 1997.

‡ LOS = Length of stay in hospital.

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

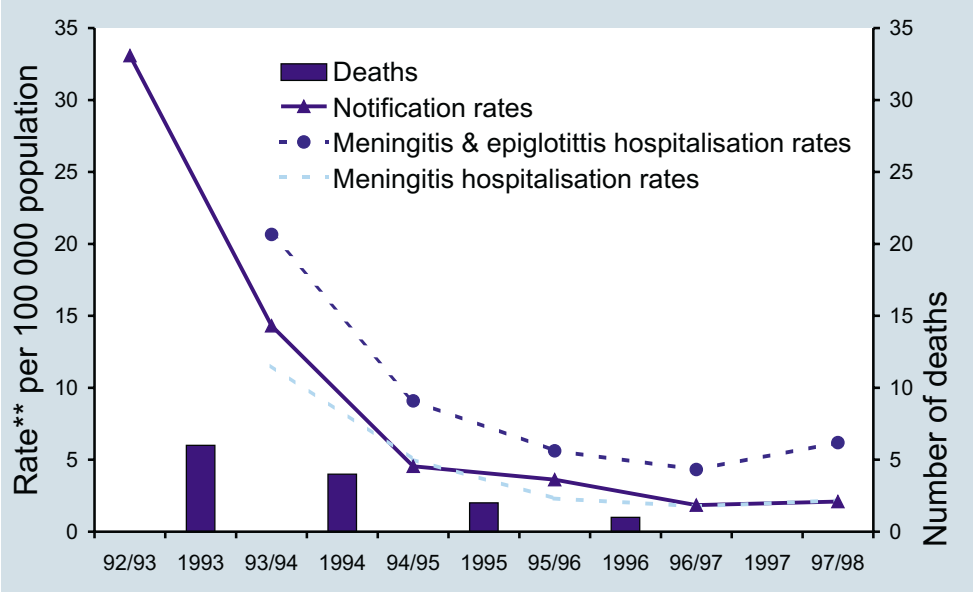
^ Principal diagnosis.

## Age and sex

All measures of Hib disease (notifications, hospitalisations and deaths) were higher in males with male:female ratios of 1.2:1, 1.4:1 and 4:1 respectively. Of children 0–14 years of age, those aged 0–4 years accounted for 84% of notifications, 61% (299) of epiglottitis hospitalisations and 90% (295) of meningitis hospitalisations and 86% of deaths.

As morbidity and mortality was concentrated in children aged 0–4 years, the following analysis is restricted to this age group. Notification data for the financial year 1992/1993 were also included in this section to demonstrate more clearly the impact of the introduction of Hib vaccination in mid 1993 (Appendix 4.) All measures of invasive Hib disease in children aged 0–4 years fell over the period of investigation (Figure 2). Notification rates fell from 33.1 per 100,000 in 1992/1993 to an average annual rate of 2.5 per 100,000 in 1995/1998. Meningitis hospitalisation rates fell from an average annual rate of 8.3 per 100,000 for the period July 1993–June1995 to 2.1 per 100,000 in July 1995–June 1998; epiglottitis rates fell from 6.6 per 100,000 to 3.3 per 100,000 over the same period. The ratio of meningitis to epiglottitis hospitalisations fell from 3.1:1 in 1993/1994 to 0.5:1 in 1997/1998. The number of deaths fell during the review period from 6 in 1993 to 0 in 1997.

**Figure 2. Hib notifications, presumed* Hib hospitalisations and deaths of children aged 0–4 years, Australia July 1992–June 1998†**




* 'Presumed' includes all *H influenzae* meningitis and acute epiglottitis.

† Notifications with onset dates between July 1992 and June 1998; hospitalisations with admission dates between July 1993 and June 1998; deaths reported between 1993 and 1997.

** Age-specific notification and hospitalisation rates.

## Geographical variation

The Northern Territory had an average annual notification rate at least twice as high as any other jurisdiction (Appendix 2). Average annual hospitalisation rates were more uniform in all States/Territories and were below 1.4 per 100,000 (Appendix 3).

## Comment

Vaccines against Hib first became available in the private sector for children aged 18 months and over in April 1992 (Appendix 4, Table 19). Hib vaccines were publicly funded for infants aged 2 months in April 1993 and for catch-up vaccinations to the age of 5 years in July 1993. The impact of Hib vaccination

has been striking. Morbidity (as estimated by hospitalisation data) and mortality for children 0–4 years old in 1998 were 67% and 100% lower respectively than in 1993. Prior to the introduction of Hib vaccine in 1993 an estimated 15 deaths from *Haemophilus* meningitis or epiglottitis occurred annually in Australian children less than 5 years of age.[21] The 13 deaths recorded in 1993–1997 represented an 83% reduction from the 75 predicted for this time period from pre-immunisation data.

Trends in notification and hospitalisation rates were similar. However, the number of hospitalisations was consistently higher than the number of notifications. Notifications probably underestimate Hib cases (especially cases of epiglottitis, which are often diagnosed clinically) while hospitalisations probably overestimate them. This is because the hospitalisation codes *(a)* lack specificity (as non-b cases may be included) and *(b)* may count cases twice if the patient is transferred to another hospital (more frequent for epiglottitis). Overall it is likely that notifications, because they are usually linked to laboratory identification of Hib, more closely represent the true incidence of Hib disease than hospitalisations.

Since the introduction of Hib vaccination, the assumption that almost all hospitalisations for acute epiglottitis and *H. influenzae* meningitis are due to Hib infection may no longer hold true. This is especially the case for epiglottitis, which may be due to organisms other than *H. influenzae*. In 1993/1994 only 28% of epiglottitis hospitalisations in children aged less than 5 years were also coded as having an *H. influenzae* infection; this fell to 12% in 1997–1998.

Meningitis due to *H. influenzae*, although not exclusively due to capsular type b, is a more reliable indicator of the impact of vaccination, especially in cases under five years of age. The incidence of *H. influenzae* meningitis hospitalisations for children less than 5 years of age prior to the introduction of Hib vaccine (29.1 per 100,000 per year)[22] was far greater than in the post-vaccine period 1995–1998 (2.1 per 100,000 per year).

# 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 (SSPE) occurs very rarely as a late sequel.[16]

### *Case definitions*

#### Notifications

a) 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**

b) Demonstration of measles specific IgM antibody

**or**

c) A fourfold or greater change in measles antibody titre between acute and convalescent phase sera obtained at least 2 weeks apart, with tests preferably conducted at the same laboratory

**or**

d) Isolation of measles virus from a clinical specimen

**or**

e) A clinically compatible case epidemiologically related to another case.

#### Hospitalisations and deaths

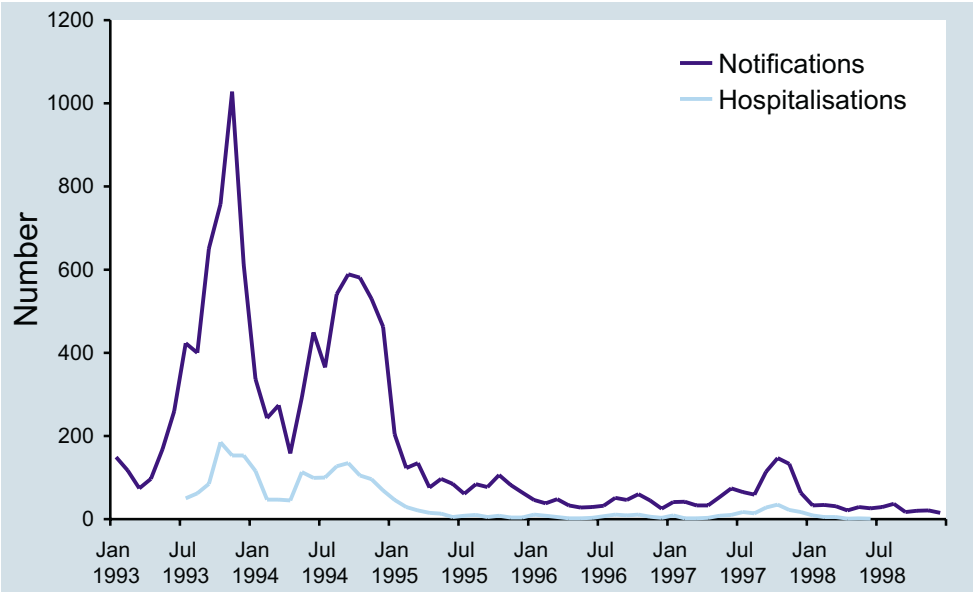
The ICD-9/ICD-9-CM code 055 (measles) was used to identify hospitalisations and deaths. SSPE (code 046.2) was not included in these analyses.

## *Secular trends*

Between 1993 and 1998 there were 12,404 notified cases of measles, an average annual notification rate of 11.4 per 100,000 (Table 4). The rate fell from 27.0 per 100,000 in 1994 to less than 5 per 100,000 between 1996 and 1998 (Appendix 2). The number of notifications peaked at 1028 in November 1993 with a second smaller peak of 589 cases in September the following year (Figure 3). The lowest number of notifications occurred in the last 6 months of the review period (July to December 1998). The median number of notifications per month was 75 (range 15–1028). However, between 1996 and 1998 (with the exception of a small increase in notifications at the end of 1997) there were fewer than 75 reported cases per month.

In the five years from 1993/1994 to 1997/1998, there were 2223 measles hospitalisations, an average annual hospitalisation rate of 2.5 per 100,000 (Table 4). Like notifications, annual hospitalisation rates peaked in 1993/1994 (6.5 per 100,000) and 1994/1995 (4.3 per 100,000), falling to less than 1 per 100,000 from 1995/1996 onwards (Appendix 3). The median number of hospitalisations per month was 11 (range 1–185).

**Figure 3. Measles notifications and hospitalisations by month of onset or admission, Australia 1993–1998***




* Notifications where the month of onset was between January 1993 and December 1998, hospitalisations where the month of admission was between 1 July 1993 and 30 June 1998.

## *Severe morbidity and mortality*

Hospital admissions for measles accounted for 8379 hospital bed days (average 1676 days per year), with a median length of stay of 2 days (Table 4). Of the 2223 hospitalisations, 1856 (83%) had measles recorded as their principal diagnosis. Complications arising from measles infection were recorded for 438 (20%) admissions. Of all measles hospitalisations 159 (7%) were coded as pneumonia, 77 (3%) as otitis media, 31 (1%) as keratoconjunctivitis and 29 (1%) as encephalitis. Multiple complications were recorded for 13 (0.6%) admissions.

**Table 4. Measles notifications, hospitalisations and deaths by age group, Australia 1993–1998***

| Age group (years) | Notifications 1993-1998 | | Hospitalisations July 1993-June 1998 | | LOS† per admission (days) | Deaths 1993-1997 | |
|---|---|---|---|---|---|---|---|
| | No. | Rate‡ | Total (^) | Rate‡ (^) | Median | No. | Rate‡ |
| 0-4 | 3,522 | 45.4 | 944 (754) | 14.6 (11.6) | 3 | 2 | 0.0 |
| 5-14 | 4,953 | 31.8 | 630 (543) | 4.9 (4.2) | 2 | 1 | 0.0 |
| 15-24 | 2,965 | 18.3 | 492 (434) | 3.6 (3.2) | 2 | 2 | 0.0 |
| 25-59 | 780 | 1.5 | 142 (117) | 0.3 (0.3) | 3 | 2 | 0.0 |
| 60+ | 34 | 0.2 | 15 (8) | 0.1 (0.1) | 4 | 0 | - |
| All ages | 12,404§ | 11.4 | 2,223 (1,856) | 2.5 (2.1) | 2 | 7 | 0.0 |

* Notifications where the month of onset was between January 1993 and December 1998; hospitalisations where the month of admission was between 1 July 1993 and 30 June 1998; deaths where the date of death was recorded between 1993 and 1997.

† LOS = length of stay in hospital.

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

§ Includes cases with unknown ages.

^ Principal diagnosis.

There were 7 deaths from measles between 1993 and 1997; 1 in 1993, 3 in 1994 and 3 in 1995. Deaths were recorded for all age groups except 60 years and above. Four of the deaths from measles occurred in Queensland and three in Victoria.

### *Age and sex distribution*

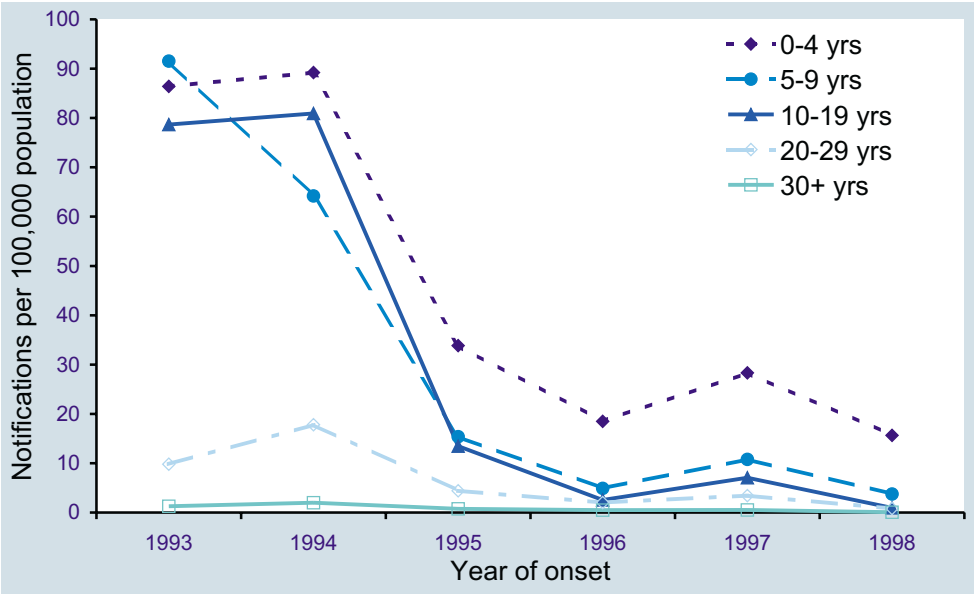
Notification and hospitalisation rates were highest for children aged 0–4 years (average annual rates 45.4 and 14.6 per 100,000 respectively). Within this age group, notification and hospitalisation rates were highest in those less than 2 years of age (72.6 and 19.1 per 100,000 respectively) (South Australia and Queensland provided hospitalisation data only by 5-year age groups, so were excluded from this calculation). Whilst the notification rate for 0–4 year olds fell from 86.4 per 100,000 in 1993 to 15.6 per 100,000 in 1998 (Figure 4a), the proportion of notifications from this age group increased from 24% to 66% over the same period. Hospitalisation rates declined for most age groups after 1994/1995, notably for 0–4 year olds (Figure 4b). Children in the 0-4 year age group accounted for proportionally more hospitalisations (42%) than notifications (29%).

Individuals aged 5–19 years accounted for 58% of notifications and 43% of hospitalisations. Children aged 10–14 years had higher notification rates than those in the 5–9 and 15–19 year age groups in 1993 and 1994 but not after 1994. The proportion of notifications from the 10–14 year age group fell from 25% in 1993 to 3% in 1998, while the proportion from the 5–9 year age group showed no continuing trend over the review period, but ranged between 13% and 25%.

Adults aged 20–29 years accounted for 9% of all notifications and 10% of hospitalisations. Notification rates in this age group increased from 9.8 per 100,000 in 1993 to 17.8 per 100,000 in 1994. From 1995 onwards, notification rates remained below 5 per 100,000 and hospitalisation rates below 1 per 100,000.

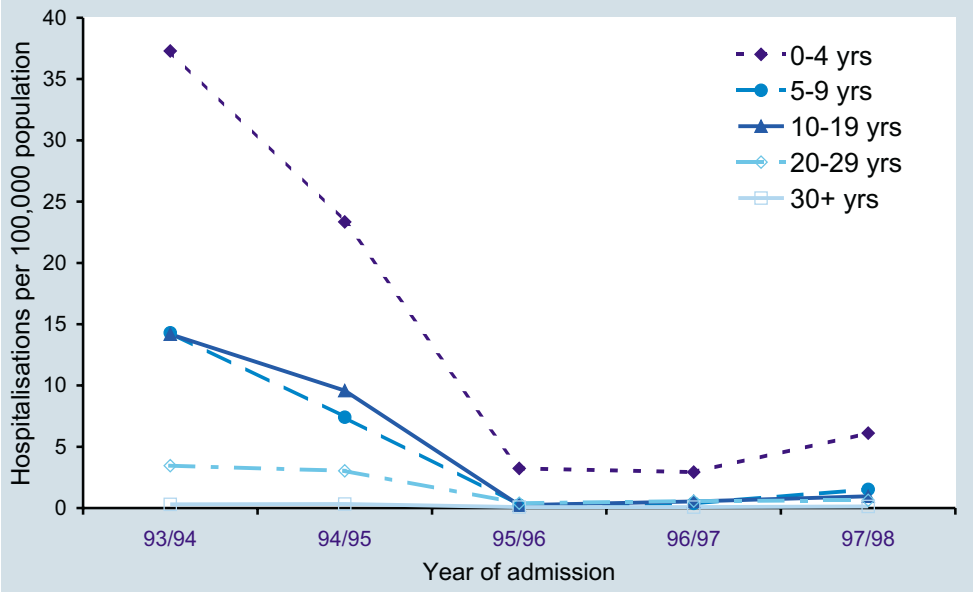
There were similar numbers of notifications and hospitalisations for males and females both overall and for each year reviewed. Of the 7 deaths from measles, 3 were male and 4 were female.

**Figure 4a. Measles notification rates for cases by age group and year of onset, Australia 1993–1998***




* Notifications where the month of onset was between January 1993 and December 1998

**Figure 4b. Measles hospitalisation rates for cases by age group and year of admission, Australia 1993–1998***




* Hospitalisations where the month of admission was between 1 July 1993 and 30 June 1998.

## *Geographical distribution*

There were considerable differences between States/Territories over the review period (Appendices 2 and 3). Overall, notification and hospitalisation rates were highest in the Northern Territory (51.7 and 9.5 per 100,000 respectively) and lowest in South Australia, Western Australia and Victoria, all of which had notification rates of less than 4 per 100,000 and hospitalisation rates of less than 0.5 per 100,000. In the epidemic years of 1993–1994, there were even greater differences between jurisdictions. Queensland, the Northern Territory, New South Wales, the Australian Capital Territory and Tasmania experienced peak annual hospitalisation and notification rates during the epidemic years that were at least five times higher than those for South Australia, Western Australia and Victoria.

Although nationally numbers of notifications and hospitalisations peaked in 1993, some States/Territories recorded higher numbers in 1994. In most jurisdictions, hospitalisation rates followed the same trend as notification rates with all States/Territories except Queensland, New South Wales and the Australian Capital Territory (where there were small outbreaks in 1997/1998) showing a progressive fall in numbers of notifications and hospitalisations over the review period. However, in all jurisdictions, rates in 1997/1998 were low compared with historical peaks (Appendix 1).

## *Comment*

The review period was dominated by high numbers of measles notifications and hospitalisations in 1993 and 1994, with numbers considerably lower in later years. There was also substantial variation in measles incidence between regions. This could not explained by differences in recent measles vaccination coverage, as the ABS surveys in 1989 and 1995 showed coverage of approximately 86%[23] and 92%[13] respectively across all jurisdictions. However, in an earlier ABS survey in 1983,[24] measles vaccination coverage differed between jurisdictions. The States with high measles vaccination coverage estimates for 2–5 year olds in 1983 (South Australia, Victoria and Western Australia) corresponded to the jurisdictions with the lowest rates of measles ten years later, in 1993–1994.

During the review period age-specific notification and hospitalisation rates were highest in the 0–4 year age group, specifically in the less than 2 year age group, followed by the 5–19 year age group. The age

distribution of measles cases in Australia was similar to that of other developed countries with relatively high vaccination coverage, where outbreaks have occurred amongst highly vaccinated populations of school children and unvaccinated preschoolers.[25] Although many of the notifications in infants were likely not to be true measles,[26] hospitalisation data indicated that the incidence of measles in this group was high. Delayed vaccination of infants aged less than 2 years may be one explanation for the high rates of measles in this age group. A national serological survey in 1998, prior to the Australian Measles Control Campaign (MCC), showed that only 70% of infants aged 12 to 23 months were seropositive for measles IgG compared with 82% of children aged 2–5 years.[27]

The measles epidemic of 1993–1994 prompted the introduction of a second dose of measles-mumps-rubella (MMR) vaccine for adolescents aged 10–16 years. Prior to this time, children received only a single dose of vaccine at 12 months of age. Since the introduction of a two-dose policy in 1994, notifications for all age groups have declined dramatically. The decrease was most marked for children aged 10–14 years, reflecting the impact of the second dose on this age group.

The low notification rates for measles in July–December 1998 may in part be due to the MCC which was conducted during this time.[27] The MCC involved vaccination of all 5–12 years olds in a mass school-based program and lowering the age for the second dose of MMR vaccine from 10–16 years to 4–5 years. In addition, parents of preschool aged children due or overdue for the first dose of MMR were sent a reminder letter. The impact of the MCC will be better assessed when surveillance data for the period following the Campaign are available.

Although notification rates among adults remained low over the review period, it is likely that older individuals will account for an increasing proportion of cases as vaccination coverage continues to improve among infants and children.[28] Young adults aged between 18 and 30 years (too young to have been extensively exposed to circulating wild virus and too old to have been included in the two-dose schedule introduced in 1994), will be most at risk of measles in the future.[29] For this reason, young Australian adults, particularly those attending tertiary institutions or planning travel to areas where measles remains endemic, are currently being encouraged to have a second dose of MMR.[30]

# Mumps

Mumps is an acute viral disease caused by a paramyxovirus. The disease is characterised by fever, swelling and tenderness of one or more salivary glands, most commonly the parotid glands. The central nervous system is frequently involved, usually without sequelae.[16]

### *Case definitions*

#### Notifications

a) Isolation of mumps virus from a clinical specimen

**or**

b) Significant rise in mumps antibody level by any standard serological assay, except following vaccination

**or**

c) A clinically compatible illness (unilateral or bilateral swelling of the parotid or other salivary glands lasting 2 days or more without other apparent cause).

Note: In NSW only laboratory confirmed cases [(a) or (b)] are notifiable.

#### Hospitalisations and deaths

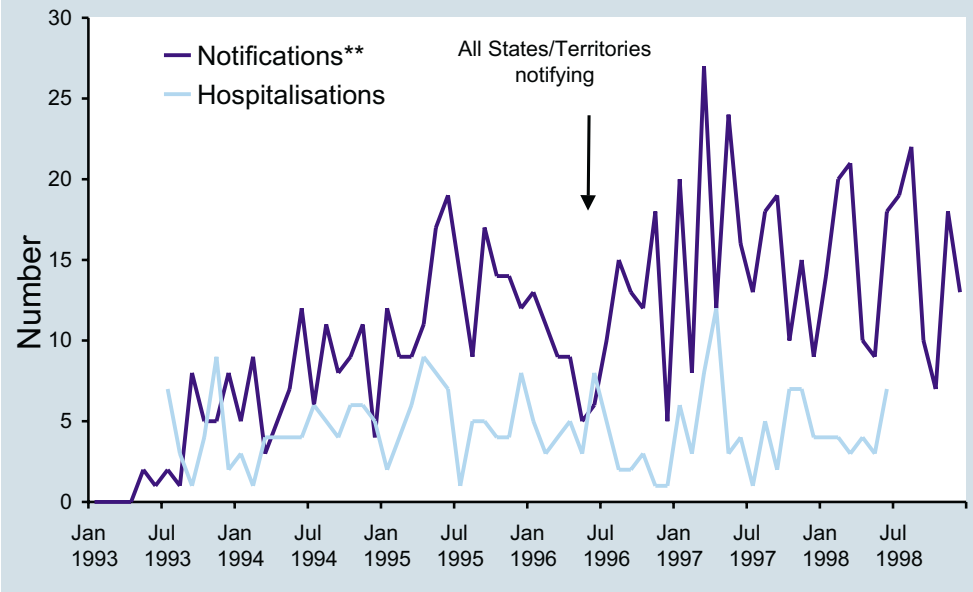
The ICD-9/ICD-9-CM code 072 (mumps) was used to identify cases and deaths.

## *Secular trends*

During the six years from 1993 to 1998 there were 760 notifications of mumps (an average annual notification rate of 0.8 per 100,000) (Table 5). Numbers of notified cases generally increased over the review period (Figure 5). Overall, notification rates were lower in 1993–1994 compared with later years (Appendix 2). Monthly numbers of notifications varied considerably, with a median of 10 (range 0–27) notifications per month. This variation did not appear to be seasonal.

From July 1993 to June 1998 there were 270 hospitalisations coded as due to mumps, an average annual hospitalisation rate of 0.3 per 100,000 (Table 5). Annual numbers and rates of hospitalisations remained fairly constant (Appendix 3), in contrast to the upward trend for notifications. However, like the notification data, numbers of hospitalisations peaked in the first half of 1997 and there was considerable monthly variation (median 4, range 1–12 per month).

**Figure 5. Mumps notifications and hospitalisations by month of onset or admission, Australia 1993–1998***




* Notifications where the month of onset was between January 1993 and December 1998; hospitalisations where the month of admission was between 1 July 1993 and 30 June 1998.

** Note that the number of jurisdictions notifying mumps increased over the review period; Only the ACT, NSW and Victoria notified for the entire review period.

**Table 5. Mumps notifications, hospitalisations and deaths by age group, Australia 1993–1998***

| Age group (years) | Notifications 1993-1998 | | Hospitalisations July 1993-June 1998 | | LOS† per admission (days) | Deaths 1993-1997 | |
|---|---|---|---|---|---|---|---|
| | No. | Rate‡ | Total (^) | Rate‡ (^) | Median | No. | Rate‡ |
| 0-4 | 143 | 2.2 | 44 (34) | 0.7 (0.5) | 2 | 0 | - |
| 5-14 | 242 | 1.9 | 53 (46) | 0.4 (0.4) | 2 | 0 | - |
| 15-24 | 109 | 0.8 | 31 (20) | 0.2 (0.1) | 2 | 0 | - |
| 25-59 | 183 | 0.4 | 100 (67) | 0.2 (0.2) | 3 | 1 | 0.0 |
| 60+ | 33 | 0.2 | 42 (23) | 0.3 (0.2) | 4 | 1 | 0.0 |
| All ages | 760§ | 0.8 | 270 (190) | 0.3 (0.2) | 2 | 2 | 0.0 |

* Notifications where the month of onset was between January 1993 and December 1998; hospitalisations where the month of admission was between 1 July 1993 and 30 June 1998; deaths where the date of death was recorded between 1993 and 1997.

† LOS = length of stay in hospital.

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

§ Includes cases with unknown ages.

^ Principal diagnosis.

## *Severe morbidity and mortality*

One thousand one hundred and sixty eight hospital bed days (average 234 per year) were recorded for patients with the ICD-9-CM code for mumps (Table 5). Of the 270 admissions, 190 (70%) had mumps recorded as their principal diagnosis (average annual rate 0.2 per 100,000). Complications arising from mumps infection were recorded for 62 admissions (26%). Of all mumps hospitalisations, 25 (9%) were coded as orchitis and 22 (8%) were coded as neurological complications (12 encephalitis, 9 meningitis, 1 polyneuropathy). Eight admissions (3%) had multiple complications. The median length of stay (LOS) in

hospital was 2 days, but adults aged at least 25 years had a longer median LOS compared with younger age groups (Table 5). Adults aged 25 years and over accounted for the greatest number of hospitalisations (53%) and hospital bed days (73%). However, hospitalisation rates by age group were highest in children.

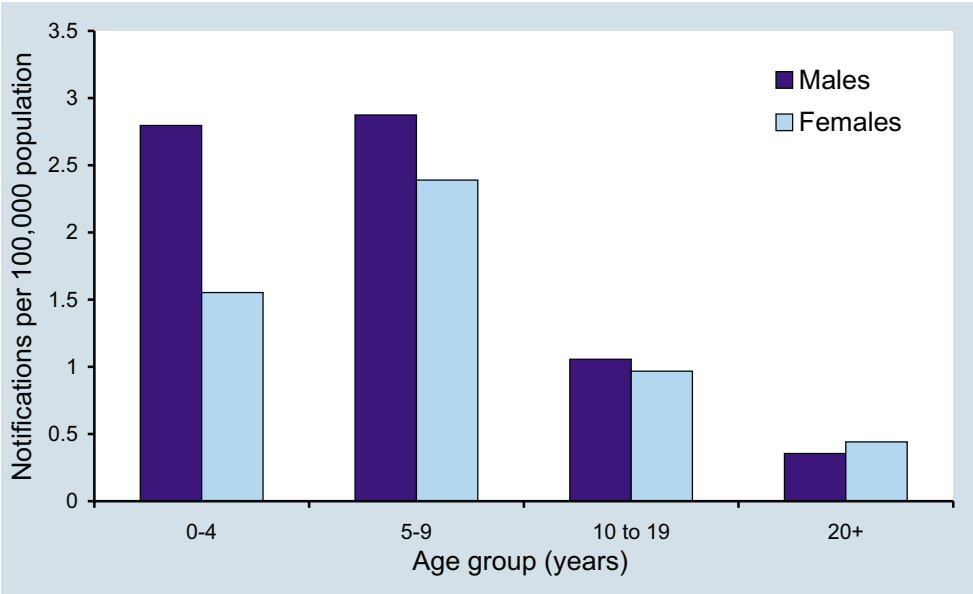
Two deaths were recorded as due to mumps, both in adults aged at least 25 years. One death was recorded in 1994 and one in 1995.

## *Age and sex distribution*

Notification rates were highest in the 5–9 year age group (average annual rate 2.6 per 100,000), while hospitalisation rates were highest for children aged 0–4 years (average annual rate 0.7 per 100,000) (Figure 6a and Figure 6b). Hospitalisations were more evenly spread across most ages than notifications; 44% of notifications were aged less than 10 years compared with only 26% of hospitalisations.

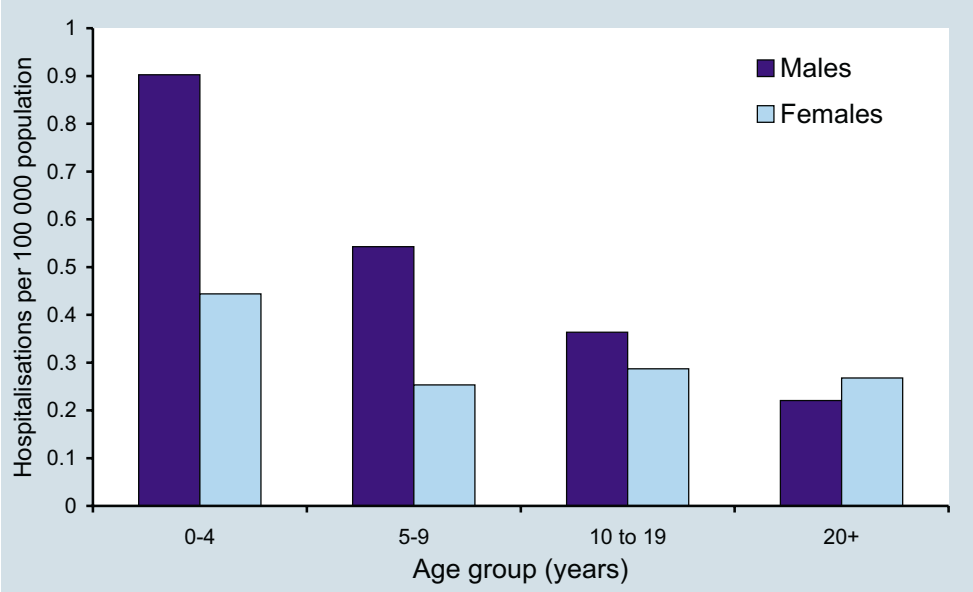
Although the overall male:female ratio was close to equality for both notifications and hospitalisations, this conceals differences by age group. Males were predominant in the age groups under 20 years, while females predominated in the 20 years and over age group. The male:female ratio decreased over time (notifications 1.6:1 in 1993 and 1.0:1 in 1998, hospitalisations 2.1:1 in 1993/1994 and 0.9:1 in 1996/1997). Despite this decrease, in the most recent year reviewed males still predominated in the younger, more frequently reported age groups.

**Figure 6a. Mumps notification rates by age group and sex, Australia, 1993–1998***




* Notifications where the month of onset was between January 1993 and December 1998

**Figure 6b. Mumps hospitalisation rates by age group and sex, Australia, 1993–1998***




* Hospitalisations where the month of admission was between 1 July 1993 and 30 June 1998

## *Geographical distribution*

For each State/Territory notification and hospitalisation rates varied over time (Appendices 2 and 3). However for most States/Territories, the numbers of notifications/hospitalisations for each year were too small to identify trends, especially in hospitalisation rates.

## *Comment*

The increased number of mumps notifications was mostly due to the increased number of States and Territories notifying the disease, however notification rates (adjusted for States/Territories not reporting) also rose over time. The increased notification rate in Australia may in part be explained by improved reporting within each jurisdiction. This upward notification trend is contrary to that seen in the USA, the UK and other European countries such as Finland and Sweden.[15] However, notification rates in the UK in 1995 (17 per 100,000)[15] were much higher than in Australia. This may reflect the introduction of mumps vaccine to the UK schedule in 1988, six years later than in Australia.[31]

The high proportion of notifications in 5–9 year olds was similar to that seen in the pre-vaccine era in the USA and UK.[15] The higher hospitalisation rates in 0–4 year olds compared with 5–9 year olds may be because the disease is more severe in younger age groups. There may also be a notification bias towards 5–9 year olds who can have a more typical disease picture.[31]

Although hospitalisation rates by age group were highest in children, most hospitalisations were in adults, who also tended to stay in hospital for longer. The high proportion of total mumps hospitalisations recorded in adults could be related to misclassification (coding errors), a real phenomenon, or both. Misclassification of other diseases as mumps, especially in the elderly, is suggested by the higher proportion of secondary diagnoses of mumps in older age groups. Coding discrepancies have been found to be more common for secondary diagnoses.[14] On the other hand, there may be cohorts of non-immune adults, who were born before the introduction of routine mumps vaccination in 1982. Adults are prone to more severe disease than children, and are therefore more likely to be hospitalised.

# Pertussis

Pertussis (whooping cough) is an acute illness, caused by the *Bordetella pertussis* bacterium, involving the respiratory tract. The 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 and are followed by a characteristic crowing or high-pitched inspiratory whoop. Infants less than 6 months old, adolescents and adults often have fewer classical symptoms without paroxysms or whoop.[16]

### *Case definitions*

#### Notifications

a) Isolation of *B. pertussis* from a clinical specimen

**or**

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

**or**

c) 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**

d) An illness characterised by a cough lasting at least 2 weeks in a patient who is epidemiologically linked to a laboratory confirmed case.

#### Hospitalisations and deaths

The ICD-9/ICD-9-CM code 033 (whooping cough) was used to identify hospitalisations and deaths. This code included codes for *B. pertussis* (033.0) and *B. parapertussis* (033.1) and whooping cough with no organism mentioned.

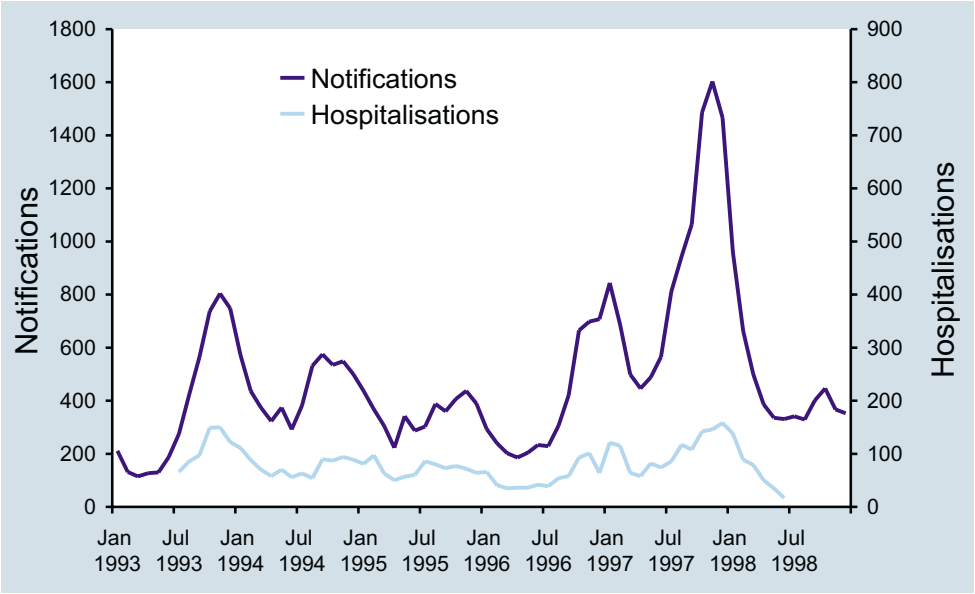
## *Secular trends*

There were 34,848 notifications of pertussis received by the NNDSS with dates of onset between 1993 and 1998 (average annual rate 31.9 per 100,000) (Table 6). A median of 396 cases was notified each month (range 115 to 1,603) (Figure 7). The lowest rate was 23.5 in 1995 and the highest was 58.9 in 1997 (Appendix 2). Pertussis notifications peaked in 1997 when 10,907 cases were notified, approximately double the number in previous and subsequent years.

There were 4804 hospital admissions coded as pertussis during the study period (Table 6). The average annual national hospitalisation rate was 5.3 per 100,000; 1995/1996 had the lowest admission rate (3.9 per 100,000), the highest rates occurred in 1993/1994 and 1997/1998 (6.4 and 6.3 per 100,000 respectively) (Appendix 3).

A clear seasonal pattern was apparent with the highest number of notifications in the Spring and Summer months between August and February each year. Notifications followed a similar pattern to hospitalisations (Figure 7).

**Figure 7. Pertussis notifications and hospitalisations by month of onset or admission, Australia 1993–1998***




Note varying scales between notifications and hospitalisations.

* Notifications where the month of onset was between January 1993 and December 1998; hospitalisations where the month of admission was between 1 July 1993 and 30 June 1998.

## *Severe morbidity and mortality*

Nineteen thousand five hundred and eighty-two hospital bed days (average 5263 days per year) were recorded for patients with an ICD-9-CM code for pertussis. Four thousand and fourteen (84%) had a principal diagnosis of pertussis (average annual rate 4.4 per 100,000) (Table 6). *B. pertussis* (ICD-9-CM code 033.0) was recorded for 1429 (30%) hospitalisations and was the principal diagnosis for 1210 (25%). *B. parapertussis* was recorded for 55 hospitalisations, and was the principal diagnosis for 25. The remaining cases were coded as whooping cough. The median length of stay per admission was 3 days.

**Table 6. Pertussis notifications, hospitalisations and deaths by age group, Australia 1993–1998***

| Age group (years) | Notifications 1993-1998 | | Hospitalisations July 1993-June 1998 | | LOS† per admission (days) | Deaths 1993-1997 | |
|---|---|---|---|---|---|---|---|
| | No. | Rate‡ | Total (^) | Rate‡ (^) | Median | No. | Rate‡ |
| 0-4 | 4482 | 57.7 | 3427 (3009) | 52.9 (46.4) | 3 | 9 | 0.1 |
| 5-14 | 13,531 | 86.9 | 741 (608) | 5.7 (4.7) | 2 | 0 | - |
| 15-24 | 3771 | 23.3 | 108 (68) | 0.8 (0.5) | 3 | 0 | - |
| 25-59 | 10,238 | 19.6 | 345 (220) | 0.8 (0.5) | 4 | 0 | - |
| 60+ | 2032 | 11.7 | 183 (109) | 1.3 (0.8) | 7 | 0 | - |
| All ages | 34,848§ | 31.9 | 4,804 (4014) | 5.3 (4.4) | 3 | 9 | 0.0 |

* Notifications where the month of onset was between January 1993 and December 1998; hospitalisations where the month of admission was between 1 July 1993 and 30 June 1998; deaths where the date of death was recorded between 1993 and 1997.

† LOS = length of stay in hospital.

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

§ Includes cases with unknown ages.

^ Principal diagnosis.

Between 1993 and 1997 there were nine deaths attributed to pertussis: all were less than 12 months of age; six occurred in 1997. Five of the deaths were in New South Wales, two in Queensland, and one each in Victoria and Western Australia.

### *Age and sex distribution*

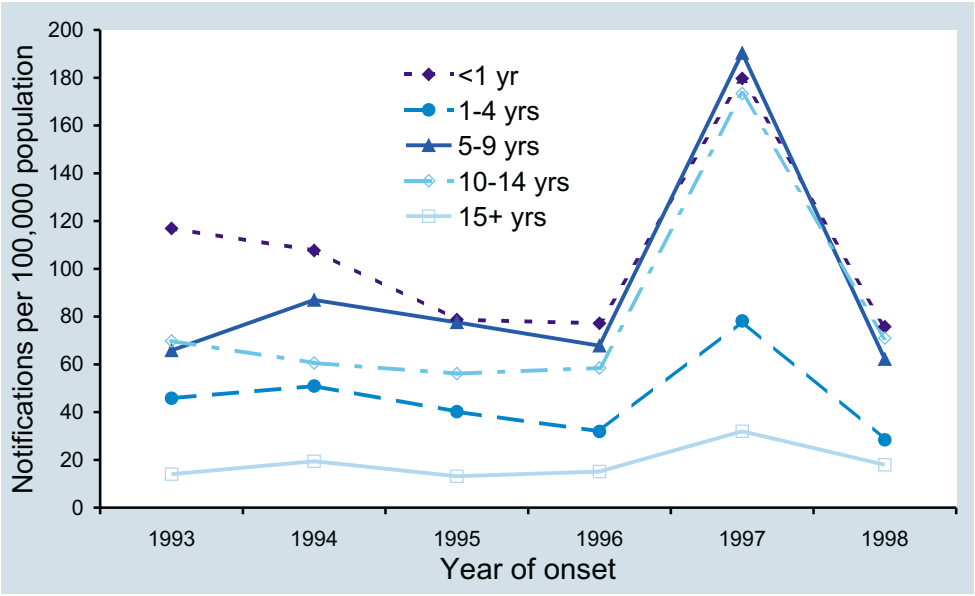
The highest notification rate overall was in infants aged less than one year (average annual rate 105.9 per 100,000) (Figure 8a). Of all notifications, infants aged less than one year accounted for 5%, and children aged less than five years accounted for 13%. Children aged less than five years accounted for 71% of hospitalisations (average annual rate 52.9 per 100,000) (Figure 8b). For jurisdictions where data were available (South Australia and Queensland provided hospitalisation data only by 5-year age groups, so were excluded from this calculation) the number of hospitalised infants aged less than one year (1,965) was 1.6 times greater than the number notified (1,208) between 1993/1994 and 1997/1998.

School aged children (5–9 and 10–14 years) accounted for 40% of all notifications (compared with 15% of all hospital admissions) and had higher notification rates than any other five-year age groups. From 1996 onwards, there was little difference between the notification rates among 5–9 year olds and 10–14 year olds. This contrasts with 1994 and 1995, when the rates for 5–9 year olds were approximately 40% higher than the rates for 10–14 year olds. In addition, the distribution by year of age within the 5–9 year age group shifted upwards. In 1993 and 1994 five and six year olds comprised 43% of notifications in the 5–9 year age group, compared with only 28% in 1995–1998.

Persons aged 15 years or more (adults) accounted for 46% of notifications. The median age of pertussis notifications was between 13 and 15 years until 1998 when it increased to 21 years. Although less apparent than the rise in notification rates for other age groups, the notification rate in adults rose from 15.1 per 100,000 in 1996 to 32.0 per 100,000 in 1997.

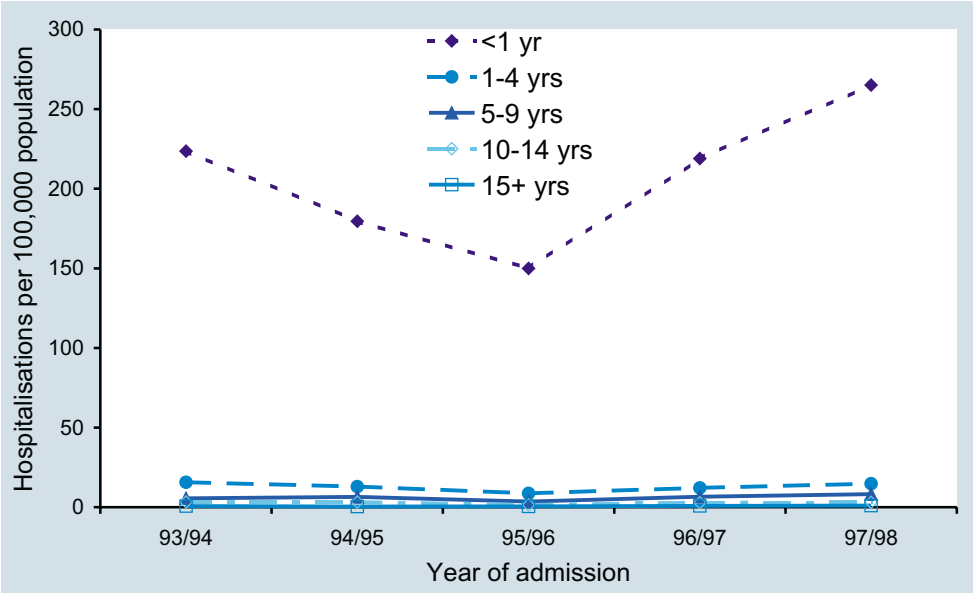
The overall male:female ratio was 1:1.2 for notifications and 1:1.1 for hospitalisations. However, there were 7 male deaths compared with only 2 female deaths.

**Figure 8a. Pertussis notification rates by age group, Australia, 1993–1998***




* Notifications where onset was between 1 January 1993 and 31 December 1998

**Figure 8b. Pertussis hospitalisation rates by age group, Australia, 1993–1998***




* Hospitalisations where admission was between 1 July 1993 and 30 June 1998.

## *Geographical distribution*

There was a substantial variation in notification (Appendix 2) and hospitalisation (Appendix 3) rates between regions and years. Jurisdictions with the highest notification rates also had the highest hospitalisation rates.

As most pertussis hospitalisations were in children aged less than 5 years, the geographical distribution of hospitalisations and notifications for this age group was compared. Nationally, notification and hospitalisation rates were similar. However, hospitalisation rates exceeded notification rates in Queensland and Victoria. Western Australia had the highest average annual notification and hospitalisation rates, while Tasmania, the Australian Capital Territory and Victoria had the lowest rates (Appendices 2 and 3).

## *Comment*

Pertussis caused the greatest morbidity of any vaccine preventable disease, both over the entire review period and in the most recent year reviewed. The highest numbers of pertussis notifications and hospitalisations were seen in 1997, with most jurisdictions experiencing an epidemic in that year. This epidemic affected all age groups with more deaths recorded than in any other year since 1960. The observed differences between jurisdictions, both in 1997 and over the review period may relate to geographical differences in past or present pertussis vaccination coverage, but may also reflect differences in surveillance methodologies.

The high proportion of hospitalised infants aged less than one year demonstrated the increased morbidity of pertussis in this age group. Notification rates are known to underestimate incidence; this was illustrated by the finding that hospitalisations in infants aged less than one year exceeded notifications by a factor of 1.6. Hospitalisation data may be more useful than notification data as an indicator of pertussis incidence in this age group. The notification and hospitalisation patterns in young children were similar to those during an epidemic in New Zealand where, from June 1995 to May 1997, children aged less than 15 months accounted for 82% of hospitalisations but only 21% of notifications.[32]

Prior to the introduction of the fifth dose of diphtheria-tetanus-pertussis (DTP) vaccine in 1994, notifications in five and six year olds comprised a much greater proportion of the notifications in the 5–9 year age group (43%) than in subsequent years (28%). This, together with the overall reduction in 5–9 year old notification

rates, relative to rates in 10–14 year olds, suggested an impact from the introduction in 1994 of the fifth dose of pertussis vaccine for preschoolers.

In this review adults accounted for a larger proportion of notifications than in the United States[33] or The Netherlands.[34] However, in the United States adults are less likely to be notified than in Australia, as the United States does not include serological diagnosis in its case definition. In the Netherlands, serological diagnosis is included, but the serological case definition is much stricter than in Australia.[34]

The increased median age of notified cases seen in Australia in 1998 suggests an additional pertussis booster in adolescence, as has been implemented in France,[35] may be required. However, consideration of such an intervention must be based on an evaluation of (a) the effect of changes in diagnostic practices, (b) the impact of the 5$^{th}$ dose of DTP vaccine at 4–5 years, and (c) the impact of the introduction of acellular vaccine for infants.

# Poliomyelitis

Poliomyelitis is caused by an enterovirus, poliovirus. Infection involves the gastrointestinal tract, and may progress to the nervous system resulting in paralysis. Acute flaccid paralysis occurs in less than 1% of infections. More than 90% of 'asymptomatic' cases are characterised by a mild febrile illness. The maximum extent of paralysis is usually reached within 3–4 days of disease onset. Any paralysis still present after 60 days is likely to be permanent.[16]

### *Case definition*

#### Notifications

Acute-onset flaccid paralysis of one or more limbs with decreased or absent tendon reflexes in the affected limbs without apparent cause, and without sensory or cognitive loss.

#### Hospitalisations and deaths

The ICD-9/ICD-9-CM code 045 (acute poliomyelitis) was used to identify cases.

## *Notifications, hospitalisations and deaths*

There were no notifications of poliomyelitis between 1993 and 1998. From July 1993 to June 1998, 328 persons were recorded as being hospitalised with acute poliomyelitis (Appendix 3). Only 16 cases (5%) were recorded as having a principal diagnosis of poliomyelitis: of these cases, 3 were children under 5 years of age, 8 were aged 15–59 years, and 5 were aged 60 years or more. Most of the cases with a secondary diagnosis (212 of 328, 65%) were aged 60 years or more. There were no deaths due to poliomyelitis recorded during the time period studied.

## *Comment*

There have been no reports of indigenous wild type poliovirus transmission in Australia for at least 20 years,[36] with laboratory investigations currently being performed to identify exactly when the last known case occurred.[37] Therefore, the hospitalised cases reported here are unlikely to be acute cases of wild-type polio infection: some may be patients with vaccine-associated poliomyelitis, and others may be cases of acute flaccid paralysis (AFP) for whom polio could not be excluded, but most are likely to be adults with late effects of poliomyelitis rather than acute cases.

Adequate surveillance of AFP cases is required to rule out poliomyelitis and to demonstrate that Australia is polio free.[36,38] This forms part of the World Health Organization's (WHO) certification process for polio eradication in the Western Pacific Region. A recent review of cases identified as AFP indicated that Australia must improve its AFP surveillance to confirm the absence of wild poliovirus; 63% of 80 cases were classified as polio-compatible because of inadequate stool testing and follow-up.[36]

# Rubella

Rubella is caused by the rubella virus (family togaviridae). It is usually a mild febrile viral disease with a rash sometimes resembling that of measles or scarlet fever. More severe disease manifestations, such as arthritis and encephalitis, also occur. Rubella is important because of its ability to produce abnormalities in the developing fetus (congenital rubella syndrome).[16]

### *Case definitions*

#### Notifications

a) A generalised maculopapular rash, fever, and one or more of arthralgia/arthritis or lymphadenopathy or conjunctivitis, and an epidemiological link to a confirmed case

**or**

b) Demonstration of rubella-specific IgM antibody, except following vaccination

**or**

c) A fourfold or greater change in rubella antibody titre between acute and convalescent phase sera obtained at least 2 weeks apart

**or**

d) Isolation of rubella virus from a clinical specimen.

#### Hospitalisations and deaths

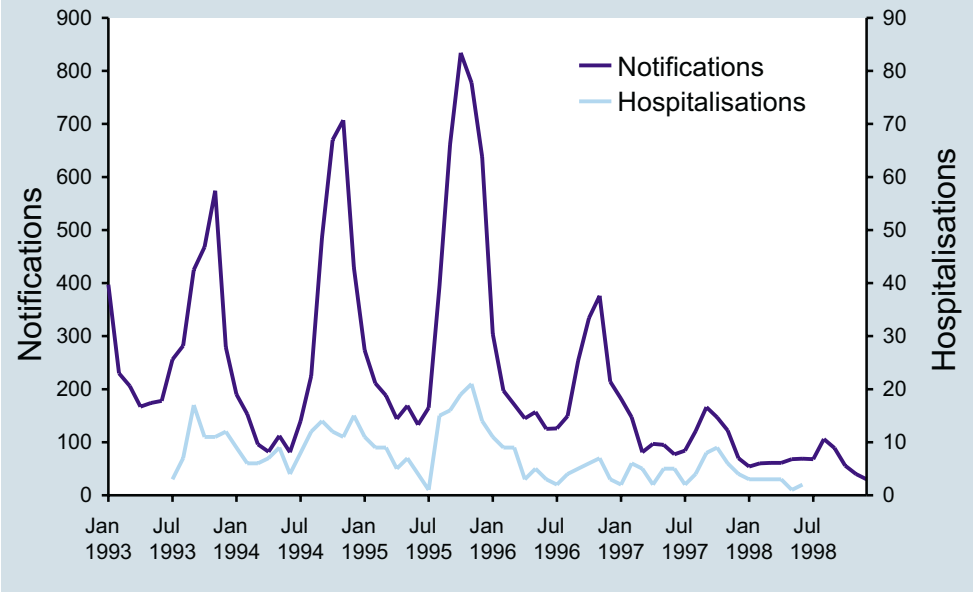
The ICD-9/ICD-9-CM code 056 (rubella) was used to identify cases.

Congenital rubella cases were not included in this report. The notification of congenital rubella is mandatory only in 5 of the 8 States/Territories.[39] A review of congenital rubella cases recorded by the Australian Paediatric Surveillance Unit between 1992 and 1997 is available elsewhere.[39]

## *Secular trends*

During the 6 years from 1993 to 1998, 15,790 notifications of rubella were recorded (an average annual rate of 14.8 per 100,000) (Table 7). In contrast, between July 1993 and June 1998, only 445 hospitalisations were coded as being due to rubella (an average annual rate of 0.5 per 100,000). A peak in the number of notifications and hospitalisations was seen in the Spring of 1995 and numbers have been decreasing since then (Figure 9, Appendices 2 and 3). A median of 166 notifications (range 30–834) and 6 hospitalisations (range 1–21) occurred each month. The large range in monthly figures is due to a marked seasonal pattern with maximum numbers in the Spring months of each year.

**Figure 9. Rubella notifications and hospitalisations by month of onset or admission, Australia 1993–1998***




Note varying scales between notifications and hospitalisations.

* Notifications where the month of onset was between January 1993 and December 1998, hospitalisations where the month of admission was between 1 July 1993 and 30 June 1998.

## *Severe morbidity and mortality*

One thousand six hundred and twenty-seven hospital bed days (average 325 per year) were recorded for patients with an ICD-9-CM code for rubella. Of the 445 admissions, 264 (59%) had a principal diagnosis of rubella (average annual rate 0.3 per 100,000). Complications arising from rubella infection were recorded for 79 admissions (18%). Of all rubella hospitalisations, 29 (7%) were coded as having neurological complications (average annual rate <0.1 per 100,000). The median length of stay in hospital was 2 days, but increased with age (Table 7). Even though older patients stayed in hospital longer than children, 60% of the admissions were children aged 0–14 years, and 39% of the total number of days spent in hospital were attributed to children in this age group.

There were no deaths due to rubella over the review period. The last recorded death was in a 70–74 year old woman in 1988.

**Table 7. Rubella notifications, hospitalisations and deaths by age group, Australia 1993–1998***

| Age group (years) | Notifications 1993-1998 | | Hospitalisations July 1993-June 1998 | | LOS† per admission (days) | Deaths 1993-1997 | |
|---|---|---|---|---|---|---|---|
| | No. | Rate‡ | Total (^) | Rate‡ (^) | Median | No. | Rate‡ |
| 0-4 | 1306 | 17.2 | 207 (131) | 3.2 (2.0) | 2 | 0 | - |
| 5-14 | 2987 | 19.6 | 58 (37) | 0.4 (0.3) | 2 | 0 | - |
| 15-24 | 6874 | 43.4 | 83 (49) | 0.6 (0.4) | 3 | 0 | - |
| 25-59 | 4174 | 8.1 | 85 (40) | 0.2 (0.1) | 4 | 0 | - |
| 60+ | 136 | 0.8 | 12 (7) | 0.1 (0.0) | 7 | 0 | - |
| All ages | 15,790§ | 14.8 | 445 (264) | 0.5 (0.3) | 2 | 0 | - |

* Notifications where the month of onset was between January 1993 and December 1998; hospitalisations where the month of admission was between 1 July 1993 and 30 June 1998; deaths where the date of death was recorded between 1993 and 1997.

† LOS = length of stay in hospital.

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

§ Includes cases with unknown ages.

^ Principal diagnosis.

## *Age and sex distribution*

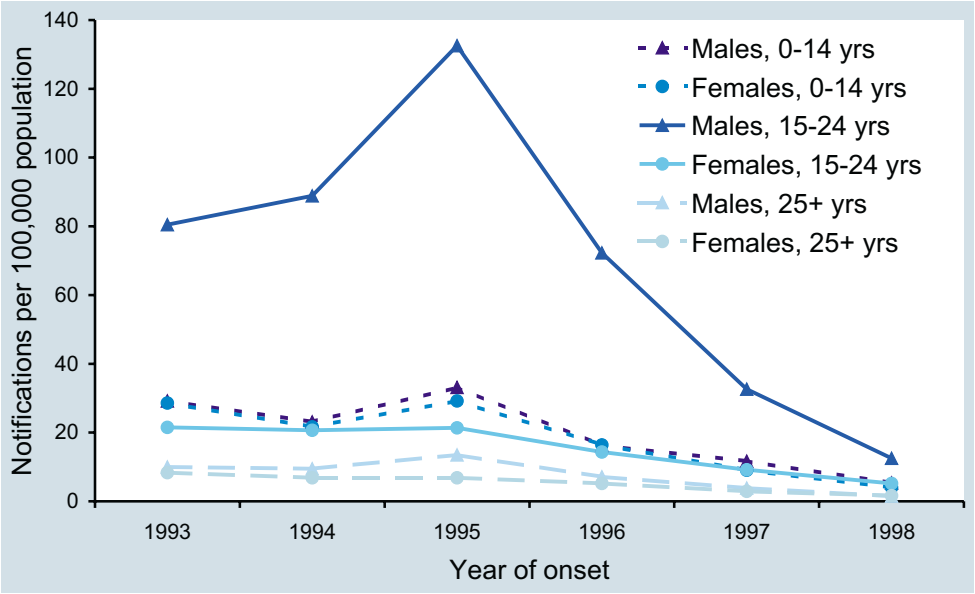
Overall and for each year reviewed, notification rates were highest in the 15–19 year age group (average annual rate 53.2 per 100,000). In contrast, hospitalisation rates were highest in children aged 0–4 years (average annual rate 3.2 per 100,000). Children aged 0–4 years made up 47% of the hospitalisations reviewed while accounting for only 9% of the notifications.

Males had higher hospitalisation and notification rates than females in all age groups for most years reviewed (Figure 10a and Figure 10b). Males aged 15–24 years had the highest notification rate (average annual rate 69.8 per 100,000), especially those aged 15–19 years (average annual rate 85.6 per 100,000). Although notifications for 15–24 year old males predominated in each year reviewed, rates for this group decreased considerably after 1995, becoming closer to those of other age/sex groups by 1998. In comparison, hospitalisation rates were highest in males aged 0–14 years (average annual rate 1.7 per 100,000), especially those aged 0–4 years (average annual rate 4.0 per 100,000).

There were more male than female rubella notifications and hospitalisations (male:female ratio 2.1:1 for notifications and 1.5:1 for hospitalisations), with the ratio varying with age and over time. For notifications the highest male:female ratio was in the 15–19 and 20–24 year age groups (5.0:1 and 4.6:1 respectively), while the ratio for hospitalisations was lower and peaked in the 0–4 and 20–24 year age groups (1.8:1 for both groups). In Spring of 1995, when rates peaked, the male:female ratio was also the highest (for notifications: 2.6:1; for hospitalisations 2.3:1). Since 1994/1995, the ratio for both notifications and hospitalisations has become more equal. In 1998, it had declined to 1.6:1 for notifications and 1.1:1 for hospitalisations.

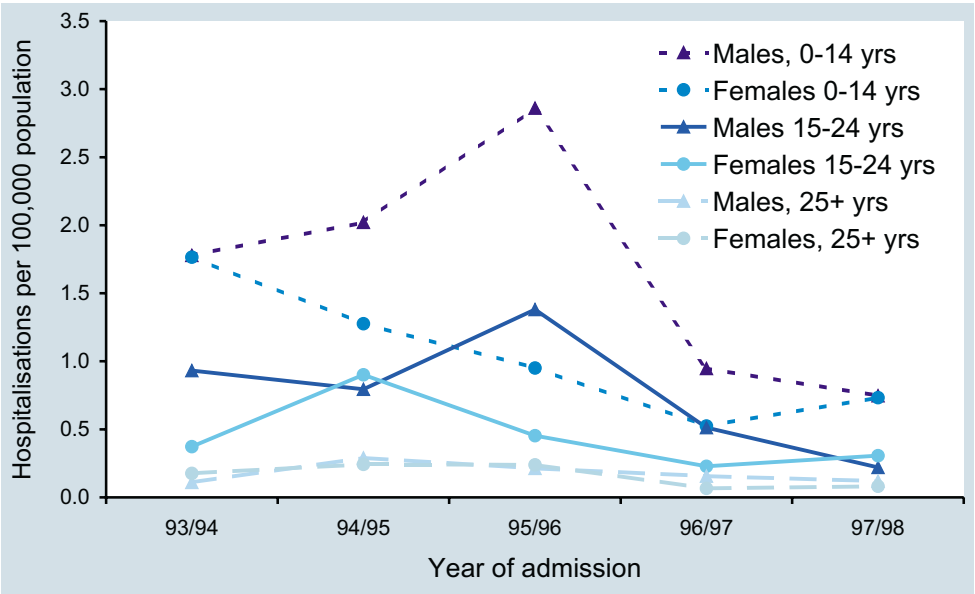
Between 1993 and 1998, there were 2328 notified cases of rubella in women of child bearing age (15–44 years), an average annual rate 9.6 per 100,000. The rate decreased considerably over the review period from 14.2 per 100,000 in 1993 to 3.5 per 100,000 in 1998.

**Figure 10a. Rubella notification rates by a age group, sex and year of onset, Australia, 1993–1998***




* Notifications where onset was between 1 January 1993 and 31 December 1998

**Figure 10b. Rubella hospitalisation rates by a age group, sex and year of admission, Australia, 1993–1998***




* Hospitalisations where admission was between 1 July 1993 and 30 June 1998.

## *Geographical distribution*

Notification and hospitalisation rates varied between States/Territories and over time (Appendices 2 and 3). Notification rates varied more than hospitalisation rates between jurisdictions. Queensland and the Australian Capital Territory had by far the highest average annual notification rates, while hospitalisation rates were highest overall for both Queensland and the Northern Territory. For each State/Territory except South Australia, notification and hospitalisation rates peaked in the same year.

### *Comment*

Notification and hospitalisation rates for rubella fell during the review period. Notification rates decreased most notably in adolescent males, while the greatest reduction in hospitalisation rates was in children, especially those aged 0–4 years. Most hospitalised patients were children aged 0–4 years, even though most notified cases were young adult males.

Over one-third (36%) of the rubella notifications were males aged between 15 and 24 years. This skewed distribution of cases reflects the lack of immunity in young adult males, as up until 1994 only girls received a dose of rubella vaccine at the age of 10–16 years. Since 1994/1995, when adolescent vaccination was introduced for both males and females in this age group, numbers of adult male notifications have fallen and the male:female ratio for both notifications and hospitalisations has become more equal. A similar picture has been seen in other countries with infant and schoolgirl vaccination schedules. In recent years in the United States of America, 85% of cases have been in adults,[15] while in 1996 a resurgence of rubella among adult and adolescent males was seen in the United Kingdom.[40]

# Tetanus

Tetanus is a disease induced by an exotoxin of the *Clostridium tetani* bacterium, which grows anaerobically at the site of an injury. The disease is characterised by painful muscle contractions, primarily of the masseter and neck muscles, secondarily of the trunk muscles. The case-fatality rate ranges from 10–90%, with the highest rates in infants and the elderly.[16]

### *Case definitions*

#### Notifications

A clinically compatible illness without other apparent cause, with or without a history of injury, and with or without laboratory evidence of the organism or its toxin.

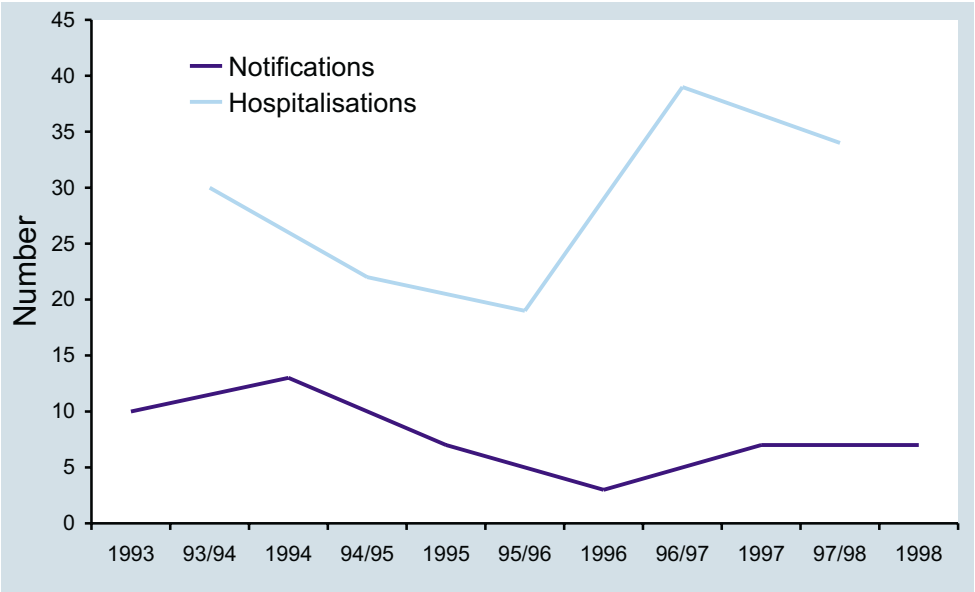
#### Hospitalisations and deaths

The ICD-9/ICD-9-CM code 037 (tetanus) was used to identify cases and deaths.

## *Secular trends*

During the six years from 1993 to 1998 there were 47 notifications of tetanus (an average annual notification rate of 0.04 per 100,000) (Table 8). In contrast, there were 144 hospitalisations coded as being due to tetanus (an average annual rate of 0.2 per 100,000) over a shorter period (July 1993 to June 1998). Annual numbers of notifications and hospitalisations varied, but no continuing trends were identified over the review time frame (Figure 11). Between 3–13 notifications (median 7) and 19–39 hospitalisations (median 30) were recorded each year.

**Figure 11. Tetanus notifications and hospitalisations by year of onset or admission, Australia 1993–1998***




* Notifications where the year of onset was between January 1993 and December 1998; hospitalisations where the month of admission was between 1 July 1993 and 30 June 1998.

## Severe morbidity and mortality

Two thousand nine hundred and eighty-eight hospital bed days (average 598 per year) were recorded for patients with an ICD-9-CM code for tetanus. Of the 144 admissions, 99 (69%) had tetanus recorded as the principal diagnosis (average annual rate 0.1 per 100,000). The median length of stay in hospital was 9 days, but varied by age (Table 8). Adults aged at least 60 years had a much longer median lengths of stay than younger age groups. They also accounted for most of the hospitalisations (57%) and hospital bed days (77%).

Between 1993 and 1997 there were 7 deaths due to tetanus. One death occurred in 1993, three in 1994, two in 1995 and one in 1997. Most of the deaths (6 of 7, 86%) were in persons aged at least 70 years.

**Table 8. Tetanus notifications, hospitalisations and deaths by age group, Australia 1993–1998***

| Age group (years) | Notifications 1993-1998 | | Hospitalisations July 1993-June 1998 | | LOS† per admission (days) | Deaths 1993-1997 | |
|---|---|---|---|---|---|---|---|
| | No. | Rate‡ | Total (^) | Rate‡ (^) | Median | No. | Rate‡ |
| 0-4 | 0 | - | 0 (0) | - (-) | 0 | 0 | - |
| 5-14 | 0 | - | 1 (1) | 0.0 (0.0) | 1 | 0 | - |
| 15-24 | 0 | - | 10 (5) | 0.1 (0.0) | 3 | 0 | - |
| 25-59 | 13 | 0.0 | 51 (37) | 0.1 (0.1) | 6 | 1 | 0.0 |
| 60+ | 34 | 0.2 | 82 (56) | 0.6 (0.4) | 20 | 6 | 0.0 |
| All ages | 47 | 0.0 | 144 (99) | 0.2 (0.1) | 9 | 7 | 0.0 |

* Notifications where the month of onset was between January 1993 and December 1998; hospitalisations where the month of admission was between 1 July 1993 and 30 June 1998; deaths where the date of death was recorded between 1993 and 1997.

† LOS = length of stay in hospital.

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

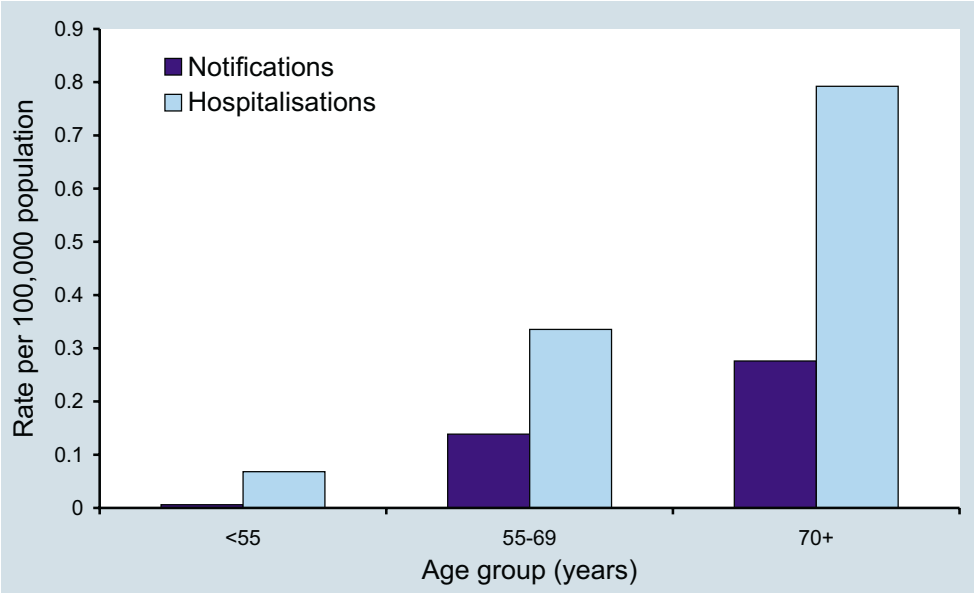
^ Principal diagnosis.

## Age and sex distribution

Eighty-nine per cent of notified cases and 66% of hospitalised cases were aged at least 55 years. Almost twice as many females were notified with tetanus compared with males (male:female ratio 1:1.8); however, the ratio was lower for hospitalisations (male:female ratio 1:1.2).

For both notifications and hospitalisations rates increased with increasing age (Figure 12). Females aged at least 70 years had the highest rates of notification (0.5 per 100,000) and hospitalisation (0.9 per 100,000).

**Figure 12. Tetanus notification and hospitalisation rates by age group, Australia 1993–1998***




* Notifications where the month of onset was between January 1993 and December 1998, hospitalisations where the month of admission was between 1 July 1993 and 30 June 1998.

## *Geographical distribution*

Notification and hospitalisation rates varied over time and between States/Territories (Appendices 2 and 3). However, there were too few cases in each jurisdiction to identify any trends.

## *Comment*

Prior to 1953, before mass vaccination of infants began, tetanus was most commonly seen in children and young adults. Since the 1950s numbers of cases have steadily declined, and the age distribution of cases has changed. A high proportion of recent notifications (27 of 47, 57%) and hospitalisations (54 of 152, 36%) in Australia were females aged at least 55 years. This group is probably most at risk due to low vaccination coverage: they would not have received infant vaccination and, unlike older males, are less likely to have been routinely vaccinated during military service.[41]

Our findings are similar to those elsewhere in Australia and overseas.[42,43] At Fairfield Infectious Diseases Hospital, Victoria, between 1981 and 1994 patients with tetanus were predominantly female (12/19) and over 50 years of age (17/19). In addition, these patients had a comparable length of stay to that found in the present review.[42] A similar picture has also been seen in the USA. However, in that country there has also been an increased proportion of cases in male injecting drug users since 1995.[43]

Serological studies in Australia and the United States have confirmed the low prevalence of immunity in older adults, especially in older females.[41,44,45] These data emphasise the need for tetanus boosters in women.

The discrepancy between the number of hospitalisations and notifications is likely to be due to both under-reporting of cases and coding errors. Coding errors may have resulted from misclassification of other conditions as tetanus, especially where tetanus was not the principal diagnosis. Equally, notifications for tetanus rely heavily on clinicians rather than laboratories, so under-notification is likely.

# 4 - Other vaccine preventable diseases

## Hepatitis A

Infection with the hepatitis A virus (HAV), a picorna virus, may produce a wide range of symptoms from subclinical hepatitis, to acute hepatitis with jaundice, to fulminant hepatitis. Onset of clinical symptoms is usually abrupt with fever, anorexia, malaise, nausea and abdominal discomfort followed by jaundice. The single most important factor in determining the outcome of HAV infection is age. Over 90% of infections acquired before the age of 5 years are silent, with the proportion of infected individuals showing symptoms increasing to 90% in adults.[15,16]

### *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-9/ICD-9-CM code 070.0 (hepatitis A with hepatic coma) and 070.1 (hepatitis A without mention of hepatic coma) were used to identify cases and deaths.

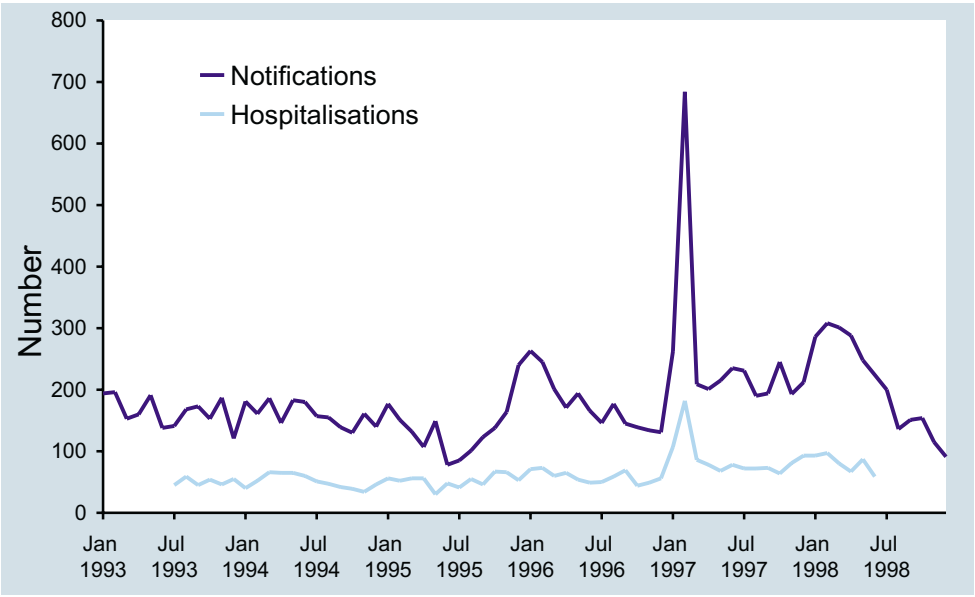
### *Secular trends*

There were 13,224 hepatitis A notifications in the review period (average annual notification rate 12.1 per 100,000) (Table 9). A median of 170 cases (range 78–684) were notified per month. There were 3773 hospitalisations (average annual hospitalisation rate 4.2 per 100,000) with a median of 59 cases (range 30–182) hospitalised per month.

There was a sharp peak in hepatitis A notifications and hospitalisations in February 1997, with case counts reaching 684 and 182 respectively. Notifications were elevated in early 1996 and the first quarter of 1998, with the number of notifications reaching 263 in January 1996 and over 300 in February and March 1998 (Figure 13).

There was no apparent seasonality in notifications or hospitalisations.

**Figure 13. Hepatitis A notifications and hospitalisations by month of onset or admission, Australia 1993–1998***




* Notifications where the month of onset was between January 1993 and December 1998; hospitalisations where the month of admission was between 1 July 1993 and 30 June 1998.

## *Severe morbidity and mortality*

Numbers and rates of notifications were approximately 3 times higher than those of hospitalisations (Table 9). Twenty-one thousand and eighty-six hospital bed days (average 4,217 per year) were recorded for patients with an ICD-9-CM code for hepatitis A. The median length of stay for those aged 60 years or more was double that for younger age groups. Hepatitis A with hepatic coma (ICD-9-CM 070.0) was recorded for 58 admissions. The majority of deaths (64%) occurred in the 60 year and over age group. Hepatitis A was the principal diagnosis in 53% of hospitalisations (2,007 cases, average annual rate 2.2 per 100,000).

**Table 9. Hepatitis A notifications, hospitalisations and deaths by age group, Australia 1993–1998***

| Age group (years) | Notifications 1993-1998 | | Hospitalisations July 1993-June 1998 | | LOS† per admission (days) | Deaths 1993-1997 | |
|---|---|---|---|---|---|---|---|
| | No. | Rate‡ | Total (^) | Rate‡ (^) | Median | No. | Rate‡ |
| 0-4 | 721 | 9.3 | 140 (84) | 2.2 (1.3) | 3 | 1 | 0.0 |
| 5-14 | 2502 | 16.1 | 300 (265) | 2.3 (2.0) | 3 | 0 | 0.0 |
| 15-24 | 2722 | 16.8 | 582 (424) | 4.3 (3.1) | 3 | 0 | 0.0 |
| 25-59 | 6569 | 12.6 | 2259 (1110) | 5.2 (2.6) | 3 | 4 | 0.0 |
| 60+ | 524 | 3.0 | 492 (124) | 3.4 (0.9) | 6 | 9 | 0.1 |
| All ages | 13,224§ | 12.1 | 3773 (2007) | 4.2 (2.2) | 3 | 14 | 0.0 |

* Notifications where the month of onset was between January 1993 and December 1998; hospitalisations where the month of admission was between 1 July 1993 and 30 June 1998; deaths where the date of death was recorded between 1993 and 1997.

† LOS = length of stay in hospital.

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

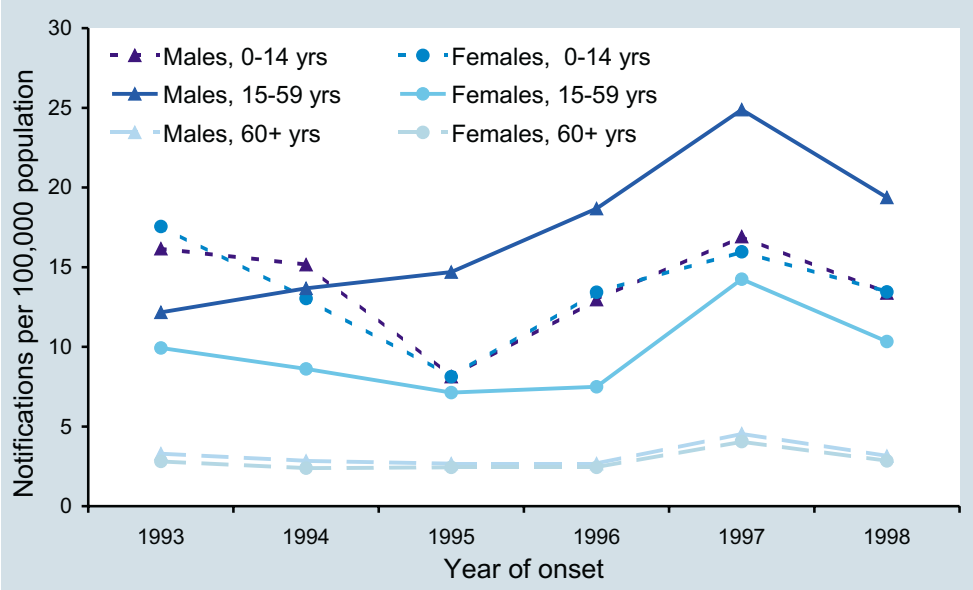
§ Includes cases with unknown ages.

^ Principal diagnosis.

## *Age and sex distribution*

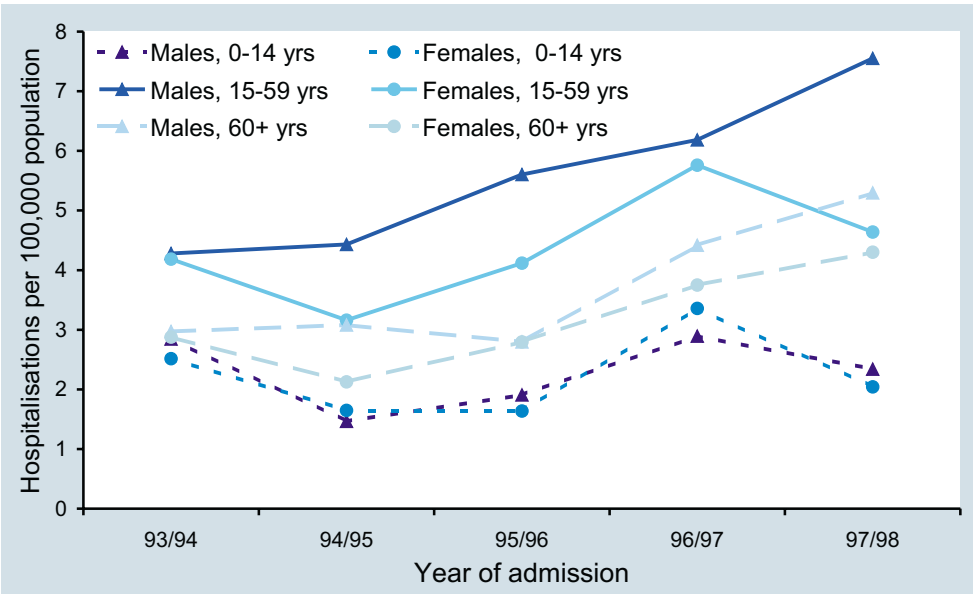
The overall male:female ratio was 1.5:1 for notifications, 1.2:1 for hospitalisations and 1.8:1 for deaths. The sex ratio differed between age groups. It was highest for cases aged 15–54 years (1.8:1 and 1.4:1 for notifications and hospitalisations respectively). For children under 15 years and adults older than 59 years it was close to 1.1:1. Notification and hospitalisation rates peaked for all age/sex groups in 1997 (Figure 14a and Figure 14b). Unlike the notification rates, hospitalisation rates for males and females aged over 59 years and males aged 15 to 59 years continued to rise in 1997/1998.

**Figure 14a. Hepatitis A notification rates for cases by age group, sex and year of onset, Australia, 1993–1998***




* Notifications where the month of onset was between January 1993 and December 1998

**Figure 14b. Hepatitis A hospitalisation rates for cases by age group, sex and year of admission, Australia, 1993–1998***




* Hospitalisations where the month of admission was between 1 July 1993 and 30 June 1998.

### Geographical distribution

Notification and hospitalisation rates were greater than those of Australia as a whole in the Northern Territory, Queensland and NSW (Appendices 2 and 3). The only years during which notification and hospitalisation rates were simultaneously elevated in all jurisdictions (except Tasmania and Western Australia) were 1996 and 1997.

### Comment

In Australia, as in other industrialised countries, hepatitis A appears sporadically with epidemic peaks.[16] While small outbreaks cannot be detected when examining the data on a national level, the increase in total hepatitis A cases as a result of the outbreak associated with consumption of Wallis Lake oysters[46] was evident in the peak in notifications and hospitalisations in February 1997. The high rate of notifications and hospitalisations for men aged 15 to 59 years is likely to be a result of hepatitis A outbreaks amongst men who have sex with men.[47] Illicit drug use has also been found to be an important risk factor for hepatitis A; this mode of transmission is likely to account for some of the cases among young adults.[47]

Hepatitis A vaccines have been used to prevent disease[48] as well as to control outbreaks.[49] Vaccination is recommended for selected at-risk groups and occupations in Australia.[20] In the United States hepatitis A vaccine is now part of the routine vaccination schedule for States with high hepatitis A notification rates.[50] The data presented here show that hepatitis A contributes to infectious disease morbidity and mortality in Australia and may warrant further general or targeted public health intervention.

# Acute Hepatitis B

Acute infection with hepatitis B virus (HBV), a hepadnavirus, may produce a range of conditions from subclinical hepatitis, to acute hepatitis with jaundice, to fulminant hepatitis. Only a small proportion of HBV infections are clinically recognised, with less than 10% of children and 30–50% of adults experiencing clinical symptoms. Onset of illness, when it occurs, is usually insidious with anorexia, vague abdominal discomfort, nausea and vomiting, sometimes arthralgia and rash, often progressing to jaundice. The risk of an acute infection becoming chronic is greatest in those infected as infants. Chronic infection can lead to cirrhosis of the liver and hepatocellular carcinoma.[15,16]

### *Case definitions*

#### Notifications

Persons who are hepatitis B surface antigen (HBsAg) positive *and* one of the following:

Hepatitis B core antibody (Anti-HBc) IgM positive, *or*

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

#### Hospitalisations

For 1993/1994 data, ICD-9-CM codes 070.2 (hepatitis B with hepatic coma) and 070.3 (hepatitis B without mention of coma) were used to select cases. In 1994/1995 the codes for hepatitis B changed to include a fifth digit allowing distinction between acute and chronic cases. For 1994/1995–1997/1998 data, the ICD-9-CM codes 070.20 and 070.21 (acute or unspecified viral hepatitis B with hepatic coma), and 070.30 and 070.31 (acute or unspecified viral hepatitis B without mention of hepatic coma) were used to select cases.

For the hospitalisation data, only cases where the principal diagnosis was one of the above hepatitis B codes were included. (There were an additional 13,780 admissions for patients with a secondary diagnosis of hepatitis B). Only 9% of total hospitalisations with any diagnosis of hepatitis B were a principal diagnosis. This is a much lower proportion than for the other diseases analysed. We considered that secondary diagnoses of acute or unspecified hepatitis B were likely to be chronic cases.

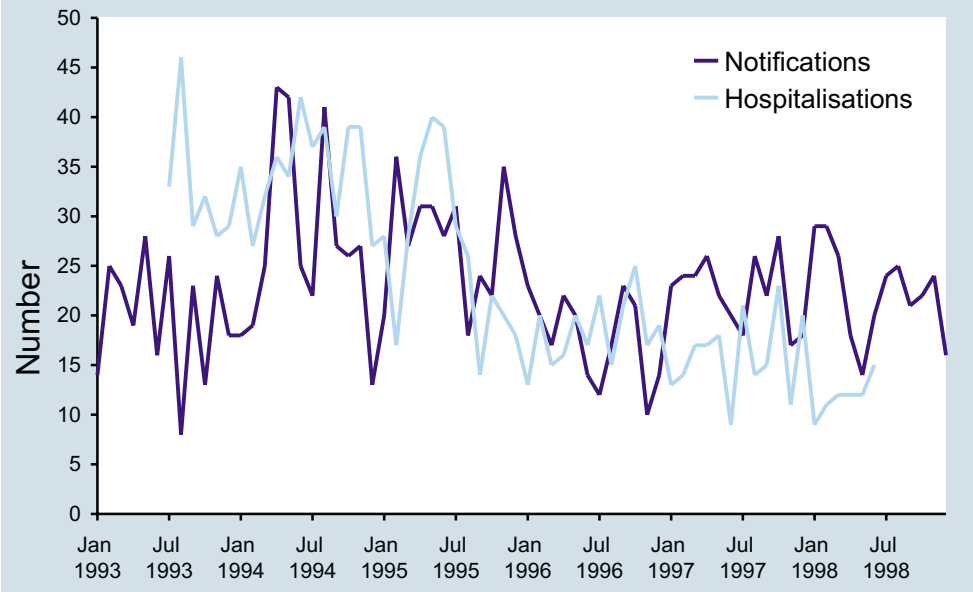
#### Deaths

The ICD-9 codes 070.2 (viral hepatitis B with coma) and 070.3 (viral hepatitis B without mention of coma) were used to select deaths. Note that these codes include deaths resulting from both acute and chronic infection.

### *Secular trends*

In the six years from 1993 to 1998, there were 1645 notifications (average annual rate 1.6 per 100,000) with a median of 23 notifications per month (range 8–43) (Figure 15, Table 10). One thousand four hundred and fourteen hospitalisations (average annual rate1.6 per 100,000) occurred in the five-year review period with a median of 21 hospitalisations per month (range 9–46). Notifications were quite variable from month to month and from year to year, with a large increase in 1994, followed by a comparable decline in 1996 and a smaller increase in 1997 (Appendix 2). Hospitalisations have declined every year, particularly in 1995/1996 (Appendix 3).

**Figure 15. Acute hepatitis B notifications, and hospitalisations with a principal diagnosis of acute hepatitis B*, by month of onset or admission, Australia 1993–1998†**




* Prior to July 1994, hospitalisations for acute hepatitis B could not be distinguished from chronic hepatitis B.

† Notifications where the month of onset was between January 1993 and December 1998; hospitalisations where the month of admission was between 1 July 1993 and 30 June 1998.

## *Severe morbidity and mortality*

Five thousand five hundred and fifty-eight hospital bed days (average 1112 per year) were recorded for patients with a principal diagnosis of acute hepatitis B. The median length of stay was one day, with longer stays for children aged 0–4 years and adults aged 60 years and over (Table 10). HBV infection with hepatic coma was recorded as the principal diagnosis for 33 hospitalisations (0.04 per 100,000 per year). There were 239 deaths due to acute and chronic hepatitis B infection from 1993 to 1997 (range 39-61 per year), occurring almost exclusively in adults aged more than 24 years, with 43% aged more than 60 years.

**Table 10. Acute hepatitis B notifications, and hospitalisations and deaths with a principal diagnosis of acute hepatitis B, by age group, Australia 1993–1998***

| Age group (years) | Notifications 1993-1998 | | Hospitalisations July 1993-June 1998 | | LOS† per admission (days) | Deaths‡ 1993-1997 | |
|---|---|---|---|---|---|---|---|
| | No. | Rate§ | Total | Rate§ | Median | No. | Rate§ |
| 0-4 | 8 | 0.1 | 6 | 0.1 | 2.5 | 0 | - |
| 5-14 | 43 | 0.3 | 37 | 0.3 | 1 | 0 | - |
| 15-24 | 606 | 4.0 | 257 | 1.9 | 2 | 4 | 0.0 |
| 25-59 | 899 | 1.8 | 964 | 2.2 | 1 | 132 | 0.3 |
| 60+ | 78 | 0.5 | 150 | 1.0 | 5 | 103 | 0.7 |
| All ages | 1645‖ | 1.6 | 1414 | 1.6 | 1 | 239 | 0.3 |

* Notifications where the month of onset was between January 1993 and December 1998; hospitalisations where the month of admission was between 1 July 1993 and 30 June 1998; deaths where the date of death was recorded between 1993 and 1997.

† LOS = length of stay in hospital.

‡ Includes deaths from acute and chronic infection.

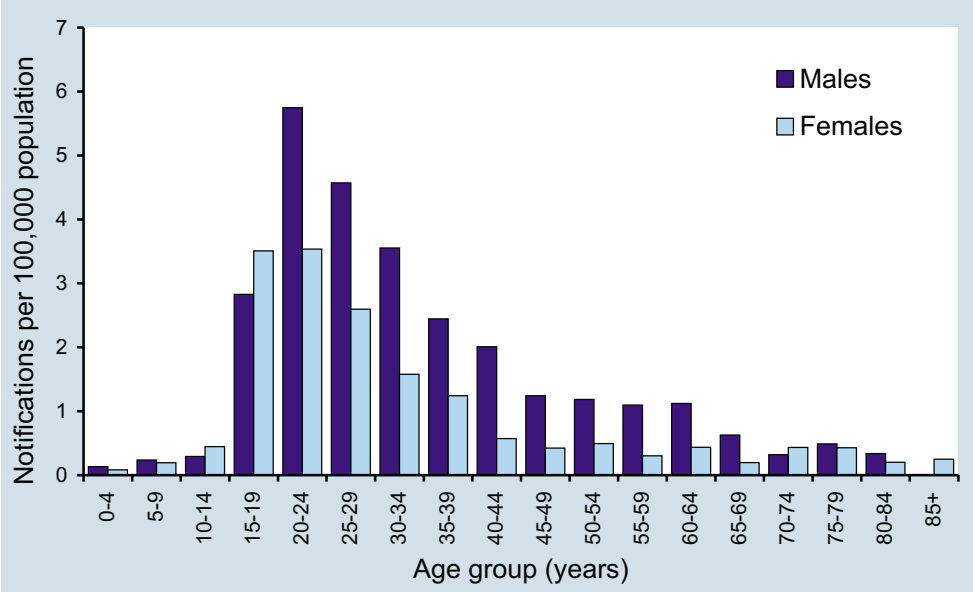
§ Average annual age-specific rate per 100,000 population.

‖ Includes cases with unknown ages.

## *Age and sex distribution*

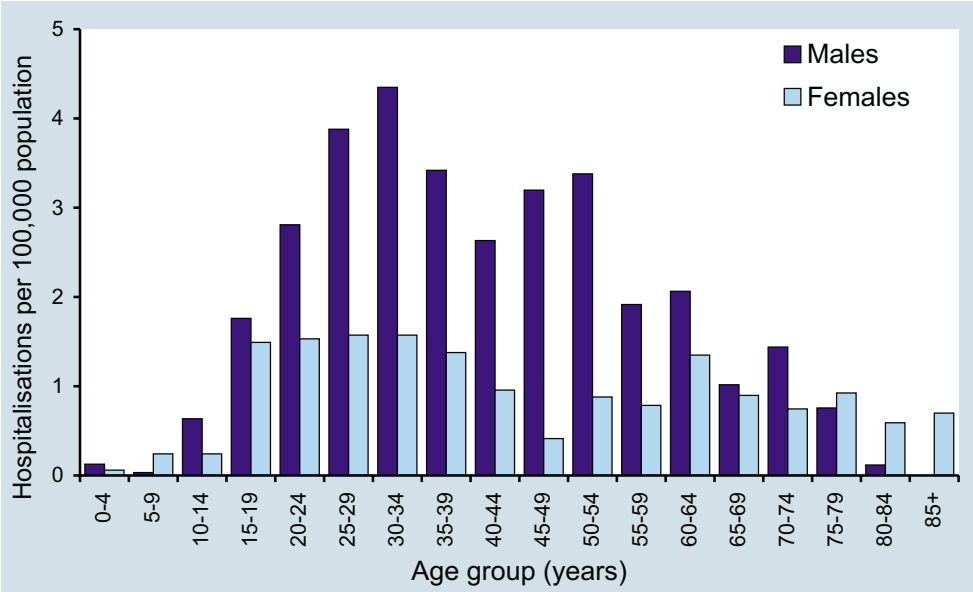
The notification rates were highest in the 20–24 year age group (Figure 16a). Males were predominant in almost all age groups, with an overall male:female ratio of 1.7:1. Hospitalisation rates were highest in an older age group, 25–34 years (Figure 16b). This peak was not as obvious as that for notifications. However, like notifications, males predominated in most age groups (overall male:female ratio 2.3:1).

**Figure 16a. Acute hepatitis B notification rates, by age group and sex, Australia 1993–1998***




* Notifications where the month of onset was between January 1993 and December 1998

**Figure 16b. Acute hepatitis B hospitalisation rates of cases with a principal diagnosis of acute hepatitis B, by age group and sex, Australia 1993–1998***




* Hospitalisations where the month of admission was between 1 July 1993 and 30 June 1998.

### Geographical distribution

The number of notifications during the review period was highest from Victoria (Appendix 2). The Northern Territory had the highest average annual notification rate at 7.7 per 100,000, followed by Victoria (2.2 per 100,000); Tasmania and New South Wales had the lowest rates at 0.9 and 1.1 per 100,000, respectively.

The Northern Territory and Victoria also had the highest average annual hospitalisation rates (2.0 per 100,000 for both) (Appendix 3). Tasmania had the lowest rate (0.4 per 100,000), with rates for the Australian Capital Territory (0.8 per 100,000) and Western Australia (1.0 per 100,000) below the national average.

### Comment

Numbers of notifications and hospitalisations for hepatitis B fell slightly over the review period. This may be attributable to changes in vaccination policy since the vaccine was first introduced in 1982, and to other targeted interventions in high-risk groups. However, for hospitalisations the decline can mostly be accounted for by coding changes in 1994/1995 which allowed chronic cases to be excluded in later years (see case definition section for details). For notifications specifically, the fall may also be partly attributable to better separation of acute and chronic cases over time. Overall there were more hospitalisations than would be expected given the number of notifications and the epidemiology of the disease. It is likely that misclassification of chronic cases as acute cases remains a problem even for admissions coded with a principal diagnosis of hepatitis B.

The highest notification and hospitalisation rates were observed in young adults and males. These rates are likely to result from sexual transmission, particularly amongst homosexual men, and transmission associated with intravenous drug use.[51]

The large variation between State/Territory notification rates may be due to differences in surveillance methods and to the proportion of high-risk groups (eg, indigenous people)[52] in the region. Notification rates will also vary depending on the accuracy of classification of acute cases. Nevertheless, the two regions with the highest notification rates, Northern Territory and Victoria, also had the highest hospitalisation rates.

In the Northern Territory hepatitis B vaccine has been routinely given at birth to Aboriginal infants since 1988, and to all infants since August 1990. In other jurisdictions in Australia hepatitis B vaccination is recommended for selected high-risk groups and, since 1997, for all pre-adolescents. From 1 May 2000 it has been recommended for all neonates.[53] This should lower the incidence of hepatitis B as these cohorts move through prime ages of infection in 20 to 30 years. This in turn will reduce the incidence of chronic hepatitis B arising from neonatal infection.

# Invasive pneumococcal disease

Invasive pneumococcal disease is caused by the bacterium *Streptococcus pneumoniae* (pneumococcus), a normal inhabitant of the upper respiratory tract. Pneumococci can spread directly from the nasopharynx to cause infection in other parts of the respiratory tract (otitis media, sinusitis, pneumonia) or enter the blood stream. Manifestations include meningitis, pneumonia and infection at a number of less common sites, as well as septicaemia without focal infection. Invasive pneumococcal disease is defined as a sterile site isolate of *Streptococcus pneumoniae*, usually from blood.

## *Case definitions*

### Notifications

Although invasive pneumococcal disease became notifiable in Queensland and the Northern Territory during the review period, national data were not available.

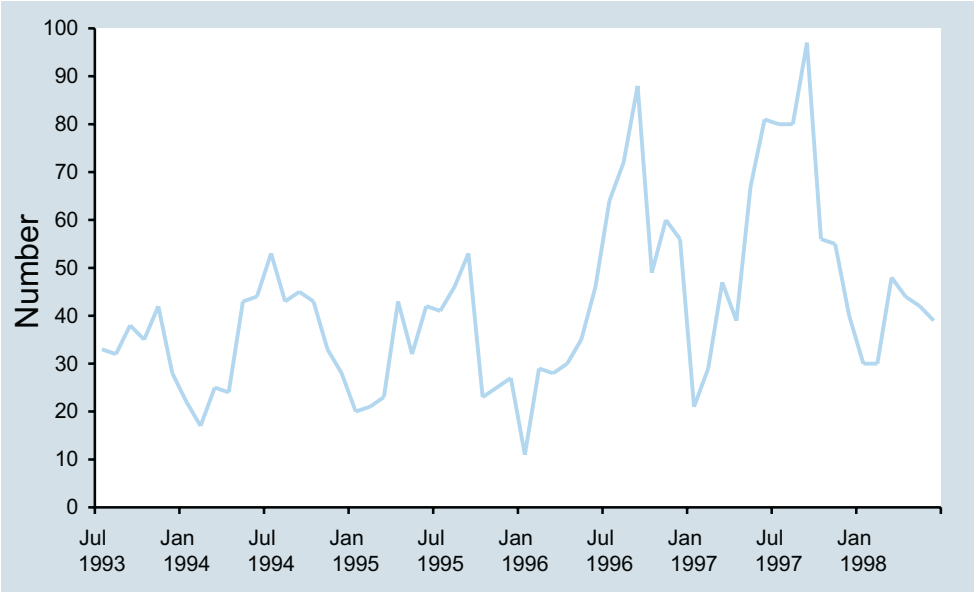
### Hospitalisations and deaths

The ICD-9/ICD-9-CM codes used to identify hospitalisations and deaths were: 320.1, pneumococcal meningitis; and 038.2, pneumococcal septicaemia. Pneumococcal pneumonia was not included unless also coded as septicaemia.

## *Secular trends*

The total number of hospitalisations for invasive pneumococcal disease for the 5-year review period was 2517, an average annual rate of 2.8 per 100,000 (Table 11). The median number of hospitalisations per month was 41 and ranged from 11 to 97 with peaks in the Winter months (Figure 17).

**Figure 17. Pneumococcal disease (meningitis and septicaemia) hospitalisations by month of admission, Australia, July 1993–June 1998**



## Severe morbidity and mortality

A total of 27,871 hospital bed days (average 5574 days per year) was recorded for admissions with an ICD-9-CM code corresponding to pneumococcal meningitis or septicaemia. The highest number and rate of hospitalisations were in the youngest age group (Table 11). However, the longest median length of stay was seen in patients 60 years and older. Patients coded as having meningitis had a median length of stay of 10 days, almost double that for septicaemia (6 days). Meningitis accounted for fewer hospitalisations (793, 32%) than did septicaemia. Of the meningitis hospitalisations, 10% were also coded as having pneumococcal septicaemia, 4% as pneumococcal pneumonia, and 2% as both. Of cases coded as septicaemia, 31% were also coded as pneumococcal pneumonia. Overall, pneumococcal meningitis or septicaemia was the principal diagnosis in 1469 cases (58%), an average annual rate 1.6 per 100,000.

The total number of deaths during the review period was 72. The youngest and oldest age groups had the highest death rates, and meningitis accounted for 56 (78%) of deaths.

**Table 11. Pneumococcal meningitis and septicaemia hospitalisations and deaths by age group, Australia 1993–1998***

| Age group (years) | Hospitalisations July 1993-June 1998 | | LOS† per admission (days) | Deaths 1993-1997 | |
|---|---|---|---|---|---|
| | Total (^) | Rate‡ (^) | Median | No. | Rate‡ |
| 0-4 | 942 (729) | 14.5 (11.3) | 5 | 25 | 0.4 |
| 5-14 | 125 (91) | 1.0 (0.7) | 6 | 0 | 0.0 |
| 15-24 | 58 (31) | 0.4 (0.2) | 5 | 0 | 0.0 |
| 25-59 | 563 (300) | 1.3 (0.7) | 8 | 16 | 0.0 |
| 60+ | 829 (318) | 5.8 (2.2) | 10 | 31 | 0.2 |
| All ages | 2517 (1469) | 2.8 (1.6) | 7 | 72 | 0.1 |

* Hospitalisations where the month of admission was between 1 July 1993 and 30 June 1998; deaths where the date of death was recorded between 1993 and 1997.

† LOS = length of stay in hospital.

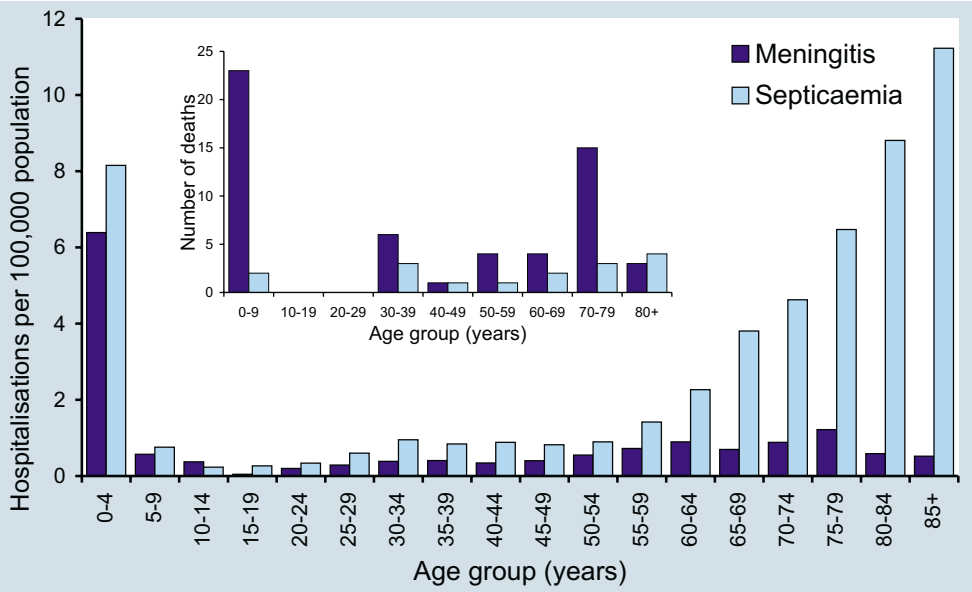
‡ Average annual age-specific rate per 100,000 population.

^ Principal diagnosis.

## Age and sex distribution

There was a predominance of male cases in all age groups (overall male:female ratio 1.4:1), except in the 85 years and older group where the male:female ratio was 0.5:1. Some inter-annual variation in hospitalisation rates was seen, but did not follow any pattern. Overall the hospitalisation rate in 0–4 year olds (14.5 per 100,000) was almost 3 times higher than in the next highest group (60 years and older) (Table 11). Meningitis accounted for 44% of hospitalisations (average annual rate 6.4 per 100,000) and 92% of deaths in 0–4 year olds. Pneumococcal septicaemia and meningitis hospitalisation rates were high in the 0–4 year age group (average annual rate 8.2 and 6.4 per 100,000 respectively) (Figure 18). Rates for septicaemia were high in the 60 year and older age group (rate 5.0 per 100,000); however, septicaemia accounted for only 30% of deaths in this age group.

**Figure 18. Pneumococcal meningitis and septicaemia hospitalisation rates and number of deaths by age group, Australia 1993–1998***




* Hospitalisations where the month of admission was between 1 July 1993 and 30 June 1998, deaths where the date of death was recorded between 1993 and 1997.

## *Geographical distribution*

The Northern Territory had by far the highest average annual hospitalisation rate (18.8 per 100,000), more than five times that of any other State/Territory (Appendix 3). The Northern Territory also had a higher proportion of its cases in the 0–4 year age group for both meningitis (74%) and septicaemia (46%) than any other jurisdiction.

## *Comment*

Polysaccharide pneumococcal vaccine is recommended and funded for Aboriginal and Torres Strait Islander people over the age of 50 years, and is recommended in all States/Territories (but not funded in all) for non-Aboriginal people 65 years and older.[20] Invasive pneumococcal infection is a notifiable condition only in the Northern Territory and Queensland, although it is now on the list of diseases recommended for notifiable status by the Communicable Diseases Network of Australia and New Zealand.

The hospitalisation rates reported here, based on a narrow case definition, underestimate the true incidence of invasive pneumococcal disease. Estimates of overall incidence, as determined by laboratory surveillance in comparable industrialised countries, range from 9 to 22 per 100,000 per year.[54] This means that rates of hospitalisation for pneumococcal meningitis and septicaemia reported here are lower than rates of invasive pneumococcal disease (from laboratory surveillance) by a factor of at least two for children aged 0–4 years and by a factor of three overall. Nevertheless, the hospitalisation data do indicate the relative incidence of invasive pneumococcal disease by age and jurisdiction, as well as the age distribution of pneumococcal meningitis.

The estimated mortality from pneumococcal septicaemia in this study for adults 60 years and older is also much lower than documented elsewhere.[54] This may be because our case definition included only cases with the underlying cause of death recorded as pneumococcal septicaemia. It would not include deaths where pneumococcal septicaemia was present with pneumonia, if pneumococcal pneumonia was coded as the underlying cause of death.

The Northern Territory had the highest rate of hospitalisation, a rate more than five times that of the next highest jurisdiction (Appendix 3). This is likely to reflect high rates among indigenous people who make up

more than 25% of the Northern Territory population. The introduction of funded pneumococcal vaccines for indigenous adults and the likely availability of a conjugate vaccine for infants by the year 2001 will require more accurate and timely monitoring than is possible from hospitalisation data, so plans to make invasive pneumococcal disease nationally notifiable are timely.

# Varicella

Varicella (chickenpox) is a highly contagious infection caused by the varicella-zoster virus. Chickenpox is usually a mild disease in healthy children. It is more severe in adults, and can be fatal in immunosuppressed individuals. The average incubation period is 14–15 days, and is followed by the appearance of a rash. About 5% of cases are subclinical. Acute varicella may be complicated by cerebellitis, aseptic meningitis, transverse myelitis, thrombocytopenia and pneumonia.[16]

### *Case definitions*

#### Notifications

Chickenpox is not a notifiable disease.

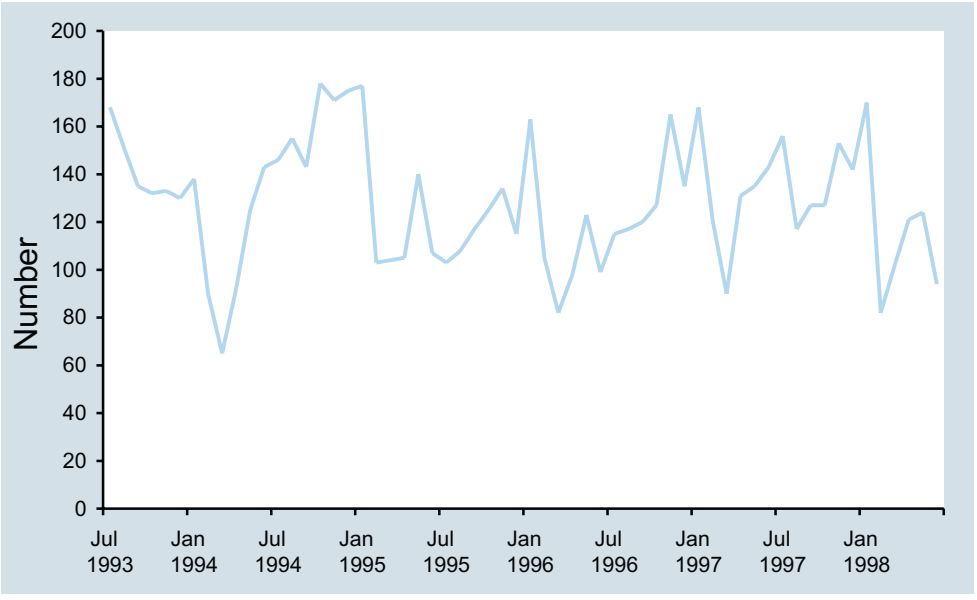
#### Hospitalisations and deaths

The ICD-9-CM/ICD-9-CM-CM code 052 (chicken pox) was used to identify varicella hospitalisations and deaths. Those coded as herpes zoster (code 053) were not included.

## *Secular trends*

There were 7660 hospitalisations (average annual hospitalisation rate 8.5 per 100,000) for varicella between 1 July 1993 and 30 June 1998 (Table 12). A median of 127 cases (range 65–178) were hospitalised per month (Figure 19). There was some indication of seasonality with hospitalisations peaking in January and dropping between February and March.

**Figure 19. Varicella hospitalisations by month of admission, Australia, July 1993–June 1998**



## Severe morbidity and mortality

Thirty-two thousand six hundred and seventy-seven hospital bed days (average 6,535 per year) were recorded for patients with an ICD-9-CM code for chickenpox. Of the 7660 admissions, 4,397 (57%) had a principal diagnosis of varicella (average annual rate 4.9 per 100,000) (Table 12). Complications arising from varicella infection were recorded for 1904 admissions (25%). Of all varicella hospitalisations, 202 (3%) were coded as having encephalitis and 495 (7%) were coded as having pneumonitis. Five cases had both encephalitis and pneumonitis. The highest number and rate of hospitalisations occurred in the youngest age groups. However, the longest median length of stay was recorded for patients 60 years and older. The youngest and oldest age groups had the highest death rates. The median number of deaths per year was 6 and the maximum, 13, was reported in 1997.

**Table 12. Varicella hospitalisations and deaths by age group, Australia 1993–1998***

| Age group (years) | Hospitalisations July 1993-June 1998 | | LOS† per admission (days) | Deaths 1993-1997 | |
|---|---|---|---|---|---|
| | Total (^) | Rate‡ (^) | Median | No. | Rate‡ |
| 0-4 | 3154 (1760) | 48.7 (27.2) | 2 | 8 | 0.1 |
| 5-14 | 1479 (809) | 11.4 (6.3) | 2 | 7 | 0.1 |
| 15-24 | 1074 (661) | 8.0 (4.9) | 3 | 2 | 0.0 |
| 25-59 | 1638 (1014) | 3.8 (2.3) | 3 | 11 | 0.0 |
| 60+ | 315 (153) | 2.2 (1.1) | 7 | 8 | 0.1 |
| All ages | 7660 (4397) | 8.5 (4.9) | 2 | 36 | 0.0 |

* Hospitalisations where the month of admission was between 1 July 1993 and 30 June 1998; deaths where the date of death was recorded between 1993 and 1997.

† LOS = length of stay in hospital.

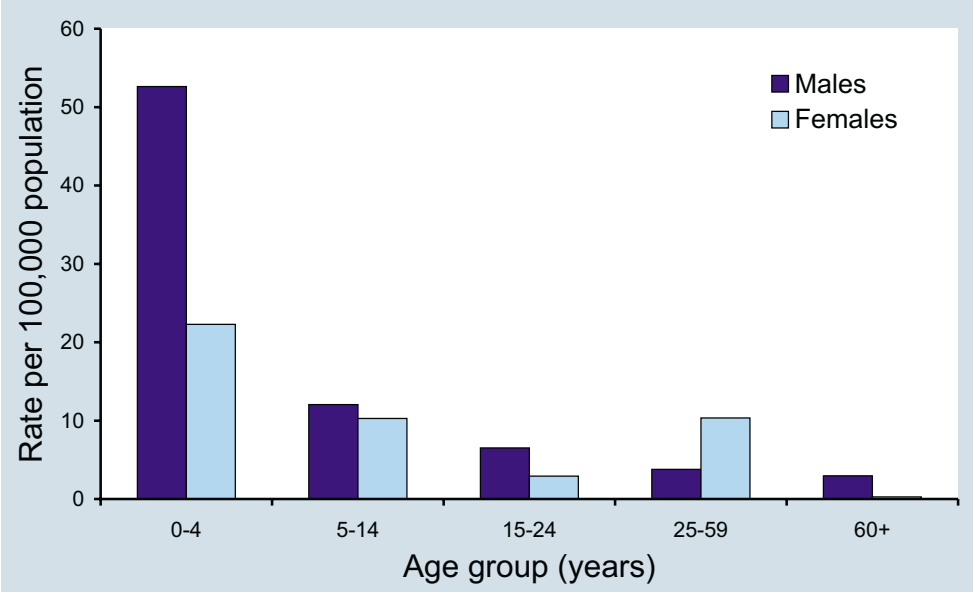
‡ Average annual age-specific rate per 100,000 population.

^ Principal diagnosis.

## Age and sex distribution

The overall male:female ratio of hospitalisations was 1.1:1. However, this varied by age group, with males predominant in the younger and older age groups and females predominant in the 25–59 year age group (Figure 20). The male:female ratio for deaths due to varicella was 2.3:1.

**Figure 20. Varicella hospitalisations by age group and sex, Australia July 1993 to June 1998**




### *Geographical distribution*

The Northern Territory had the highest hospitalisation rate (Appendix 3). No jurisdiction showed a distinct change over the time period of investigation.

### *Comment*

Hospitalisations for varicella were not uncommon with over 1000 admissions per year. The very young were most commonly hospitalised while the elderly had the longest length of stay. In our data, 25% of hospitalised cases had a recorded complication. A more detailed study found a similar level of complications (20%).[55] Varicella hospitalisations occurred throughout Australia, with the Northern Territory having a notably higher rate than any other jurisdiction. Varicella vaccine is included in the routine childhood vaccination schedule in Canada and the United States. Before vaccination policy is determined in Australia a good understanding of the local epidemiology is required. Without notification data, information about hospitalised cases is our only indicator of varicella morbidity.

# 5 - Vaccination coverage

## *Australian Standard Vaccination Schedule 1993–1998*

The Australian Standard Vaccination Schedule for children aged 0–6 years changed in 1993 with the addition of *Haemophilus influenzae* type b (Hib) vaccine and in 1994 with the addition of a fifth dose of pertussis vaccine as diphtheria-tetanus-pertussis (DTP) vaccine at 4–5 years. The full schedule and changes to it are outlined in Table 13. From 1994, full vaccination at 12 months of age required three doses of DTP and oral poliomyelitis (OPV) vaccine and immunisation against Hib. Full Hib immunisation at 12 months required either two doses of PRP-OMP (*Haemophilus influenzae* type b polysaccharide conjugated to the outer membrane protein of *Neisseria meningitidis* type b) or three doses of HbOC (*Haemophilus influenzae* type b polysaccharide conjugated to mutant diphtheria toxin). In the second year of life, a dose of measles-mumps-rubella (MMR) vaccine was scheduled at 12 months of age as well as booster doses of DTP (at 18 months) and Hib vaccines (at 12 or 18 months).

**Table 13. Australian Standard Vaccination Schedule 1993–1998 for children**

| Age | Vaccines | | |
|---|---|---|---|
| 2 months | DTP* | Hib[1,2] | OPV[†] |
| 4 months | DTP | Hib[1,2] | OPV |
| 6 months | DTP | Hib[1] | OPV |
| 12 months | MMR[‡] | Hib[2] | |
| 18 months | DTP[§] | Hib[1] | |
| 5 years | DTP[‖] | | OPV |

* Diphtheria-tetanus-pertussis vaccine.
† Oral poliomyelitis vaccine.
‡ Measles-mumps-rubella vaccine.
§ Acellular pertussis vaccines were generally used at 18 months from 1998.
‖ Changed from diphtheria-tetanus to DTP in 1995.
[1] Hib HBOC, [2] Hib OMP.

## *Vaccination coverage estimates prior to the Australian Childhood Immunisation Register*

Prior to the implementation of the Australian Childhood Immunisation Register (ACIR) in January 1996, vaccination coverage estimates were derived from a variety of sources.[12] The primary source for national data was household surveys conducted by the Australian Bureau of Statistics (ABS), most recently in 1995.[13] Various surveys employing different methodologies were also conducted at State and local area levels.[12] Comparison of these estimates with those from the ACIR is problematic, because of differing methodologies and age groups. In general, surveys such as those of the ABS which had higher response rates and a population-based design yielded lower estimates of coverage than surveys without these features.[12]

Overall, the 1995 ABS survey is the most appropriate and timely reference standard for coverage estimates prior to the ACIR.[12] This survey included 6768 children aged 0–6 years sampled proportional to State and Territory populations. However, the ABS estimates are not directly comparable with the ACIR because ABS coverage is measured cross-sectionally for children aged 12 to 24 months of age (for vaccines due by 12 months) and for children aged 24 to 36 months of age (for vaccines due in the second year of life).[5,12,13]

## *Vaccination coverage estimates from the ACIR 1996–1998*

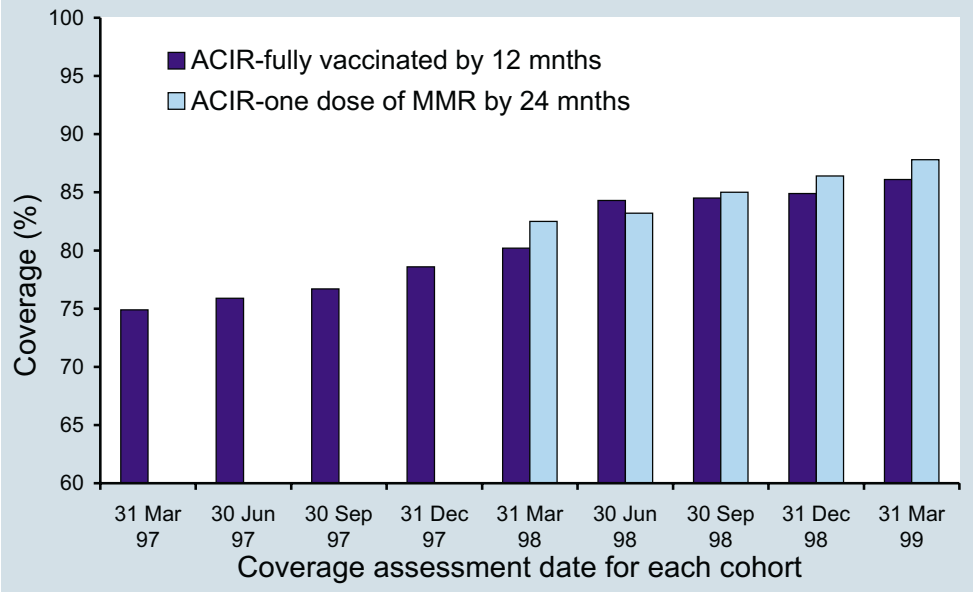
The methodology for calculating cohort-based vaccination coverage from the ACIR was published with the first coverage estimates in 1998.[11] Using this method, a cohort of children is defined by date of birth in three month groups, the first being born between 1 January 1996 and 31 March 1996.[5] The 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. To minimise duplicate records, the cohort includes only children enrolled with Medicare.[11] It is assumed that notification of receipt of a later vaccine dose implies receipt of earlier doses, even if no earlier vaccination is recorded.[5] A child is defined as 'fully vaccinated' at 12 months of age if he or she has received a third dose of DTP (acellular or whole-cell), poliomyelitis vaccine (oral or inactivated) and HbOC (or two doses of PRP-OMP). ACIR coverage estimates for the first vaccination milestone (the first three scheduled doses of DTP, OPV and two or three doses of Hib) have been reported in Communicable Diseases Intelligence since 1998.[11] The coverage for MMR has been reported in Communicable Diseases Intelligence since 1999.[56]

## *Trends in vaccination coverage estimates from the ACIR*

### Vaccines scheduled in the first year of life

The trends in childhood vaccination coverage in Australia for three doses of DTP, OPV and Hib assessed at one year, and one dose of MMR assessed at two years, are shown in Figure 21. Coverage was calculated for 8 consecutive three-month cohorts born from 1 January 1996 to 31 December 1997. For all vaccines due by one year of age, coverage estimates steadily increased from 75% for the first cohort to 85% by the eighth cohort, assessed on 31 December 1998. For MMR assessed at two years of age, coverage estimates also steadily increased from 83% for the first cohort to 86% by the end of 1998.

**Figure 21. Trends in vaccination coverage estimates from the Australian Childhood Immunisation Register for 1 and 2 year olds***



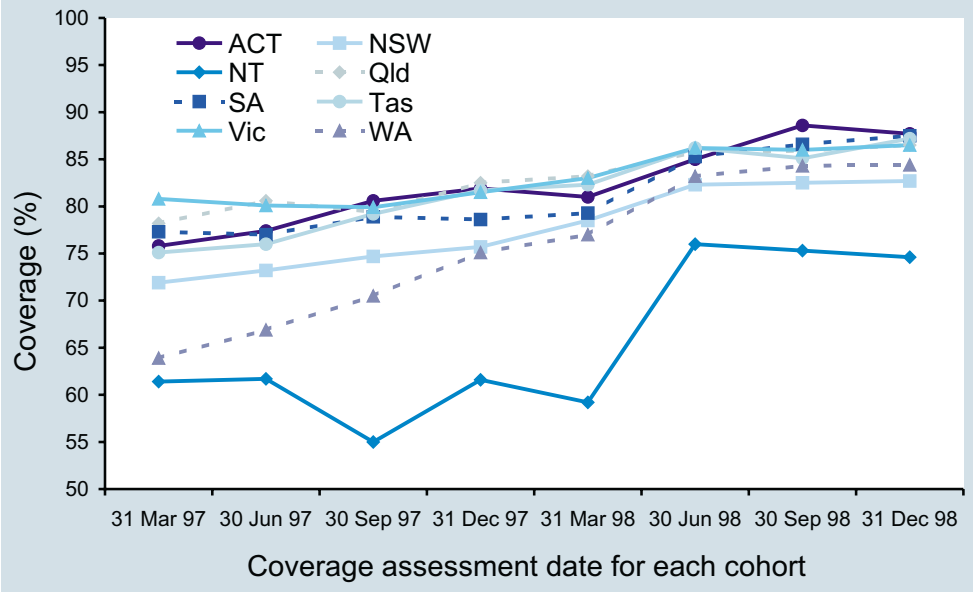

Source: Australian Childhood Immunisation Register.

* By 3-month birth cohorts born between January 1996 and December 1997, assessed between March 1997 and December 1998.

Differences between estimates of the proportion of children classified as 'fully vaccinated' by State/Territory are shown in Figure 22. 'Fully vaccinated' coverage for consecutive cohorts increased over the two-year assessment period for all jurisdictions. The greatest increases in coverage were seen where estimates for the

first cohort were relatively low (such as the Northern Territory and Western Australia) where increases of 15% and 20%, respectively, were seen. However, these low early estimates almost certainly arose from difficulties these regions had in transmitting data to the ACIR in the early days of its operation. Once delays in data transmission from the Northern Territory had been rectified, the most likely reason for the lower coverage estimates was the limited use of Medicare numbers as unique identifiers for Northern Territory data, which made matching of vaccination encounters difficult. Coverage estimates from the Northern Territory Childhood Immunisation Database were around 20% greater than ACIR estimates for dose 3 of DTP and OPV for cohorts assessed on 31 March and 30 September 1997.[57,58] While a steady increase in childhood vaccination coverage was experienced, no jurisdiction had, even in the most recent coverage estimates, reached the *Immunise Australia* Program target of 90% coverage for the first milestone vaccines. However, under-reporting to the ACIR was estimated to reduce coverage estimates by up to 10%.[5]

**Figure 22. Trends in vaccination coverage estimates by jurisdiction — children fully vaccinated for 3 doses of DTP, OPV and Hib at the age of 1 year***




Source: Australian Childhood Immunisation Register

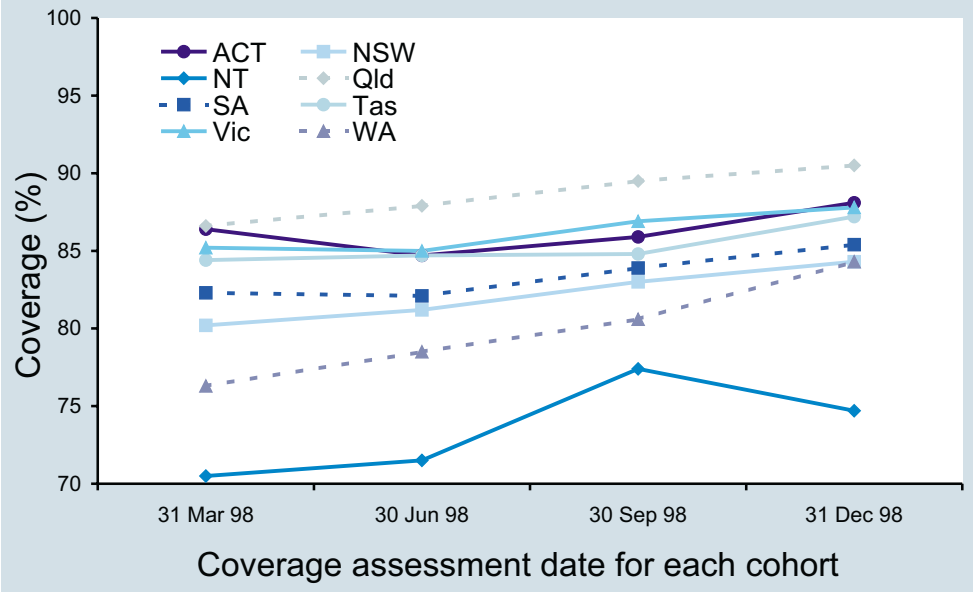
* By 3-month birth cohorts born between January 1996 and December 1997, assessed between March 1997 and December 1998.

## Vaccines scheduled in the second year of life

The cohort-based ACIR coverage estimates for one dose of MMR, assessed at 2 years of age, began with those born between 1 January 1996 and 31 March 1996 inclusive. Figure 23 shows trends in MMR coverage for four cohorts of 2 year olds by jurisdiction, with assessment dates up to 31 December 1998.

MMR coverage generally increased for all jurisdictions. However, no jurisdiction had, as of the most recently calculated ACIR coverage estimates, reached the *Immunise Australia* program target of 95% coverage for MMR vaccination. Most jurisdictions were well below this target, with only Queensland attaining greater than 90% coverage. MMR encounters notified as part of the Measles Control Campaign produced a large increase in MMR notifications to the ACIR, but would have had little effect on the MMR coverage estimates reported here. Most of the MMR notifications received at the time of the Campaign (July 1998 to December 1998) were for children aged 30 months and older, who are not included in MMR coverage estimates at two years.[27]

**Figure 23. Trends in MMR vaccination coverage estimates for 2 year olds by jurisdiction***




Source: Australian Childhood Immunisation Register

* By 3-month birth cohorts born between 1 January 1996 and 31 March 1996, assessed between 31 March 1998 and 31 December 1998.

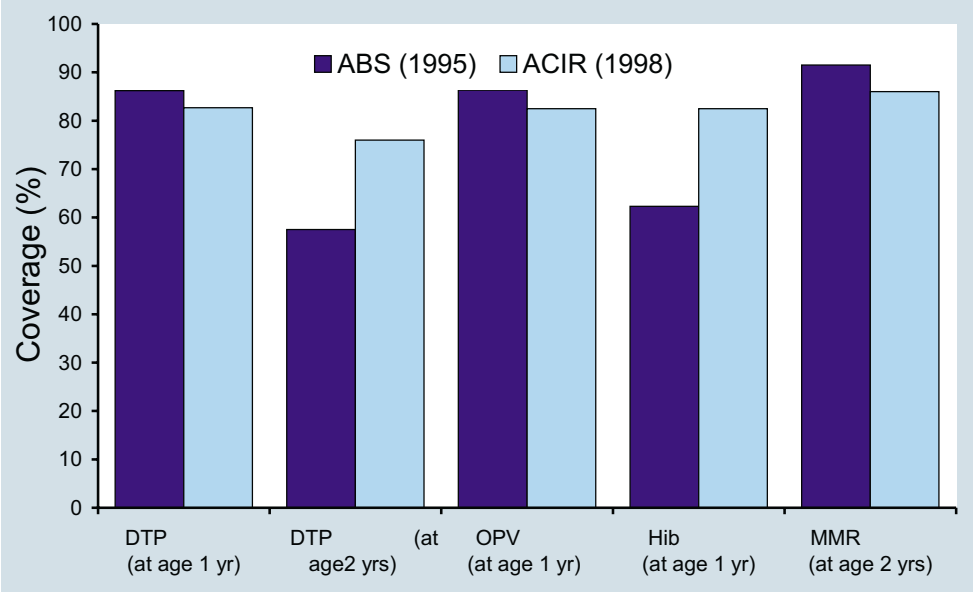
### Vaccines given at 4–5 years of age

Data on vaccination coverage for 4–5 year olds have not yet been reported by the ACIR, as the first cohort of children born since the ACIR commenced do not reach 4 years of age until 2000. Estimates of vaccination coverage in this age group are available from the 1995 ABS survey (22%) and from a number of State and Territory surveys (67–89%).[12,13]

## *Comparison of ACIR and ABS coverage estimates*

Coverage estimates from the ACIR in 1998 compared with those from the ABS survey in 1995 for vaccines at one and two years of age are shown in Figure 24. At the end of 1998 the coverage estimates from the ACIR for individual vaccines well established on the schedule, such as DTP, OPV and MMR, were very similar to those of the ABS in 1995. This was probably due to the level of under-notification to the ACIR being greater than any increase in vaccination coverage over this period. In contrast, the proportion of children recorded by the ACIR as having received either the fourth dose of DTP by two years or 2 or 3 doses of Hib vaccine by one year of age was much higher than reported by the ABS survey. This probably reflects large increases in coverage which overwhelmed any lack of reporting to the ACIR.

**Figure 24. Vaccination coverage estimated by Australian Bureau of Statistics (ABS) in 1995 versus the Australian Childhood Immunisation Register (ACIR) in 1998**




## *Comment*

Estimates of vaccination coverage in Australia steadily increased since the ACIR commenced in 1996. Based on comparisons with estimates from the ABS survey in 1995, it appears likely that coverage for DTP at 12 months and MMR at 2 years have increased only slightly in real terms. In contrast, there have been larger increases in coverage for Hib and for the 4$^{th}$ dose of DTP, assessed at 2 years of age. Overall, it is probable that the ACIR still underestimates coverage by at least 5%.[5] Therefore, it is likely that vaccination coverage at the end of 1998 was higher than 90% for vaccines due in the first year of life and for the first dose of MMR. It is hoped that implementation of the various vaccination incentives incorporated in the Immunise Australia program will increase vaccination coverage and improve reporting by providers to the ACIR. This would lead to improved coverage estimates using ACIR data.

# 6 - Discussion

## *Changes in vaccination practice 1993–1998*

The years 1993–1998 marked the most rapid changes in vaccination practice ever to occur in Australia, with major revisions to the schedule, national monitoring of vaccination coverage and introduction of incentives to promote vaccination to parents and providers.

The Australian Standard Vaccination Schedule (ASVS) was substantially altered over this time (Appendix 4, Tables 18-24). Changes included the introduction of vaccines against Hib, additional doses of MMR vaccine at 10–16 years, and a fifth dose of pertussis-containing vaccine at 4–5 years, as well as the replacement in 1998 of whole-cell by acellular vaccines for the fourth and fifth pertussis vaccine doses.[20] In July 1998, at the time of the Measles Control Campaign (MCC), the second dose of MMR was moved from age 10–16 years to 4–5 years. The universal use of acellular pertussis vaccines in infants was funded during 1999. Further substantial changes are to occur in 2000, with the revised ASVS incorporating fully funded universal infant vaccination against hepatitis B and the use of only one type of Hib vaccine (PRP-OMP) for infants commencing the schedule.[53]

The measurement and monitoring of vaccination coverage in Australia was enhanced by the implementation of the Australian Childhood Immunisation Register (ACIR) in 1996. Subsequently a number of policies and programs aimed at improving vaccination uptake by parents and promoting vaccination and notification to the ACIR by providers were introduced in 1997. For parents, these included linkage of maternity allowance and childcare assistance payments to documentation of vaccination by the ACIR; for providers, they included payment for notification to the ACIR. In 1998, additional payments to general practitioner providers for vaccination, notification to the ACIR and achievement of practice coverage targets were introduced.

These changes represented a large investment in public health over a short period. Evaluation of their impact and consideration of new vaccines in the next 3–5 years requires the use and integration of multiple data sources. The analysis of notification, hospitalisation and mortality data on each of the diseases currently and potentially preventable by vaccination covered in this report provides a comprehensive picture of the impact of present vaccination programs and of the priorities for vaccine preventable diseases policy in Australia in the future.

## *Current levels of morbidity from vaccine preventable diseases*

A summary of the relative morbidity and mortality due to the diseases covered in this report is shown in Table 14. While the limitations of notification, hospitalisation and death data should be borne in mind (pages 5-6) and are especially evident for rare diseases, together these data provide an important overview of disease burden.

For young children the greatest number of hospitalisations were due to pertussis and varicella, while most deaths resulted from Hib disease and invasive pneumococcal disease. In adults, the greatest number of hospitalisations were for varicella and hepatitis A, while most deaths resulted from hepatitis B infection. Neurological complications contributed to prolonged morbidity, particularly for invasive pneumococcal disease, Hib disease and varicella.

In all age groups, the most striking recent changes in the epidemiology of vaccine preventable diseases in Australia have been in measles, rubella and invasive Hib disease.

**Table 14. Morbidity and mortality from vaccine preventable diseases in Australia for 5 years 1993/1994–1997/1998***

| Disease† | Hospitalisations (no.) | | Hospitalisation rate/100,000 (average annual) | | Hospital bed days (total no.) | Neurological complications** | Deaths‡ | |
|---|---|---|---|---|---|---|---|---|
| | Age 0-4 yrs | All ages | Age 0-4 yrs | All ages | | | Age 0-4 yrs | All ages |
| Diphtheria | 2 | 20 | 0.0 | 0.0 | ‖ | ¶ | 0 | 0 |
| Hib§ | 594 | 818 | 9.2 | 4.2 | 4031 | 295 | 13 | 15 |
| Measles | 944 | 2233 | 14.6 | 2.5 | 8379 | 29 | 2 | 7 |
| Mumps | 44 | 270 | 0.7 | 0.3 | 1168 | 22 | 0 | 2 |
| Pertussis | 3427 | 4804 | 52.9 | 5.3 | 19,582 | ¶ | 9 | 9 |
| Polio‡ | 3 | 16 | 0.0 | 0.0 | ‖ | ¶ | 0 | 0 |
| Rubella | 207 | 445 | 3.2 | 0.5 | 1627 | 29 | 0 | 0 |
| Tetanus | 0 | 144 | - | 0.2 | 2988 | ¶ | 0 | 7 |
| Hepatitis A | 140 | 3773 | 2.2 | 4.2 | 21,086 | 58 | 1 | 14 |
| Hepatitis B‡ | 6 | 1414 | 0.1 | 1.6 | 5558 | 33 | 0†† | 239†† |
| Invasive pneumo-coccal disease | 942 | 2517 | 14.5 | 2.8 | 2781 | 793 | 25 | 72 |
| Varicella | 3154 | 7660 | 48.7 | 8.5 | 32,677 | 202 | 8 | 36 |

* Hospitalisation data, Australian Institute of Health and Welfare, July 1993–June 1998; and Australian Bureau of Statistics death data, January 1993–December 1997.

† See Chapters 3 and 4 for case definitions.

‡ Includes only principal diagnosis.

§ Data for *Haemophilus influenzae* disease include only cases aged 0–14 years of age.

‖ These results are not presented due to limitations of the data (see pages 7 and 27).

¶ ICD-9-CM codes for these diseases do not specify neurological complications.

** Neurological complications include meningitis, encephalitis and hepatic coma.

†† Includes deaths from acute and chronic hepatitis B infection.

## Measles

The review period was dominated by major, but largely geographically limited, epidemics in 1993 and 1994. The number of hospital bed days related to measles (Table 14) indicated the severity of this disease. The impact of introducing a second dose of measles vaccine (as MMR) for all children at 10–16 years of age in 1994 is evidenced by the decline in both notifications and hospitalisations since 1995. However, the potential for further epidemics among children under 12 years of age, older teenagers and young adults remained prior to one of the largest vaccination initiatives in Australia's history (the Measles Control Campaign, MCC) in late 1998. Following the MCC, major changes in measles epidemiology were expected, and improved procedures for measles surveillance in Australia were endorsed by the NHMRC.[30,59] Gaps will remain in measles immunity in late teenage and young adult years, unless these age groups are also targeted for a second dose of MMR.

## Rubella and mumps

The epidemiology of rubella also changed in tandem with the introduction of MMR for 10–16 year olds, with the excess number of cases in males aged 15 to 24 years decreasing. Rubella remained a problem in older males, but notifications among females of child bearing age were low, and no cases of congenital rubella occurred after 1997 (Forrest JM, personal communication). Mumps surveillance data were more difficult to interpret because of differences in notification requirements between jurisdictions prior to 1997.

However, hospitalisation rates for mumps cases remained constant, implying little change in the epidemiology over the period of review.

### Invasive Hib disease

The virtual disappearance of invasive Hib disease among children less than five years old was the greatest success story for vaccination in the 1990s. In 1991–1993, prior to vaccination, there were approximately 500 notifications of Hib and an estimated 15 deaths annually in Australian children aged 0–4 years.[21] Without vaccination, 2000 notifications would have been expected in this age group between 1995 and 1998, whereas only 98 cases were notified, a reduction of over 95%. Although the reduction in hospitalisations coded as *Haemophilus influenzae* meningitis or epiglottitis was less dramatic, the available ICD-9-CM codes do not allow Hib meningitis to be distinguished from meningitis due to other types of *Haemophilus influenzae*, or to distinguish epiglottitis due to Hib from other causes of epiglottitis. The ABS data showed one death from *Haemophilus influenzae* meningitis or epiglottitis in a child under 5 years of age in 1996, compared with 30 predicted from pre-vaccination data, a reduction of 97%.

### Pertussis

Pertussis caused the greatest morbidity from vaccine preventable diseases during the review period. Although notification and mortality rates decreased dramatically compared with the pre-vaccination era (Table 1, Appendix 1), the 9 deaths recorded in 1993–1997 equalled the number in the previous decade. Notification and hospitalisation data for pertussis showed epidemics in 1993 and 1997/1998 with substantial background activity in other years. The hospital bed days and deaths due to pertussis were higher than for any other VPD targeted in the routine schedule. The incidence of pertussis was particularly high among school aged children, who may well represent the major source of infection for infants less than 12 months of age. Infants are at highest risk of severe illness; incidence rates in this group remained high. Nevertheless, there was clear evidence of a vaccine effect, with the lowest rates among the most completely vaccinated group (1–4 years of age) and lower rates among the age cohorts eligible since 1994 for a fifth dose of pertussis vaccine. Coverage against pertussis must be high to reduce transmission in the population. It will be important to monitor the impact of the change to acellular pertussis vaccines, increased infant coverage and the fifth dose on the epidemic cycle of pertussis and disease activity in adolescents and adults. If indicated by these data, a booster at high school entry, similar to the recent French initiative,[35] should be considered.

### Rare vaccine preventable diseases

Tetanus continued to occur predominantly in elderly women. The high number of hospital bed days arising from a small number of cases demonstrated the high morbidity of tetanus. These data suggest that tetanus vaccination is particularly important for older adults.

No cases of diphtheria have been notified since 1992. Poliomyelitis appears to have been eradicated, although surveillance of acute flaccid paralysis must continue.[36]

## *Vaccine preventable disease notification rates compared with other industrialised countries*

The 1998 notification rates for the five most frequently occurring diseases preventable by vaccines on the Australian childhood vaccination schedule, compared with the rates in New Zealand, the United States, Canada and England, are shown in Table 15. Notifications of invasive Hib disease were low in all countries, reflecting the excellent results of Hib vaccination programs. Australia was in an interepidemic period for measles in 1998, with notification rates lower than in New Zealand and England, but failing to reach the low levels achieved in the USA and Canada. Pertussis notification rates in Australia were much higher than those in New Zealand, the United States and England, but were comparable to those in Canada. While there is little doubt that pertussis was prevalent in Australia in the Summer of 1997/1998, comparisons with other countries are difficult because of differences in notification case definitions. Notifications in Australia and

New Zealand include cases diagnosed serologically, but those of Canada and the United States do not, while in the United Kingdom most notifications are based on a clinical rather than a serological diagnosis.

**Table 15. Notification rates per 100,000 population for the most frequently notified vaccine preventable diseases by country of residence, 1998**

| Disease | Australia | New Zealand[60] | USA[61] | Canada[62] | England[63,64] |
|---|---|---|---|---|---|
| Hib* | 0.2 | 0.4 | 0.4 | 0.2 | 0.07† |
| Measles | 1.7 | 4.9 | 0.0 | 0.0 | 7.1 |
| Mumps | 1.0 | 2.4 | 0.2 | 0.4 | 3.1 |
| Pertussis | 28.9 | 4.3 | 2.7 | 25.1 | 3.0 |
| Rubella | 4.1 | 1.6 | 0.1 | 0.2 | 6.2 |

* *Haemophilus influenzae* type b.

† England and Wales.

## *Future surveillance priorities*

The data available on vaccine preventable diseases from the NNDSS, the AIHW National Hospital Morbidity Database, and the ABS Causses of Death Collection could be enhanced in several ways. At the time of this report important fields on the NNDSS database, such as laboratory confirmation and immunisation status, were too incomplete to be usefully analysed. These fields will be increasingly important with higher immunisation coverage and the increasing rarity of conditions such as Hib disease and measles, which require specific laboratory tests for validation.

Case definitions for the notification of some conditions such as Hib disease and hepatitis B require revision. Initiatives are under way to enhance collaboration among the State and Territory public health authorities and laboratories to achieve these objectives. In addition, a specific code for Hib infections will be included in the ICD-10-AM coding system from July 2000, and this will enhance the specificity of hospitalisation data.

## *Future vaccination priorities*

The summary table (Table 14) provides a number of measures of morbidity which can be used to compare the disease burden for current, universal and targeted as well as potential vaccination programs. Following the decline in measles and Hib, varicella stands out as the potentially vaccine preventable disease with the highest number of hospital bed days, both overall and for children aged 0–4 years. In this age group, the hospitalisation rate for varicella was comparable to that of Hib disease before vaccination.[21] However, cases of varicella which could have long term neurological sequelae (such as encephalitis) and deaths from varicella (both overall and for children under 5 years of age) were less than for invasive pneumococcal disease. Vaccines against both varicella and invasive pneumococcal disease in infants are, or soon will be, available in Australia, so more detailed evaluation of their likely impact and cost is required.

The disease burden from hepatitis B was greater than for any other VPD as judged by mortality, but was almost entirely a problem in older age groups. Hospitalisations for acute hepatitis B among children 0–4 years of age occurred at less than 10% the rate for all ages, indicating that the introduction of hepatitis B vaccination for adolescents and infants will take many years to have a measurable impact. Hepatitis A also had most of its disease burden (hospitalisations and deaths) in older age groups, but was a substantially greater problem in young children than hepatitis B. Hepatitis A is known to be a more significant problem in some groups of Aboriginal and Torres Strait Islander children, and has been targeted for childhood vaccination in north Queensland from 1999.[65]

Of vaccines currently on the Australian Standard Vaccination Schedule, immediate priority should be given to initiatives aimed at delivering a second dose of MMR vaccine to the cohorts of older teenagers and young adults who were not covered in the school-based vaccination programs, and to consideration of the use of a

routine booster of acellular pertussis vaccine for adolescents and parents of young infants. For vaccines not currently on the Australian Standard Vaccination Schedule, the disease burden data presented here suggest that varicella vaccine and conjugate pneumococcal vaccines should have the highest priority for consideration.

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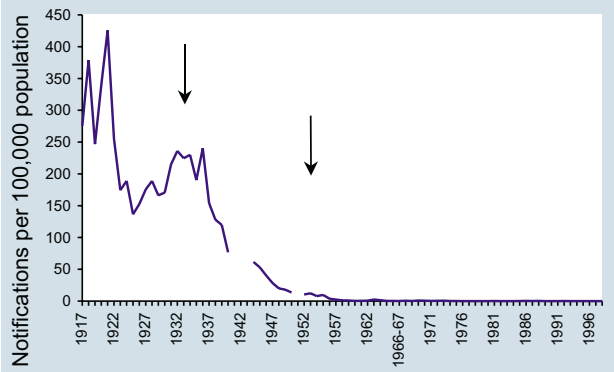
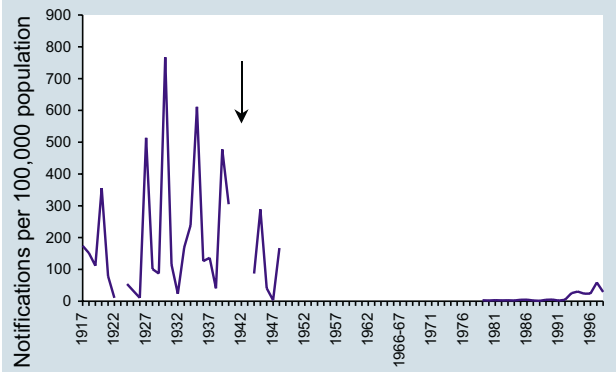
# Appendix 1

## Historical charts of notifications of vaccine preventable diseases

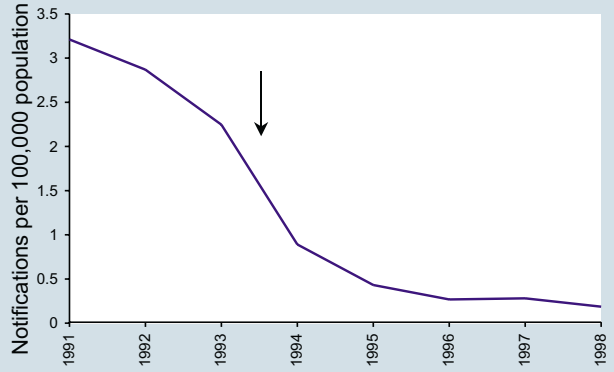
### Diphtheria, 1917–1998



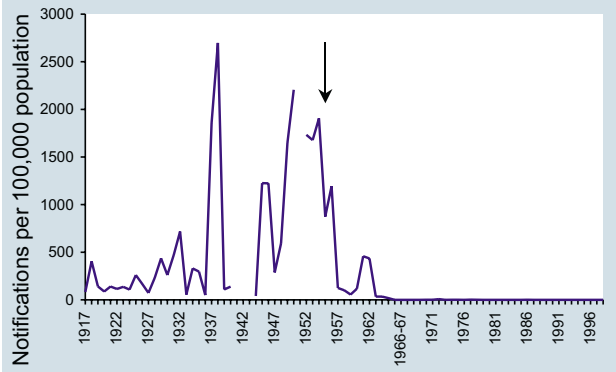

### Pertussis, 1917–1998



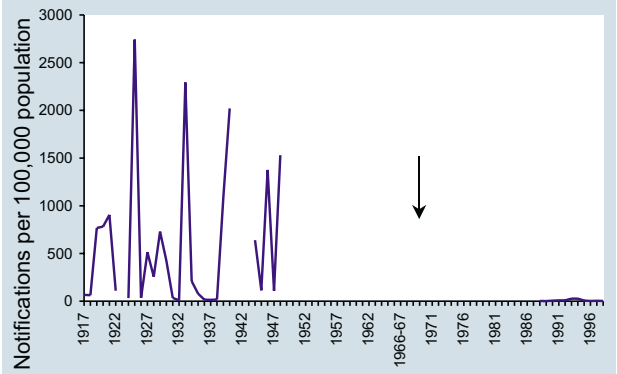

### *H. influenzae* type b disease, 1991–1998



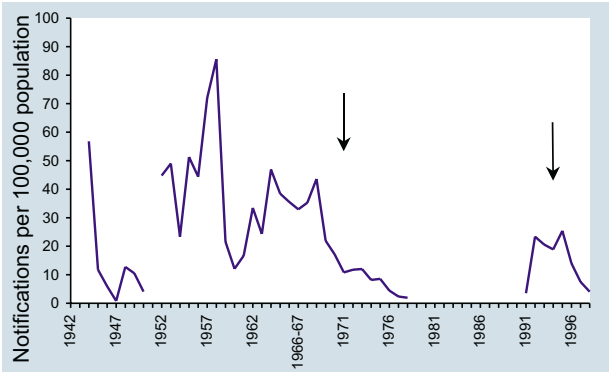

### Poliomyelitis, 1917–1998




### Measles, 1917–1998




### Rubella, 1917–1998

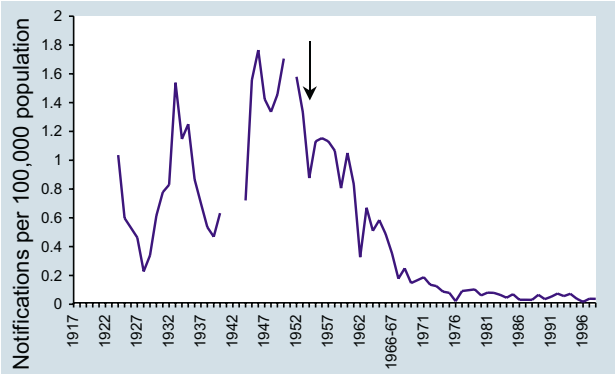



Indicates major change in vaccination policy.

Source: Hall R. Notifiable disease surveillance, 1917 to 1991. *Commun Dis Intell* 1993;17:226-36.

Updated with NNDSS data 1992–1998.

### Tetanus, 1917–1998




Indicates major change in vaccination policy.

Source: Hall R. Notifiable disease surveillance, 1917 to 1991. *Commun Dis Intell* 1993;17:226-36.

Updated with NNDSS data 1992–1998.

# Appendix 2

## Notifications by State/Territory and year (January 1993–December 1998)

## Table 18. Notifications by State/Territory and year (January 1993–December 1998)

| Disease* | Year | Number of notifications | | | | | | | | | Notification rate per 100 000 population | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ACT | NSW | NT | QLD | SA | TAS | VIC | WA | Total | ACT | NSW | NT | QLD | SA | TAS | VIC | WA | Total |
| Diphtheria | 1993 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | - | - | - | - |
| | 1994 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | - | - | - | - |
| | 1995 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | - | - | - | - |
| | 1996 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | - | - | - | - |
| | 1997 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | - | - | - | - |
| | 1998 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | - | - | - | - |
| | Total[§] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | - | - | - | - |
| *Haemophilus influenzae* type b disease (<15 yr only) | 1993 | 9 | 117 | 19 | 60 | 43 | 10 | 76 | (26)[†] | 334 | 13.2 | 9.1 | 40.3 | 8.6 | 14.3 | 9.3 | 8.0 | NN | 9.7 |
| | 1994 | 1 | 48 | 1 | 26 | 15 | 3 | 24 | 10 | 128 | 1.5 | 3.7 | 2.1 | 3.7 | 5.0 | 2.8 | 2.5 | 2.6 | 3.3 |
| | 1995 | 1 | 24 | 4 | 8 | 7 | 4 | 14 | 4 | 66 | 1.5 | 1.8 | 8.2 | 1.1 | 2.3 | 3.8 | 1.5 | 1.0 | 1.7 |
| | 1996 | 2 | 9 | 4 | 9 | 5 | 1 | 7 | 1 | 38 | 2.9 | 0.7 | 8.1 | 1.2 | 1.7 | 0.9 | 0.7 | 0.3 | 1.0 |
| | 1997 | 0 | 12 | 3 | 12 | 2 | 2 | 7 | 3 | 41 | 0.0 | 0.9 | 6.0 | 1.6 | 0.7 | 1.9 | 0.7 | 0.8 | 1.0 |
| | 1998 | 0 | 11 | 0 | 7 | 1 | 2 | 1 | 5 | 27 | 0.0 | 0.8 | 0.0 | 0.9 | 0.3 | 2.0 | 0.1 | 1.3 | 0.7 |
| | Total[§] | 13 | 221 | 31 | 122 | 73 | 22 | 129 | 23 | 634 | 3.2 | 2.8 | 10.6 | 2.8 | 4.1 | 3.5 | 2.3 | 1.2 | 2.8 |
| Measles | 1993 | 181 | 2390 | 7 | 990 | 88 | 851 | 187 | 42 | 4736 | 60.5 | 39.8 | 4.1 | 31.8 | 6.0 | 180.4 | 4.2 | 2.5 | 26.8 |
| | 1994 | 120 | 1500 | 434 | 2361 | 67 | 32 | 177 | 132 | 4823 | 39.8 | 24.8 | 250.3 | 74.1 | 4.6 | 6.8 | 3.9 | 7.8 | 27.0 |
| | 1995 | 41 | 604 | 78 | 201 | 6 | 53 | 152 | 59 | 1194 | 13.5 | 9.9 | 43.9 | 6.2 | 0.4 | 11.2 | 3.4 | 3.4 | 6.6 |
| | 1996 | 10 | 191 | 29 | 91 | 13 | 21 | 94 | 32 | 481 | 3.2 | 3.1 | 15.9 | 2.7 | 0.9 | 4.4 | 2.1 | 1.8 | 2.6 |
| | 1997 | 76 | 264 | 8 | 268 | 28 | 38 | 92 | 83 | 857 | 24.5 | 4.2 | 4.3 | 7.9 | 1.9 | 8.0 | 2.0 | 4.6 | 4.6 |
| | 1998 | 38 | 119 | 1 | 35 | 5 | 36 | 27 | 52 | 313 | 12.3 | 1.9 | 0.5 | 1.0 | 0.3 | 7.6 | 0.6 | 2.8 | 1.7 |
| | Total[§] | 466 | 5068 | 557 | 3946 | 207 | 1031 | 729 | 400 | 12404 | 25.4 | 13.7 | 51.5 | 20.0 | 2.3 | 36.3 | 2.7 | 3.8 | 11.4 |
| Mumps | 1993 | 1 | 13 | NN | NN | (4)[†] | NN | 4 | (10)[†] | 18 | 0.3 | 0.2 | NN | NN | - | NN | 0.1 | - | 0.2 |
| | 1994 | 5 | 11 | (3)[†] | NN | 6 | NN | 58 | 7 | 87 | 1.7 | 0.2 | - | NN | 0.4 | NN | 1.3 | 0.4 | 0.6 |
| | 1995 | 17 | 14 | 8 | NN | 12 | 9 | 80 | 17 | 157 | 5.6 | 0.2 | 4.5 | NN | 0.8 | 1.9 | 1.8 | 1.0 | 1.1 |
| | 1996 | 6 | 28 | 5 | (0)[†] | 14 | 3 | 51 | 19 | 126 | 1.9 | 0.5 | 2.7 | - | 0.9 | 0.6 | 1.1 | 1.1 | 0.8 |
| | 1997 | 7 | 29 | 10 | 16 | 26 | 3 | 64 | 36 | 191 | 2.3 | 0.5 | 5.3 | 0.5 | 1.8 | 0.6 | 1.4 | 2.0 | 1.0 |
| | 1998 | 5 | 39 | 5 | 31 | 8 | 2 | 52 | 39 | 181 | 1.6 | 0.6 | 2.6 | 0.9 | 0.5 | 0.4 | 1.1 | 2.1 | 1.0 |
| | Total[§] | 41 | 134 | 28 | 47 | 66 | 17 | 309 | 118 | 760 | 2.2 | 0.4 | 3.8 | 0.7 | 0.9 | 0.9 | 1.1 | 1.3 | 0.8 |

NN = not notifiable. *See Chapters 3 and 4 for case definitions. [§]Total cases for 6 year period & average annual rate per 100,000 population. [†] Disease not notifiable for complete year, data not included in totals.

## Table 18. Notifications by State/Territory and year (January 1993–December 1998), (continued)

| Disease* | Year | Number of notifications | | | | | | | | | Notification rate per 100,000 population | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ACT | NSW | NT | QLD | SA | TAS | VIC | WA | Total | ACT | NSW | NT | QLD | SA | TAS | VIC | WA | Total |
| Pertussis | 1993 | 48 | 1548 | 7 | 687 | 1351 | 56 | 496 | 261 | 4454 | 16.0 | 25.8 | 4.1 | 22.1 | 92.5 | 11.9 | 11.1 | 15.6 | 25.2 |
| | 1994 | 19 | 1427 | 182 | 1923 | 748 | 34 | 448 | 662 | 5443 | 6.3 | 23.5 | 105.0 | 60.3 | 51.0 | 7.2 | 10.0 | 38.9 | 30.5 |
| | 1995 | 35 | 1385 | 132 | 1354 | 454 | 110 | 438 | 339 | 4247 | 11.5 | 22.6 | 74.3 | 41.5 | 30.9 | 23.2 | 9.7 | 19.6 | 23.5 |
| | 1996 | 40 | 1146 | 14 | 774 | 774 | 31 | 1378 | 227 | 4384 | 13.0 | 18.5 | 7.7 | 23.2 | 52.5 | 6.5 | 30.2 | 12.9 | 23.9 |
| | 1997 | 105 | 4297 | 24 | 1902 | 1673 | 120 | 1583 | 1203 | 10907 | 33.9 | 68.5 | 12.8 | 55.9 | 113.1 | 25.3 | 34.4 | 66.9 | 58.9 |
| | 1998 | 102 | 1921 | 24 | 1386 | 568 | 55 | 1052 | 305 | 5413 | 33.1 | 30.3 | 12.6 | 40.1 | 38.2 | 11.7 | 22.6 | 16.7 | 28.9 |
| | Total* | 349 | 11724 | 383 | 8026 | 5568 | 406 | 5395 | 2997 | 34848 | 19.0 | 31.7 | 35.4 | 40.6 | 63.0 | 14.3 | 19.8 | 28.5 | 31.9 |
| (<5 yr only) | Total§ | 52 | 1678 | 86 | 696 | 440 | 73 | 728 | 729 | 4482 | 39.1 | 63.7 | 81.3 | 48.4 | 75.1 | 35.7 | 38.2 | 95.9 | 57.7 |
| Poliomyelitis | 1993 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | - | - | - | - |
| | 1994 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | - | - | - | - |
| | 1995 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | - | - | - | - |
| | 1996 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | - | - | - | - |
| | 1997 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | - | - | - | - |
| | 1998 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | - | - | - | - |
| | Total§ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | - | - | - | - |
| Rubella | 1993 | 127 | 812 | 18 | 1404 | 275 | NN‡ | 491 | (509)† | 3127 | 42.4 | 13.5 | 10.5 | 45.1 | 18.8 | NN | 11.0 | - | 20.2 |
| | 1994 | 49 | 113 | 45 | 2148 | 75 | NN‡ | 211 | 730 | 3371 | 16.3 | 1.9 | 26.0 | 67.4 | 5.1 | NN | 4.7 | 42.9 | 19.4 |
| | 1995 | 173 | 1213 | 10 | 1073 | 87 | 169 | 1468 | 396 | 4589 | 56.8 | 19.8 | 5.6 | 32.9 | 5.9 | 35.7 | 32.5 | 22.8 | 25.4 |
| | 1996 | 70 | 254 | 7 | 979 | 382 | 32 | 667 | 161 | 2552 | 22.7 | 4.1 | 3.8 | 29.3 | 25.9 | 6.7 | 14.6 | 9.1 | 13.9 |
| | 1997 | 32 | 155 | 7 | 539 | 183 | 18 | 371 | 84 | 1389 | 10.3 | 2.5 | 3.7 | 15.8 | 12.4 | 3.8 | 8.1 | 4.7 | 7.5 |
| | 1998 | 31 | 74 | 5 | 372 | 16 | 14 | 184 | 66 | 762 | 10.1 | 1.2 | 2.6 | 10.8 | 1.1 | 3.0 | 3.9 | 3.6 | 4.1 |
| | Total§ | 482 | 2621 | 92 | 6515 | 1018 | 233 | 3392 | 1437 | 15790 | 26.3 | 7.1 | 8.5 | 33.0 | 11.5 | 12.3 | 12.4 | 16.3 | 14.8 |
| Tetanus | 1993 | 0 | 5 | 0 | NN | 3 | 0 | 2 | 0 | 10 | - | 0.1 | - | NN | 0.2 | - | 0.0 | - | 0.1 |
| | 1994 | 0 | 4 | 0 | 0 | 6 | 0 | 1 | 2 | 13 | - | 0.1 | - | - | 0.4 | - | 0.0 | 0.1 | 0.1 |
| | 1995 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 3 | 7 | - | - | - | - | - | - | 0.1 | 0.2 | 0.0 |
| | 1996 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | - | 0.0 | - | - | - | - | 0.0 | 0.1 | 0.0 |
| | 1997 | 0 | 3 | 0 | 2 | 0 | 1 | 1 | 0 | 7 | - | 0.0 | - | 0.1 | - | 0.2 | 0.0 | - | 0.0 |
| | 1998 | 0 | 3 | 0 | 1 | 0 | 1 | 1 | 1 | 7 | - | 0.0 | - | 0.0 | - | 0.2 | 0.0 | 0.1 | 0.0 |
| | Total§ | 0 | 16 | 0 | 3 | 9 | 2 | 10 | 7 | 47 | - | 0.0 | - | 0.0 | 0.1 | 0.1 | 0.0 | 0.1 | 0.0 |

NN = not notifiable. *See Chapters 3 and 4 for case definitions. §Total cases for 6 year period & average annual rate per 100,000 population. † Disease not notifiable for complete year, data not included in totals.‡ Only congenital rubella notifiable.

## Table 18. Notifications by State/Territory and year (January 1993–December 1998), (continued)

| | | Number of notifications | | | | | | | | | Notification rate per 100,000 population | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Disease* | Year | ACT | NSW | NT | QLD | SA | TAS | VIC | WA | Total | ACT | NSW | NT | QLD | SA | TAS | VIC | WA | Total |
| Hepatitis A | 1993 | 19 | 594 | 108 | 917 | 114 | 3 | 170 | 50 | 1975 | 6.3 | 9.9 | 63.3 | 29.5 | 7.8 | 0.6 | 3.8 | 3.0 | 11.2 |
| | 1994 | 14 | 591 | 72 | 792 | 50 | 10 | 154 | 236 | 1919 | 4.6 | 9.8 | 41.5 | 24.9 | 3.4 | 2.1 | 3.4 | 13.9 | 10.7 |
| | 1995 | 17 | 631 | 50 | 446 | 39 | 9 | 285 | 168 | 1645 | 5.6 | 10.3 | 28.2 | 13.7 | 2.7 | 1.9 | 6.3 | 9.7 | 9.1 |
| | 1996 | 61 | 963 | 73 | 408 | 39 | 9 | 447 | 112 | 2112 | 19.8 | 15.5 | 40.1 | 12.2 | 2.6 | 1.9 | 9.8 | 6.3 | 11.5 |
| | 1997 | 52 | 1454 | 95 | 917 | 92 | 3 | 341 | 117 | 3071 | 16.8 | 23.2 | 50.8 | 27.0 | 6.2 | 0.6 | 7.4 | 6.5 | 16.6 |
| | 1998 | 49 | 941 | 40 | 1044 | 95 | 8 | 175 | 150 | 2502 | 15.9 | 14.8 | 21.1 | 30.2 | 6.4 | 1.7 | 3.8 | 8.2 | 13.3 |
| | Total§ | 212 | 5174 | 438 | 4524 | 429 | 42 | 1572 | 833 | 13224 | 11.6 | 14.0 | 40.5 | 22.9 | 4.9 | 1.5 | 5.8 | 7.9 | 12.1 |
| Hepatitis B (acute) | 1993 | NN | 102 | 1 | NN | 35 | 2 | 97 | NN | 237 | NN | 1.7 | 0.6 | NN | 2.4 | 0.4 | 2.2 | NN | 1.9 |
| | 1994 | NN | 83 | 26 | 51 | 31 | 2 | 96 | 39 | 328 | NN | 1.4 | 15.0 | 1.6 | 2.1 | 0.4 | 2.1 | 2.3 | 1.9 |
| | 1995 | 12 | 67 | 14 | 64 | 33 | 8 | 102 | 31 | 331 | 3.9 | 1.1 | 7.9 | 2.0 | 2.2 | 1.7 | 2.3 | 1.8 | 1.8 |
| | 1996 | 4 | 43 | 5 | 33 | 18 | 7 | 92 | 11 | 213 | 1.3 | 0.7 | 2.7 | 1.0 | 1.2 | 1.5 | 2.0 | 0.6 | 1.2 |
| | 1997 | 2 | 50 | 20 | 43 | 16 | 1 | 117 | 19 | 268 | 0.6 | 0.8 | 10.7 | 1.3 | 1.1 | 0.2 | 2.5 | 1.1 | 1.4 |
| | 1998 | 0 | 58 | 17 | 48 | 18 | 6 | 88 | 33 | 268 | 0.0 | 0.9 | 8.9 | 1.4 | 1.2 | 1.3 | 1.9 | 1.8 | 1.4 |
| | Total§ | 18 | 403 | 83 | 239 | 151 | 26 | 592 | 133 | 1645 | 1.5 | 1.1 | 7.7 | 1.4 | 1.7 | 0.9 | 2.2 | 1.5 | 1.6 |

NN = not notifiable. *See Chapters 3 and 4 for case definitions. §Total cases for 6 year period & average annual ate per 100,000 population. † Disease not notifiable for complete year, data not included in totals.

# Appendix 3

## Hospitalisations by State/Territory (July 1993–June 1998)

## Table 19. Hospitalisations by State/Territory and financial year (July 1993–June 1998)

| | | Number of hospitalisations | | | | | | | | | Hospitalisation rate per 100,000 population | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Disease* | Year | ACT | NSW | NT | QLD | SA | TAS | VIC | WA | Total | ACT | NSW | NT | QLD | SA | TAS | VIC | WA | Total |
| Diphtheria | 93/94 | 0 | 3 | 0 | 0 | 0 | 0 | 4 | 0 | 7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| | 94/95 | 0 | 2 | 0 | 0 | 1 | 2 | 1 | 0 | 6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.4 | 0.0 | 0.0 | 0.0 |
| | 95/96 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 2 | 6 | 0.0 | 0.0 | 0.6 | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 | 0.0 |
| | 96/97 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 97/98 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Total† | 0 | 6 | 1 | 2 | 2 | 2 | 5 | 2 | 20 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 |
| H*aemophilus influenzae* type b disease (<15 yr) | 93/94 | 6 | 129 | 6 | 68 | 41 | 12 | 67 | 26 | 355 | 8.8 | 10.0 | 12.7 | 9.8 | 13.6 | 11.2 | 7.1 | 6.8 | 9.3 |
| | 94/95 | 0 | 42 | 2 | 43 | 11 | 12 | 32 | 14 | 156 | 0.0 | 3.2 | 4.2 | 6.1 | 3.7 | 11.2 | 3.4 | 3.6 | 4.0 |
| | 95/96 | 2 | 41 | 0 | 16 | 13 | 2 | 23 | 9 | 106 | 2.9 | 3.1 | 0.0 | 2.2 | 4.3 | 1.9 | 2.4 | 2.3 | 2.7 |
| | 96/97 | 0 | 34 | 1 | 20 | 5 | 3 | 11 | 9 | 83 | 0.0 | 2.6 | 2.0 | 2.7 | 1.7 | 2.8 | 1.2 | 2.3 | 2.1 |
| | 97/98 | 1 | 34 | 3 | 18 | 4 | 2 | 13 | 43 | 118 | 1.5 | 2.6 | 6.0 | 2.4 | 1.3 | 1.9 | 1.4 | 10.9 | 3.0 |
| | Total† | 9 | 280 | 12 | 165 | 74 | 31 | 146 | 101 | 818 | 0.6 | 0.9 | 1.3 | 1.0 | 1.0 | 1.3 | 0.6 | 1.2 | 0.9 |
| Measles | 93/94 | 21 | 474 | 3 | 571 | 5 | 34 | 42 | 5 | 1155 | 7.0 | 7.9 | 1.8 | 18.4 | 0.3 | 7.2 | 0.9 | 0.3 | 6.5 |
| | 94/95 | 13 | 233 | 72 | 401 | 10 | 0 | 24 | 8 | 761 | 4.3 | 3.8 | 41.5 | 12.6 | 0.7 | 0.0 | 0.5 | 0.5 | 4.3 |
| | 95/96 | 1 | 29 | 1 | 21 | 5 | 3 | 8 | 2 | 70 | 0.3 | 0.5 | 0.6 | 0.6 | 0.3 | 0.6 | 0.2 | 0.1 | 0.4 |
| | 96/97 | 0 | 35 | 8 | 17 | 2 | 1 | 12 | 6 | 81 | 0.0 | 0.6 | 4.4 | 0.5 | 0.1 | 0.2 | 0.3 | 0.3 | 0.4 |
| | 97/98 | 11 | 63 | 1 | 59 | 4 | 3 | 12 | 3 | 156 | 3.6 | 1.0 | 0.5 | 1.7 | 0.3 | 0.6 | 0.3 | 0.2 | 0.8 |
| | Total† | 46 | 834 | 85 | 1069 | 26 | 41 | 98 | 24 | 2223 | 3.0 | 2.7 | 9.5 | 6.6 | 0.4 | 1.7 | 0.4 | 0.3 | 2.5 |
| Mumps | 93/94 | 1 | 16 | 0 | 14 | 5 | 0 | 10 | 0 | 46 | 0.3 | 0.3 | 0.0 | 0.5 | 0.3 | 0.0 | 0.2 | 0.0 | 0.3 |
| | 94/95 | 1 | 24 | 1 | 11 | 7 | 1 | 15 | 8 | 68 | 0.3 | 0.4 | 0.6 | 0.3 | 0.5 | 0.2 | 0.3 | 0.5 | 0.4 |
| | 95/96 | 1 | 18 | 3 | 8 | 8 | 0 | 14 | 3 | 55 | 0.3 | 0.3 | 1.7 | 0.2 | 0.5 | 0.0 | 0.3 | 0.2 | 0.3 |
| | 96/97 | 0 | 17 | 0 | 10 | 6 | 0 | 11 | 6 | 50 | 0.0 | 0.3 | 0.0 | 0.3 | 0.4 | 0.0 | 0.2 | 0.3 | 0.3 |
| | 97/98 | 2 | 18 | 1 | 10 | 3 | 1 | 8 | 8 | 51 | 0.6 | 0.3 | 0.5 | 0.3 | 0.2 | 0.2 | 0.2 | 0.4 | 0.3 |
| | Total† | 5 | 93 | 5 | 53 | 29 | 2 | 58 | 25 | 270 | 0.3 | 0.3 | 0.6 | 0.3 | 0.4 | 0.1 | 0.3 | 0.3 | 0.3 |

* See Chapters 3 and 4 for case definitions. †Total cases for six year period and average annual rate per 100,000 population.

## Table 19. Hospitalisations by State/Territory and financial year (July 1993–June 1998), (continued)

| Disease* | Year | Number of hospitalisations | | | | | | | | | Hospitalisations rate per 100,000 population | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ACT | NSW | NT | QLD | SA | TAS | VIC | WA | Total | ACT | NSW | NT | QLD | SA | TAS | VIC | WA | Total |
| Pertussis | 93/94 | 6 | 480 | 5 | 274 | 145 | 13 | 140 | 60 | 1123 | 2.0 | 8.0 | 2.9 | 8.8 | 9.9 | 2.8 | 3.1 | 3.6 | 6.4 |
| | 94/95 | 12 | 238 | 45 | 253 | 52 | 21 | 157 | 107 | 885 | 4.0 | 3.9 | 26.0 | 7.9 | 3.5 | 4.4 | 3.5 | 6.3 | 5.0 |
| | 95/96 | 5 | 199 | 11 | 171 | 86 | 15 | 164 | 57 | 708 | 1.6 | 3.2 | 6.2 | 5.2 | 5.9 | 3.2 | 3.6 | 3.3 | 3.9 |
| | 96/97 | 7 | 261 | 3 | 88 | 157 | 8 | 275 | 124 | 923 | 2.3 | 4.2 | 1.6 | 2.6 | 10.6 | 1.7 | 6.0 | 7.0 | 5.0 |
| | 97/98 | 9 | 439 | 8 | 213 | 123 | 11 | 125 | 237 | 1165 | 2.9 | 7.0 | 4.3 | 6.3 | 8.3 | 2.3 | 2.7 | 13.2 | 6.3 |
| | Total† | 39 | 1617 | 72 | 999 | 563 | 68 | 861 | 585 | 4804 | 2.6 | 5.3 | 8.1 | 6.1 | 7.7 | 2.9 | 3.8 | 6.7 | 5.3 |
| (<5 yr only) | Total† | 28 | 1215 | 61 | 652 | 316 | 48 | 642 | 465 | 3427 | 25.1 | 55.3 | 69.3 | 54.6 | 64.4 | 27.9 | 40.3 | 73.5 | 52.9 |
| Poliomyelitis | 93/94 | 0 | 23 | 1 | 13 | 3 | 1 | 6 | 0 | 47 | 0.0 | 0.4 | 0.6 | 0.4 | 0.2 | 0.2 | 0.1 | 0.0 | 0.3 |
| | 94/95 | 1 | 27 | 0 | 15 | 10 | 0 | 18 | 1 | 72 | 0.3 | 0.4 | 0.0 | 0.5 | 0.7 | 0.0 | 0.4 | 0.1 | 0.4 |
| | 95/96 | 0 | 22 | 0 | 13 | 8 | 5 | 20 | 3 | 71 | 0.0 | 0.4 | 0.0 | 0.4 | 0.5 | 1.1 | 0.4 | 0.2 | 0.4 |
| | 96/97 | 0 | 28 | 0 | 16 | 0 | 3 | 20 | 0 | 67 | 0.0 | 0.5 | 0.0 | 0.5 | 0.0 | 0.6 | 0.4 | 0.0 | 0.4 |
| | 97/98 | 0 | 31 | 0 | 19 | 6 | 1 | 14 | 0 | 71 | 0.0 | 0.5 | 0.0 | 0.6 | 0.4 | 0.2 | 0.3 | 0.0 | 0.4 |
| | Total† | 1 | 131 | 1 | 76 | 27 | 10 | 78 | 4 | 328 | 0.1 | 0.4 | 0.1 | 0.5 | 0.4 | 0.4 | 0.3 | 0.0 | 0.4 |
| (Principal diagnoses only) | Total† | 0 | 5 | 0 | 8 | 1 | 0 | 2 | 0 | 16 | - | 0.0 | - | 0.0 | 0.0 | - | 0.0 | - | 0.0 |
| Rubella | 93/94 | 2 | 46 | 2 | 23 | 7 | 2 | 7 | 13 | 102 | 0.7 | 0.8 | 1.2 | 0.7 | 0.5 | 0.4 | 0.2 | 0.8 | 0.6 |
| | 94/95 | 3 | 38 | 3 | 41 | 11 | 0 | 9 | 12 | 117 | 1.0 | 0.6 | 1.7 | 1.3 | 0.8 | 0.0 | 0.2 | 0.7 | 0.7 |
| | 95/96 | 1 | 61 | 0 | 22 | 5 | 5 | 19 | 13 | 126 | 0.3 | 1.0 | 0.0 | 0.7 | 0.3 | 1.1 | 0.4 | 0.7 | 0.7 |
| | 96/97 | 1 | 18 | 1 | 18 | 3 | 3 | 6 | 2 | 52 | 0.3 | 0.3 | 0.5 | 0.5 | 0.2 | 0.6 | 0.1 | 0.1 | 0.3 |
| | 97/98 | 1 | 22 | 0 | 12 | 5 | 0 | 3 | 5 | 48 | 0.3 | 0.4 | 0.0 | 0.4 | 0.3 | 0.0 | 0.1 | 0.3 | 0.3 |
| | Total† | 8 | 185 | 6 | 116 | 31 | 10 | 44 | 45 | 445 | 0.5 | 0.6 | 0.7 | 0.7 | 0.4 | 0.4 | 0.2 | 0.5 | 0.5 |
| Tetanus | 93/94 | 2 | 9 | 0 | 2 | 8 | 0 | 7 | 2 | 30 | 0.7 | 0.1 | 0.0 | 0.1 | 0.5 | 0.0 | 0.2 | 0.1 | 0.2 |
| | 94/95 | 1 | 4 | 0 | 0 | 9 | 0 | 5 | 3 | 22 | 0.3 | 0.1 | 0.0 | 0.0 | 0.6 | 0.0 | 0.1 | 0.2 | 0.1 |
| | 95/96 | 0 | 3 | 0 | 3 | 3 | 1 | 4 | 5 | 19 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.1 | 0.3 | 0.1 |
| | 96/97 | 0 | 9 | 0 | 11 | 2 | 1 | 15 | 1 | 39 | 0.0 | 0.1 | 0.0 | 0.3 | 0.1 | 0.2 | 0.3 | 0.1 | 0.2 |
| | 97/98 | 0 | 20 | 0 | 2 | 3 | 1 | 4 | 4 | 34 | 0.0 | 0.3 | 0.0 | 0.1 | 0.2 | 0.2 | 0.1 | 0.2 | 0.2 |
| | Total | 3 | 45 | 0 | 18 | 25 | 3 | 35 | 15 | 144 | 0.2 | 0.1 | 0.0 | 0.1 | 0.3 | 0.1 | 0.2 | 0.2 | 0.2 |

* See Chapters 3 and 4 for case definitions. †Total cases for six year period and average annual rate per 100,000 population.

## Table 19. Hospitalisations by State/Territory and financial year (July 1993–June 1998), (continued)

| Disease* | Year | Number of hospitalisations | | | | | | | | | Hospitalisation rate per 100,000 population | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ACT | NSW | NT | QLD | SA | TAS | VIC | WA | Total | ACT | NSW | NT | QLD | SA | TAS | VIC | WA | Total |
| Hepatitis A | 93/94 | 4 | 226 | 10 | 210 | 25 | 3 | 87 | 87 | 652 | 1.3 | 3.8 | 5.9 | 6.8 | 1.7 | 0.6 | 1.9 | 5.2 | 3.7 |
| | 94/95 | 3 | 192 | 14 | 136 | 47 | 2 | 92 | 71 | 557 | 1.0 | 3.2 | 8.1 | 4.3 | 3.2 | 0.4 | 2.1 | 4.2 | 3.1 |
| | 95/96 | 5 | 241 | 18 | 203 | 32 | 4 | 155 | 42 | 700 | 1.6 | 3.9 | 10.1 | 6.2 | 2.2 | 0.8 | 3.4 | 2.4 | 3.9 |
| | 96/97 | 9 | 403 | 40 | 218 | 48 | 4 | 160 | 44 | 926 | 2.9 | 6.5 | 22.0 | 6.5 | 3.3 | 0.8 | 3.5 | 2.5 | 5.1 |
| | 97/98 | 11 | 393 | 20 | 291 | 53 | 0 | 96 | 74 | 938 | 3.6 | 6.3 | 10.7 | 8.6 | 3.6 | 0.0 | 2.1 | 4.1 | 5.1 |
| | Total† | 32 | 1455 | 102 | 1058 | 205 | 13 | 590 | 318 | 3773 | 2.1 | 4.7 | 11.5 | 6.5 | 2.8 | 0.5 | 2.6 | 3.7 | 4.2 |
| Hepatitis B (acute)‡ | 93/94 | 2 | 165 | 3 | 71 | 37 | 1 | 107 | 17 | 403 | 0.7 | 2.7 | 1.8 | 2.3 | 2.5 | 0.2 | 2.4 | 1.0 | 2.3 |
| | 94/95 | 5 | 159 | 7 | 68 | 25 | 4 | 112 | 19 | 399 | 1.7 | 2.6 | 4.0 | 2.1 | 1.7 | 0.8 | 2.5 | 1.1 | 2.2 |
| | 95/96 | 2 | 64 | 4 | 38 | 24 | 1 | 82 | 15 | 230 | 0.7 | 1.0 | 2.3 | 1.2 | 1.6 | 0.2 | 1.8 | 0.9 | 1.3 |
| | 96/97 | 0 | 64 | 3 | 19 | 16 | 3 | 81 | 21 | 207 | 0.0 | 1.0 | 1.6 | 0.6 | 1.1 | 0.6 | 1.8 | 1.2 | 1.1 |
| | 97/98 | 3 | 54 | 1 | 23 | 13 | 0 | 66 | 15 | 175 | 1.0 | 0.9 | 0.5 | 0.7 | 0.9 | 0.0 | 1.4 | 0.8 | 0.9 |
| | Total† | 12 | 506 | 18 | 219 | 115 | 9 | 448 | 87 | 1414 | 0.8 | 1.6 | 2.0 | 1.3 | 1.6 | 0.4 | 2.0 | 1.0 | 1.6 |
| Invasive pneumococcal disease | 93/94 | 10 | 133 | 24 | 74 | 42 | 3 | 70 | 27 | 383 | 3.3 | 2.2 | 14.1 | 2.4 | 2.9 | 0.6 | 1.6 | 1.6 | 2.2 |
| | 94/95 | 10 | 134 | 45 | 80 | 51 | 4 | 83 | 19 | 426 | 3.3 | 2.2 | 26.0 | 2.5 | 3.5 | 0.8 | 1.8 | 1.1 | 2.4 |
| | 95/96 | 14 | 136 | 35 | 67 | 31 | 4 | 82 | 25 | 394 | 4.6 | 2.2 | 19.7 | 2.1 | 2.1 | 0.8 | 1.8 | 1.4 | 2.2 |
| | 96/97 | 9 | 262 | 31 | 111 | 57 | 10 | 164 | 29 | 673 | 2.9 | 4.2 | 17.0 | 3.3 | 3.9 | 2.1 | 3.6 | 1.6 | 3.7 |
| | 97/98 | 6 | 260 | 32 | 71 | 63 | 12 | 143 | 54 | 641 | 1.9 | 4.1 | 17.1 | 2.1 | 4.3 | 2.5 | 3.1 | 3.0 | 3.5 |
| | Total† | 49 | 925 | 167 | 403 | 244 | 33 | 542 | 154 | 2517 | 3.2 | 3.0 | 18.8 | 2.5 | 3.3 | 1.4 | 2.4 | 1.8 | 2.8 |
| Varicella | 93/94 | 29 | 476 | 28 | 274 | 140 | 31 | 346 | 178 | 1502 | 9.7 | 7.9 | 16.4 | 8.8 | 9.6 | 6.6 | 7.7 | 10.6 | 8.5 |
| | 94/95 | 35 | 562 | 32 | 406 | 132 | 30 | 329 | 178 | 1704 | 11.6 | 9.3 | 18.5 | 12.7 | 9.0 | 6.3 | 7.3 | 10.5 | 9.5 |
| | 95/96 | 28 | 432 | 16 | 245 | 148 | 26 | 317 | 160 | 1372 | 9.2 | 7.1 | 9.0 | 7.5 | 10.1 | 5.5 | 7.0 | 9.2 | 7.6 |
| | 96/97 | 23 | 545 | 11 | 374 | 126 | 31 | 324 | 133 | 1567 | 7.5 | 8.8 | 6.0 | 11.2 | 8.5 | 6.5 | 7.1 | 7.5 | 8.6 |
| | 97/98 | 27 | 440 | 18 | 300 | 126 | 25 | 365 | 214 | 1515 | 8.7 | 7.0 | 9.6 | 8.8 | 8.5 | 5.3 | 7.9 | 11.9 | 8.2 |
| | Total† | 142 | 2455 | 105 | 1599 | 672 | 143 | 1681 | 863 | 7660 | 9.3 | 8.0 | 11.8 | 9.8 | 9.1 | 6.0 | 7.4 | 9.9 | 8.5 |

* See Chapters 3 and 4 for case definitions. †Total cases for six year period and average annual rate per 100,000 population. ‡Acute and chronic infections could not be distinguished prior to 94/95.

# Appendix 4

## Changes to the Australian vaccination schedule 1992–1998

### Table 20. Diphtheria, tetanus and pertussis (DTP) vaccination practice in Australia 1992–1998

| Date | Intervention |
|---|---|
| 1994 | 5th dose of DTP at 4-5 years added to the recommended vaccination schedule (replacing CDT vaccine)<br>Active ADT school vaccination programs commenced in some States for 15-19 year olds |
| 1996 | Diphtheria-tetanus-acellular pertussis vaccine (DTPa) licensed in Australia |
| 1997 | DTPa recommended for 4th and 5th doses of DTP vaccination (due at 18 months and 4-5 years) |

### Table 21. *Haemophilus influenzae* type b vaccination practice in Australia 1992–1998

| Date | Intervention |
|---|---|
| 1992 | 1st Hib vaccines (PRP-D; ProHIBit) licensed in Australia for vaccinating infants aged at least 18 months |
| 1993 | Hib vaccine recommended as part of the childhood vaccination schedule<br>Hib vaccines: HBOC (HibTITER), PRP-T (Act-HIB), and PRP-OMP (PedvaxHIB) licensed for infants aged <18 months<br>PRP-OMP recommended at 2, 4 and 12 months, HBOC and PRP-T at 2, 4, 6 and 18 months |

### Table 22. Measles, mumps and rubella vaccination practice in Australia 1992–1998

| Date | Intervention |
|---|---|
| 1992 (Nov) | NHMRC recommended 2nd dose of MMR vaccine for both sexes to replace schoolgirl rubella vaccination program |
| 1993 (Nov) | Childhood vaccination schedule updated to include second dose of MMR vaccine for 10-16 year olds (replacing schoolgirl rubella vaccination) |
| 1998 | Recommended age for 1st dose of MMR vaccine for Aboriginal children in the Northern Territory increased to 12 months of age (in line with non-Aboriginal infants)<br>July: Recommended age for 2nd MMR vaccine dose lowered to 4-5 years<br>July-December: Implementation of Measles Control Campaign (involving mass vaccination of primary school aged children with MMR vaccine) |

### Table 23. Polio vaccination practice in Australia 1992–1998

| Date | Intervention |
|---|---|
| 1994 | Recommendation for reinforcing dose of OPV to 15 year old adolescents |

### Table 24. Hepatitis A vaccination practice in Australia 1992–1998

| Date | Intervention |
|---|---|
| 1994 | Hepatitis A vaccine (formaldehyde inactivated HAV) licensed in Australia for at risk groups, 3 doses recommended |

### Table 25. Hepatitis B vaccination practice in Australia 1992–1998

| Date | Intervention |
|---|---|
| 1997 | Vaccination recommended for adolescents aged 10-16 yrs |
| 1997 | Interim recommendation for universal vaccination of infants at birth |
| 1998 | School based programs commenced for 10-16 year olds in South Australia and Victoria. A 'catch up' campaign was conducted in the Northern Territory for children 6-16 years of age |

# Appendix 5

## Vaccination funding in Australia

Prior to 1988, the Commonwealth provided childhood vaccines to States/Territories for distribution to providers in the public sector. During the same time, live-attenuated vaccines such as Oral Polio Vaccine (OPV) and measles vaccine were provided to private practitioners, although it is not certain that this occurred in all States/Territories. Private practitioners who provided vaccination services were required to issue prescriptions for the supply of inactivated vaccines, such as DTPw, by a pharmacist.

In July 1988, the Commonwealth made a decision to withdraw from the direct provision of funding to purchase childhood vaccines, and instead increased funding provided to States/Territories as part of the Finance Assistance Grants (FAGs) and Hospital Funding Grants (HFGs). The increase in funding was equivalent to the level of immunisation activity in each jurisdiction in 1988.

The level of funding provided via the FAGs/HFGs was in dispute by States/Territories from a very early stage, as increases in vaccination activity above the 1988 level began to put pressure on the resources provided. Details of the funding arrangements were also interpreted differently by the Commonwealth and each State/Territory, leading to variations in implementation of immunisation programs and uncoordinated and fragmented service delivery.

In April 1993, the National Health and Medical Research Council (NHMRC) reported on Australia's immunisation programs and made recommendations concerning a National Immunisation Strategy (NIS). The NHMRC Report identified a number of factors that had contributed to the poor immunisation rate and rising incidence of vaccine preventable diseases in Australian children. Contributing factors were the lack of a coordinated scheme for the provision of vaccines, and the wide variation in prices which the States/Territories paid for vaccines, with the smaller jurisdictions paying higher prices. The Strategy recommended that vaccine purchase be coordinated centrally and funding occur directly to States/Territories based on population size.

In 1992, *Haemophilus influenzae* type b (Hib) vaccine became licensed and was recommended for children aged 18 months and older. In January 1993, a vaccine became available for use in younger children. As these were new vaccines, there was no funding available within existing funding arrangements to enable purchase by States/Territories. In July 1993, the Commonwealth provided funds to States/Territories for this to occur and Hib vaccines became the first to be funded via the mechanism recommended in the NIS.

In 1994, the Commonwealth Government decided to fund the purchase of a number of childhood vaccines (DTP, MMR, OPV) via Specific Purpose Payments to States/Territories. Commonwealth funding was conditional on vaccines being provided to all public and private practitioners and was formalised in Bilateral Agreements with each State/Territory.

From 1997–1998 funds for vaccination were included in the Public Health Outcome Funding Agreements (PHOFAs). However, a number of vaccines continued to be funded via Finance Assistance Grants (OPV doses 1, 2, 3 and 4 and MMR dose 1) and Hospital Funding Grants (ADT).

In 1997, the NHMRC recommended that the diphtheria-tetanus-acellular pertussis vaccine (DTPa) be used for the 4$^{th}$ and 5$^{th}$ doses of DTP vaccination. These became funded nationally in September 1997.

The 1998–1999 Commonwealth Budget included an initiative to streamline all childhood vaccine funding as from 1999–2000, resulting in funding for all childhood vaccines on the Australian Standard Vaccination Schedule (ASVS) (up to 15 years of age) being included in the PHOFAs. In the same financial year, pneumococcal vaccine for Indigenous Australians and influenza vaccine for those aged over 65 years were also funded. Existing vaccine funding allocations via FAGs and HFGs were not adjusted, thereby freeing up State/Territory resources to purchase non-Commonwealth funded vaccines.

Federal funding to use DTPa for all 5 infant vaccinations began in February 1999, immediately after the NHMRC recommended the schedule change.

In 1999–2000, PHOFA funding to purchase enough vaccine for 105% of the eligible cohort for each vaccine (with the current exception of influenza vaccine) was made available. Funding for vaccines is approved by the Federal Minister for Health and Aged Care as a 'special appropriation' under the provisions of Section 9B of the *National Health Act 1953*. Based on interpretation of this provision, funds appropriated are for the sole purpose of vaccine purchase.

From May 2000, universal infant vaccination with hepatitis B vaccine was recommended and funded.

The availability of free vaccines to the Australian Community has been determined by the funding mechanisms described above. Dates when vaccines became free of charge in the public and private sectors are summarised in Table 26.

## *Acknowledgements*

We thank Brenda White, Department of Health and Aged Care, and representatives from each State and Territory, for their assistance in preparing this Appendix.

## Table 26. Dates when childhood vaccines became available in Australia free of charge* in the public and private sectors

| Vaccine | Public sector | | Private sector† | |
|---|---|---|---|---|
| | Australia | Exceptions | Australia | Exceptions |
| OPV | 1966 | | 1994 | Qld (? 1998)<br>NSW 1966<br>Tas 1966 |
| DTPw | 1953 | | 1994 | WA 1998 |
| Rubella (adolescent girls) | 1971 | | | |
| MMR<br>(infant dose) | 1989 | | 1994 | NSW 1989<br>Qld 1989 |
| MMR<br>(adolescent dose) | 1994 | SA 1996 | 1994 | WA 1993<br>SA 1996 |
| ADT | 1982 | | 1994 | WA 1988 |
| CDT | 1975 | | 1994 | WA 1988 |
| Hib vaccines<br>(infants born from Feb 1993) | 1993 April | | 1993 April | |
| Hib vaccines<br>(all infants aged <5 years) | 1993 July | WA 1993 Jan<br>NT 1993 April | 1993 July | WA 1993 Jan<br>NT 1994 |
| DTPa boosters (infants aged 18 months and 4-5 years) | 1997 Sept | Tas 1997 Oct<br>Qld 1997 Dec | 1997 Sept | Tas 1997 Oct<br>Qld 1997 Dec |
| DTPa<br>(infants aged 2, 4 and 6 months) | 1999 Feb | NT 1997 Aug<br>SA 1997 Aug<br>Tas 1999 Feb<br>Qld 1999 April | 1999 Feb | NT 1997 Aug<br>SA 1997 Aug<br>Tas 1999 Feb<br>Qld 1999 April |
| Hep B<br>(at-risk infants) | 1987 | NT 1988 Jan<br>SA 1996 | Not funded by the C'wealth | NSW 1987 |
| Hep B<br>(adolescent dose) | 1998 Jan | Qld 1998 March<br>Tas 1998 March<br>NT 1998 April<br>NSW 1999<br>SA 1999 | ?1998 | Qld 1998 March<br>Tas 1998 March<br>NT 1998 April<br>NSW 1999 |
| Hep B (universal infant dose) | 2000 May | NT 1990 Aug | 2000 May | NT 1994 |

* Vaccines on the current Australian Standard Childhood Vaccination schedule became free of charge in the public and private sector in all jurisdictions in 1999/2000.

† All scheduled childhood vaccines became free in the private sector in the ACT in 1993 (except for MMR vaccine which became free in the private sector in 1994) and in the NT in 1994.