Vaccine preventable diseases and vaccination coverage in Australia, 1999 to 2000

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Contents

Authors ii

Executive summary ix

Acknowledgements xi

Abbreviations xi

1 - Introduction 1

2 - Methods 3

Vaccine preventable diseases data 3

Vaccination coverage data 4

Notes on interpreting data 5

3 - Vaccine preventable diseases 7

Diphtheria 7

Haemophilus influenzae type b (Hib) disease 8

Hepatitis A 13

Acute hepatitis B 17

Influenza 22

Measles 26

Meningococcal disease 32

Mumps 37

Pertussis 42

Pneumococcal disease 47

Poliomyelitis 53

Rubella 55

Tetanus 60

Varicella 64

4 - Vaccination coverage 67

5 - Discussion 73

References 81

Appendix 1 Historical charts of notifications of vaccine preventable diseases 87

Appendix 2 Notifications by State/Territory and year (January 1995–December 2000) 93

Appendix 3 Hospitalisations by State/Territory and year (July 1995–June 2000) 97

Appendix 4 Changes to the Australian Standard Vaccination Schedule (1992–2000) 103

Appendix 5 Vaccination funding in Australia 107

List of Tables

Table 1. Notifications, hospitalisations and deaths from diseases preventable by vaccines on the childhood vaccination schedule, Australia, 1995 to 2000 ix

Table 2. Deaths from diseases commonly vaccinated against, Australia 1926 to 2000 1

Table 3. *H. influenzae* type b (Hib) notifications, presumed Hib hospitalisations and deaths, Australia, 1998 to 2000, by age group 9

Table 4. Indicators of severe morbidity for hospitalised cases of *H. influenzae* type b infection, Australia, 1998-2000, by age group 10

Table 5. Hepatitis A notifications, hospitalisations and deaths, Australia, 1998 to 2000, by age group 14

Table 6. Indicators of severe morbidity for hospitalised cases of hepatitis A, Australia, 1998-2000, by age group 15

Table 7. Acute hepatitis B notifications, hospitalisations and deaths, Australia, 1998 to 2000, by age group 18

Table 8. Indicators of severe morbidity and mortality for hospitalised cases of acute hepatitis B, Australia, 1998-2000, by age group 19

Table 9. Influenza hospitalisations and deaths, Australia, 1998 to 2000, by age group 23

Table 10. Indicators of severe morbidity and mortality for hospitalised cases of influenza, Australia, 1998-2000, by age group 23

Table 11. Measles notifications, hospitalisations and deaths, Australia, 1998 to 2000, by age group 27

Table 12. Indicators of severe morbidity for hospitalised cases of measles, Australia, 1998-2000, by age group 28

Table 13. Meningococcal notifications, hospitalisations and deaths, Australia, 1998 to 2000 by age group 34

Table 14. Indicators of severe morbidity for hospitalised cases of meningococcal disease, Australia, 1998-2000, by age group 34

Table 15. Mumps notifications, hospitalisations and deaths, Australia, 1998 to 2000, by age group 39

Table 16. Indicators of severe morbidity for hospitalised cases of mumps, Australia, 1998-2000, by age group 39

Table 17. Pertussis notifications, hospitalisations and deaths, Australia, 1998 to 2000, by age group 44

Table 18. Indicators of severe morbidity for hospitalised cases of pertussis, Australia, 1998-2000, by age group 44

Table 19. Pneumococcal pneumonia, meningitis and septicaemia hospitalisations and deaths, Australia, 1998 to 2000, by age group 49

Table 20. Indicators of severe morbidity and mortality for hospitalised cases of pneumococcal meningitis and septicaemia, Australia, 1998-2000, by age group 50

Table 21. Rubella notifications, hospitalisations and deaths, Australia, 1998 to 2000, by age group 56

Table 22. Indicators of severe morbidity for hospitalised cases of rubella, Australia, 1998-2000, by age group 57

Table 23. Tetanus notifications, hospitalisations and deaths, Australia, 1998 to 2000, by age group 61

Table 24. Indicators of severe morbidity for hospitalised cases of tetanus, Australia, 1998-2000, by age group 62

Table 25. Varicella hospitalisations and deaths, Australia, 1998 to 2000, by age group 65

Table 26. Indicators of severe morbidity for hospitalised cases of varicella, Australia, 1998-2000, by age group 65

Table 27. Australian Standard Vaccination Schedule 1998 to 2001 for children 67

Table 28. Average annual morbidity and mortality from vaccine preventable diseases in Australia for 5 years 1993/1994–1997/1998 74

Table 29. Average annual morbidity and mortality from vaccine preventable diseases in Australia for 2 years 1998/1999–1999/2000 75

Table 30. Most recent* notification rates per 100 000 population for frequently notified vaccine preventable diseases, by country of residence 79

Table 31. Notifications by State/Territory and year (January 1995–December 2000) 94

Table 32. Hospitalisations by State/Territory and financial year (July 1995–June 2000) 98

Table 33. Diphtheria, tetanus and pertussis (DTP) vaccination practice in Australia, 1992 to 2000 104

Table 34. *Haemophilus influenzae* type b vaccination practice in Australia, 1992 to 2000 104

Table 35. Hepatitis B vaccination practice in Australia, 1992 to 2000 104

Table 36. Measles, mumps and rubella vaccination practice in Australia, 1992 to 2000 105

Table 37. Polio vaccination practice in Australia, 1992 to 2000 105

Table 38. Dates when childhood vaccines became available in Australia free of charge in the public and private sectors 111

List of Figures

Figure 1. *H. influenzae* type b (Hib) notifications and presumed Hib hospitalisations for all ages, Australia, 1993 to 2000, by month of onset or admission 9

Figure 2. *H. influenzae* type b (Hib) notification and presumed Hib hospitalisation rates, Australia, 1998 to 2000, by age at admission 10

Figure 3. *H. influenzae* type b (Hib) notification and presumed Hib hospitalisation rates and numbers of deaths for children aged 0–4 years, Australia, 1993 to 2000 11

Figure 4. Hepatitis A notifications and hospitalisations, Australia, 1993 to 2000, by month of onset or admission 14

Figure 5. Hepatitis A notification rates, Australia, 1993 to 2000, by age group, sex and year of onset 15

Figure 6. Hepatitis A hospitalisation rates, Australia, 1993 to 2000, by age group, sex and year of separation 16

Figure 7. Acute hepatitis B notifications, and hospitalisations, Australia, 1993 to 2000, by month of onset or admission 18

Figure 8. Acute hepatitis B notification rates, Australia, 1993 to 2000, by age group 19

Figure 9. Acute hepatitis B hospitalisation rates, Australia, 1998 to 2000, by age group and sex 20

Figure 10. Influenza hospitalisations, Australia, July 1993 to June 2000, by month of admission ..22

Figure 11. Influenza hospitalisation rates, Australia, 1993 to 2000, by age group and sex 24

Figure 12. Measles notifications and hospitalisations, Australia, 1993 to 2000, by month of onset or admission 27

Figure 13. Measles notification rates, Australia, 1997 to 2000, by age group and year of onset 29

Figure 14. Measles hospitalisation rates, Australia, 1996/1997–1999/2000 by age group and year of separation 29

Figure 15. Meningococcal notifications and hospitalisations, Australia, 1998 to 2000, by year of onset or admission 33

Figure 16. Meningococcal disease notification and death rates, Australia, 1998 to 2000, by age group 35

Figure 17. Meningococcal disease hospitalisation rates, Australia, 1998 to 2000, by age group 35

Figure 18. Mumps notifications and hospitalisations, Australia, 1993 to 2000, by month of onset or admission 38

Figure 19. Mumps notifications rates, Australia, 1993 to 2000, by age group and year of onset 40

Figure 20. Mumps hospitalisation rates, Australia, 1993 to 2000, by age group and year of separation 41

Figure 21. Pertussis notifications and hospitalisations, Australia, 1993 to 2000, by month of onset or admission 43

Figure 22. Pertussis notification rates, Australia, 1993 to 2000, by age group 45

Figure 23. Pertussis hospitalisation rates, Australia, 1993 to 2000, by age group 45

Figure 24. Pneumococcal disease hospitalisations, Australia, 1993 to 2000, by month of admission 48

Figure 25. Pneumococcal meningitis, septicaemia and pneumonia death rates, Australia, 1998 to 2000, by age group 49
Figure 26. Pneumococcal meningitis, septicaemia and pneumonia hospitalisation rates, Australia, 1998 to 2000, by age group 51
Figure 27. Rubella notifications and hospitalisations, Australia, 1993 to 2000, by month of onset or admission 56
Figure 28. Rubella notification rates, Australia, 1993 to 2000, by age group, sex and year of onset 57
Figure 29. Rubella hospitalisation rates, Australia, 1993 to 2000, by age group, sex and year of separation 58
Figure 30. Tetanus notifications and hospitalisations, Australia, 1993 to 2000, by year of onset or admission 60
Figure 31. Tetanus notification and hospitalisation rates, Australia, 1998 to 2000, by age group 62
Figure 32. Varicella hospitalisations, Australia, 1993 to 2000, by month of admission 64
Figure 33. Varicella hospitalisations, Australia, 1998 to 2000, by age group and sex 66
Figure 34. Trends in vaccination coverage estimates from the Australian Childhood Immunisation Register for 1 and 2 year olds 69
Figure 35. Trends in vaccination coverage estimates by jurisdiction: children fully vaccinated for 3 doses of DTP, OPV and Hib at the age of 1 year 69
Figure 36. Trends in vaccination coverage estimates for individual vaccines: children vaccinated for 3 doses of DTP, OPV and Hib at the age of 1 year 70
Figure 37. Trends in vaccination coverage estimates, by jurisdiction: children fully vaccinated for 4 doses of DTP and Hib, 3 doses of OPV and 1 dose of MMR at the age of 2 years 71
Figure 38. Trends in MMR1 vaccination coverage estimates for 2 year olds, by jurisdiction 71

Historical charts of notifications of vaccine preventable diseases

Diphtheria, 1917–2000 88
Haemophilus influenzae type b disease, 1991–2000 88
Hepatitis A, 1952–2000 89
Measles, 1917–2000 89
Meningococcal disease (invasive), 1949–2000 90
Pertussis, 1917–2000 90
Poliomyelitis, 1917–2000 90
Rubella, 1917–2000 91
Tetanus, 1917–2000 91

Executive summary

In June 2000 the first report of the morbidity and mortality from vaccine preventable diseases (VPDs) in Australia (1993 to 1998) using nationally collected data was published. The striking feature was the progressive decline in the incidence of all the childhood VPDs except pertussis. Even more striking was the more than 99 per cent decline in the number of deaths from these diseases since the prevaccination era, despite the Australian population increasing 2.8 fold and the close association this rate of decline has had with the introduction of specific vaccination programs. 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 four national sources of routinely collected data about VPDs and vaccination (deaths, notifications, hospitalisations and vaccination coverage) for all age groups between 1999 and 2000 and to compare them with the data for 1993 to 1998.

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 AIHW Mortality Database 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.

Table 1. Notifications, hospitalisations and deaths from diseases preventable by vaccines on the childhood vaccination schedule, Australia, 1995 to 2000*

Disease†	Notifications		Hospitalisations		Deaths	
	Average per year 1995–1999	2000	Average per year July 95–June 99	July 1999–June 2000	Average per year 1995–1999	2000
Diphtheria	0	0	2	1	0	0
Hib (<5 yrs)	30	10	62	37	0.8	0
Measles	615	107	96	67	0.6	0
Mumps	165‡	212	54	54	0.2	2
Pertussis	5870	5942	798	349	1.8	1
Polio	0	0	2§	2§	0	0
Rubella	1933	322	67	29	0	0
Tetanus	5	6	31	32	1	2
Total	**8618**‖	**6599**	**1111**‖	**571**	**4.4**‖	**5**

* Notifications where the month of onset was between January 1995 and December 2000; hospitalisations where the month of separation was between 1 July 1995 and 30 June 2000; deaths where the date of death was recorded between 1995 and 2000.

† See Chapter 3 for case definitions.

‡ Only the Australian Capital Territory, New South Wales and Victoria reported mumps notifications for the entire period. For these States/Territories the average number of mumps notifications per year from 1995–1999 was 104 and there were 152 notifications in 2000.

§ Principal diagnosis only. See page 53 for comment.

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

Results

Notifications for the 8 diseases covered by the routine childhood vaccination schedule declined by 23 per cent, from an average of 8618 cases each year in 1995–1999 to 6599 in 2000 (Table 1). Hospitalisations fell by 49 per cent, from an average of 1111 per year in 1995–1999 to 571 in 1999/2000. Deaths remained unchanged at 5 per year over the review period. Tetanus caused 1 or 2 of the deaths each year. Only one of the 5 deaths in 2000 was in an infant with pertussis; the other 4 deaths (2 tetanus, 2 mumps) were in women aged over 80 years. Pertussis was the reason for the majority of notifications (90%) and hospitalisations (61%). The notification rate for pertussis in 2000 (31.0 per 100 000) was the highest since the outbreak year of 1997 (58.9 per 100 000). Most of the pertussis notifications (58%) were in adults, but the majority of hospitalisations (70%) were in children aged 0–14 years. There were notable declines in the number of notifications of invasive *Haemophilus influenzae* type b (Hib) disease in children under 5 years of age (66%), and in the number of notifications of measles (83%) and rubella (83%). There were no notifications of diphtheria or poliomyelitis.

In 2000 there were more notifications for acute hepatitis B (n=395) than for any other year since national surveillance commenced in 1996. Many of the notifications (25%) were in the 20–24 year age group. Even so, acute hepatitis A caused more notifications (n=812) in 2000.

Of vaccine preventable diseases not included on the childhood schedule during the review period the greatest morbidity and mortality at all ages in 2000 resulted from influenza (67 deaths), pneumococcal disease (50 deaths), meningococcal disease (28 deaths), acute hepatitis B (7 deaths) and varicella (5 deaths). In 2000 varicella, influenza, pneumococcal and meningococcal disease caused almost 9000 hospital admissions with more than one-third of these occurring in children aged 0–4 years.

Vaccination coverage estimated using ACIR data reached the targets set by the *Immunise Australia* program. By September 2001 coverage for the first 3 doses of diphtheria, tetanus, pertussis and Hib vaccines, assessed at 1 year of age, had reached 90 per cent, while coverage for measles-mumps-rubella (MMR) vaccine, assessed at 2 years of age, had reached 93 per cent. At the age of 2 years 88 per cent of children were fully immunised. It is likely that these data underestimated coverage by 2–5 per cent, and that the increase in coverage partly reflected better reporting to the ACIR by providers.

Comment

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

In 2000 Australia had the lowest measles notification rate on record (0.6 per 100 000) with 107 notifications and no measles deaths since 1995. These low rates are the result of both high routine immunisation coverage and the Measles Control Campaign which was conducted in late 1998, when 1.7 million primary school children were vaccinated with MMR vaccine. There has also been a marked decline in both Hib disease and rubella. Measles, rubella and Hib disease are now close to elimination in Australia.

Pertussis caused the greatest morbidity from a disease preventable by the current childhood schedule, indicating the need for additional interventions aimed at controlling spread of this infection in children and adults.

Hepatitis B vaccination has been recommended for all infants born since May 2000 and for adolescents since 1997, but these initiatives are likely to take at least 10 years to impact on the incidence of acute hepatitis B. The need for a program aimed at young adults (aged 20–25 years) is also indicated.

Morbidity and mortality from varicella, influenza, pneumococcal disease and meningococcal disease, especially in children aged 0–4 years, could be reduced by the use of vaccines now available in Australia.

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We thank the Scientific Advisory Committee of the National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases, especially Dr Cathy Mead and Professor John Kaldor, who generated the initial ideas for these reports and commented on the draft of this document. We also thank Dr Jill Forrest, Dr Alison Williams, Catherine King and Alison Milton, who provided invaluable advice and edited the manuscript, and Donna Armstrong and Jan Michniewicz who helped prepare the manuscript.

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

Abbreviations

ABS	Australian Bureau of Statistics
ACIR	Australian Childhood Immunisation Register
ADT	Adult diphtheria-tetanus
AFP	Acute flaccid paralysis
AIHW	Australian Institute of Health and Welfare
Anti-HBc	Hepatitis B core antibody
ASVS	Australian Standard Vaccination Schedule
CDT	Combined diphtheria-tetanus
CSL	Commonwealth Serum Laboratories
DTP	Diphtheria-tetanus-pertussis
DTPa	Diphtheria-tetanus-pertussis (acellular)
DTPw	Diphtheria-tetanus-pertussis (whole cell)
HAV	Hepatitis A virus
HBV	Hepatitis B virus
HBsAg	Hepatitis B surface antigen
Hib	*Haemophilus influenzae* (type b)
HIC	Health Insurance Commission
ICD	International Classification of Diseases
IPD	Invasive pneumococcal disease
LOS	Length of stay
MMR	Mumps-measles-rubella
NHMRC	National Health and Medical Research Council
NIS	National Immunisation Strategy
NNDSS	National Notifiable Diseases Surveillance System
OPV	Oral poliomyelitis vaccine
SSPE	Subacute sclerosing panencephalitis
VAPP	Vaccine-associated paralytic poliomyelitis
VPD	Vaccine preventable disease
WHO	World Health Organization

1 - Introduction

In June 2000 the first report of the morbidity and mortality from vaccine preventable diseases (VPDs) in Australia (1993 to 1998) using nationally collected data was published.[1] The striking feature was the progressive decline in the incidence of all the childhood VPDs except pertussis. Even more striking has been the 99 per cent decline in the number of deaths from these diseases since the prevaccination era, despite the Australian population increasing 2.8 fold (Table 2), and the close association this rate of decline has had with the introduction of specific vaccination programs.[2]

The 1990s saw the introduction of a number of major surveillance and vaccination initiatives in Australia:

- a national disease notification system in 1991;
- the Australian Childhood Immunisation Register in 1996,[3] and
- the *Seven Point Plan* in 1997 (this included the Measles Control Campaign in the later part of 1998).[4]

It is important to measure the ongoing impact of vaccination initiatives. This second report uses similar methods to the first and brings together four national sources of routinely collected data about VPDs and vaccination (deaths, notifications, hospitalisations and vaccination coverage) for all age groups between 1999 and 2000, and compares them with the data for 1993 to 1998.

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, hepatitis B (from 2000), measles, mumps, pertussis, poliomyelitis, rubella and tetanus), those for which vaccines were available but only funded or recommended for specific risk groups (hepatitis A, invasive pneumococcal disease, influenza) and varicella and meningococcal disease (for which new vaccines became available in 2000 and late 2001, respectively). The report does not cover some other diseases which are vaccine-preventable, such as tuberculosis, for which reports can be found elsewhere.[5]

This and the previous report, both from the National Centre for Immunisation Research and Surveillance (NCIRS), provide evidence of the impact of changes in vaccination policy over the past decade, the most evident in the current review period being the effects of the Measles Control Campaign. These reports provide baselines against which further initiatives can be evaluated.

Table 2. Deaths from diseases commonly vaccinated against, Australia 1926 to 2000*

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
1996–2000	0	9	5	0	0	18 734 000

* Sources: Feery B. One hundred years of vaccination. *Public Health Bulletin* 1997; 8:61-63; Feery B. Impact of immunization on disease patterns in Australia. *Med J Aust* 1981;2:172-176. Deaths recorded for 1966–1975 and 1996–2000 updated with data provided by ABS and the Australian Institute of Health and Welfare Mortality Database.

† Excludes deaths from subacute sclerosing panencephalitits.

Indicates decade in which community vaccination started for the disease.

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, and mortality data from the AIHW Mortality Database (unpublished data).

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.[6] However, application of these definitions and even the definitions themselves may differ between jurisdictions. In 1999 to 2000 pneumococcal disease, influenza and varicella were not notifiable to the NNDSS.

We used the same data sets extracted from NNDSS as those used for the 1999 and 2000 'Australia's Notifiable Disease Status' reports.[7,8] Disease notification data for cases with an onset between 1 January 1999 and 31 December 2000 (2 years) are included in this report. Those with onset dates between 1 January 1993 and 31 December 1998 were reported previously.[1] The variables extracted for analysis 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. Data are received by financial year of separation (discharge) and the two most recent years for which data are available (1998/1999 and 1999/2000) were examined. Cases with separation dates between 1 July 1993 and 30 June 1998 (5 years) were reported previously.[1] In the current report all hospitalisations with a separation date in 1998/1999 or 1999/2000 were included, whereas in the previous report only those with admission and separation dates in the 5-year review period were examined. Data were extracted based on the International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Australian Modification, 1st Edition (ICD-10-AM). However, in 1998/1999 Queensland, South Australia, Western Australia and Tasmania were still using ICD-9-CM (International Classification of Diseases, 9th Revision, Clinical Modification). AIHW provided the mapped ICD-10-AM codes for this year and we reviewed mapping tables provided by the National Centre for Classification in Health to ensure that all disease-specific ICD-9-CM codes corresponded to the ICD-10-AM codes examined. The ICD-10-AM codes are provided in each disease section and where these do not directly correspond to the ICD-9-CM codes used in the previous report, this is stated. Eligible separations were those with the code of interest listed in the principal diagnosis (the diagnosis chiefly responsible for the admission of the patient to hospital) or in any other diagnoses. The proportion of separations for which the diseases were coded as the principal diagnosis is reported for each disease. For hepatitis B, only principal diagnoses were included. Where the ICD-10-AM code for a disease specifies a severe manifestation (eg, measles encephalitis) the number and type of these were reported as complications. The variables extracted for analysis were: date of admission, financial year of separation, age at admission, sex, State/Territory of residence, length of stay (LOS), mode of separation (whether a patient died while in hospital), hours of mechanical ventilation (as a measure of critical care) and diagnosis (principal and other diagnoses — up to 31 diagnoses were recorded for each admission) coded using ICD-10-AM.

Deaths

Death data were obtained from the AIHW Mortality Database. These data are supplied annually to the AIHW from the Registrars of Births Deaths and Marriages in each State and Territory via the Australian Bureau of Statistics (ABS). Deaths include those in Australian waters as well as on Australian soil, whereas ABS published data exclude deaths in Australian waters. Since 1997, the International Classification of Disease, 10th Revision (1992), ICD-10 has been used to identify the cause of death. Although multiple causes of death have been recorded since 1997, only those where the underlying cause of death was the disease of interest are used in this report. Analysis was by year of registration for those deaths recorded in 1998 to 2000 (3 years). The variables extracted for each death were: underlying cause, age, year death was reported, sex, and State/Territory in which death was recorded.

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 geographical 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 1998 mid-year population estimate was used to calculate rates for 1998/1999. 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, critical care, principal diagnosis, 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 was one source of data about national vaccination coverage: the Australian Childhood Immunisation Register (ACIR). The ACIR commenced in January 1996 and is administered by the Health Insurance Commission for the Commonwealth Department of Health and Ageing. 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.[9] In this report we have described trends in ACIR vaccination coverage estimates for all vaccines on the current childhood schedule.

Notes on interpreting data

Vaccine preventable diseases data

Comparisons between the notification, hospitalisation and death databases should be made with caution as they differ in their purposes, 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 databases and because of differences in the accuracy of each database, 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 (i.e., 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 represent only 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 case definitions for surveillance and varying reporting requirements by medical practitioners, laboratories and hospitals. In addition, data accuracy may change over time as new diagnostic tests are introduced or surveillance practices change.

Hospitalisation data

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. In 1998/1999 most States and Territories began using ICD-10-AM and in 1999/2000 all jurisdictions were using the new classification. This change has impacted on the sensitivity and specificity of some diagnostic codes (see each disease section for details where appropriate). The most notable impact has been on the number of hospitalisations for 'acute' hepatitis B as, unlike the previously used ICD-9-CM, ICD-10-AM allows differentiation between acute and unspecified infection.

There are also limitations associated with the use of ICD codes to identify cases. Hospital coding errors have been reported to occur more commonly for diseases that the coder was less familiar with (eg, rare diseases) and for admissions with multiple diagnoses.[10] Assignation of codes is based on information in medical records, as recorded by clinicians, and there are few strict case definitions. For some diseases, such as *Haemophilus influenzae* type b infection, the ICD-9-CM and ICD-10-AM codes lack specificity. This is in contrast to the more stringent case definitions used for notification data. It must also be noted that the hospitalisation database contains a record for each admission, which means that there are separate records for each readmission or inter-hospital transfer. This is unlikely to have a major impact on the numbers reported for most diseases reviewed, as they are acute illnesses. However, for diseases where it was likely that readmissions could have affected the numbers reported, a frequency of 'date of birth' was examined as a proxy measure of the number of multiple admissions. For diseases where the results of this analysis indicated that readmissions might have significantly affected the numbers reported, this is indicated in the comments section. 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

Mortality data were analysed by year of registration rather than by year of death, as annual reports to AIHW are by year of registration, so not all deaths occurring in a year would be included in that year's data. Approximately 6 per cent of deaths in a particular calendar year are registered in the subsequent year, with the bulk comprising that calendar year's December deaths.

Only those deaths where the underlying cause of death was the disease of interest are reported here. Hence deaths where the disease of interest was a contributing cause of death are not included.

The problems associated with the accuracy of the ICD codes used for hospital separations may also apply to the mortality data. As noted for hospitalisation data, the move from ICD-9 to ICD-10 codes (which occurred in 1997) may impact on the comparability of some death data and this must be borne in mind when comparing years. This is especially important for numbers of deaths where the underlying cause was recorded as hepatitis B. Prior to the use of ICD-10, acute, chronic and unspecified infections could not be differentiated.

Vaccination coverage data

Limitations of data available from the ACIR must be considered when it is used to estimate vaccination coverage. Vaccine coverage estimates calculated using ACIR data should be considered minimum estimates due to under-reporting.[3,11] However, reporting of vaccination encounters to the ACIR by providers improved significantly since the last vaccine preventable diseases (VPD) report due to the implementation of various financial incentives for both general practitioners and parents.[12] This resulted in improved accuracy of vaccine coverage estimates calculated using ACIR data. Another limitation of ACIR data is that records are only held for children up to 7 years of age. Also, coverage is calculated only for children registered on Medicare; however, by the age of 12 months it is estimated that over 98 per cent of Australian children have been registered with Medicare.[9]

3 - Vaccine preventable diseases

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.[13,14]

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-10-AM codes used to identify hospitalisations were: A36.0, pharyngeal diphtheria; A36.1, nasopharyngeal diphtheria; A36.2, laryngeal diphtheria; A36.8 + I41.0, diphtheritic myocarditis.

Deaths

The ICD-10 code A36 (diphtheria) was used to identify deaths.

Notifications, hospitalisations and deaths

There have been no notifications of, or deaths due to, diphtheria during the review period. There were 2 hospitalisations in 1998/1999–1999/2000 coded as laryngeal diphtheria. Both were female, aged 1 and 39 years, respectively, both had diphtheria recorded as their principal diagnosis and both had a length of stay of 3 days.

Comment

Diphtheria has become rare in Australia. Over the past 8 years only 14 people, predominantly adults, had hospitalisations coded as diphtheria, with 3 of these in the last 4 years. There have, however, been no notifications of diphtheria for over 8 years, so it is probable that even the small number of hospitalisations recorded are not true cases. At the time of writing this report, hospitalisations for Victoria were being reviewed by the Department of Human Services as they believe them to be incorrect.

The epidemiology of diphtheria in Australia is similar to that in Western Europe, the United States of America (USA) and the United Kingdom. Numbers have declined and almost all recent cases in the United Kingdom, the USA and countries bordering the Newly Independent States of the Soviet Union have been associated with imported infections.[15] Hence, there is still the possibility of an imported case occurring in Australia, particularly from developing countries,[16] such as recently occurred in New Zealand where an unimmunised child was infected by a contact returning from Bali.[17] It is therefore important for Australia to retain high levels of immunity through high vaccination coverage.

Haemophilus influenzae type b disease

Haemophilus influenzae (Hib) is a fastidious Gram-negative bacterium which occurs in both encapsulated and unencapsulated forms. Before Hib vaccines became available one encapsulated serotype, type b (Hib), caused at least 95 per cent of infections due to *H. influenzae* in children.[18,19] 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.[19-21] Aboriginal children had a particularly high risk of Hib meningitis with rates among the highest recorded anywhere in the world.[22] 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 include 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 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.

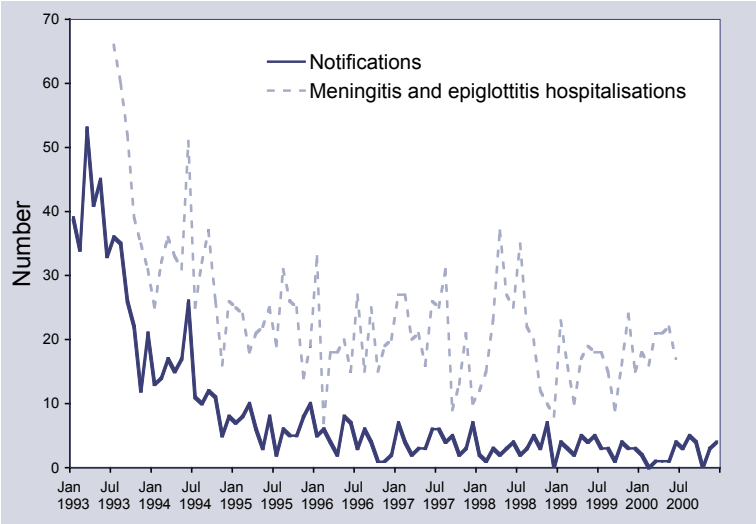
Hospitalisations and deaths

There were no ICD-10-AM/ICD-10 codes which specified Hib as a causative organism. Two ICD-10-AM/ICD-10 codes were used to identify presumed Hib cases: G00.0 (*Haemophilus* meningitis), and J05.1 (acute epiglottitis). The ICD-10-AM/ICD-10 codes for H. influenzae pneumonia, *H. influenzae* septicaemia and *H. influenzae* infection were not included as these were thought to be less specific for invasive *H. influenzae* type b disease.

Secular trends

There were a total of 68 Hib notifications (average annual notification rate 0.2 per 100 000) during the review period (Table 3). A median of 3 cases (range 0–5) were notified per month (Figure 1). There were 429 hospitalisations (average annual rate 1.1 per 100 000) for presumed Hib, with a median of 18 cases (range 8–35) hospitalised per month. Acute epiglottitis accounted for 361 (84%) of these hospitalisations and meningitis for 68 (16%). Hospitalisations occurred throughout the year but were slightly more frequent during the winter months.

Figure 1. *H. influenzae* type b (Hib) notifications and presumed Hib hospitalisations* for all ages, Australia, 1993 to 2000†, by month of onset or admission



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

† Notifications where the month of onset was between January 1993 and December 2000, hospitalisations where the month of admission was between 1 July 1993 and 30 June 2000.

Severe morbidity and mortality

At all ages, the number and rate of hospitalisations were higher than the number and rate of notifications (Table 3). The principal diagnosis was *H. influenzae* meningitis or acute epiglottitis in 329 (77%) of the hospitalisations. Over the review period a total of 2182 hospital bed days (average, 1091 days per year) were recorded for patients with presumed Hib. Children 0–4 years of age had a longer median length of stay than older children. Once hospitalised, older adults were more likely than younger adults or children to require critical care (Table 4). In the 3 years 1998 to 2000, *H. influenzae* meningitis was recorded as the underlying cause of death for 2 children (less than 10 years old) and acute epiglottitis for 3 adults aged at least 50 years.

Table 3. *H. influenzae* type b (Hib) notifications, presumed Hib hospitalisations* and deaths, Australia, 1998 to 2000,† by age group

Age group (years)	Notifications 2 years (1999–2000)		Hospitalisations 2 years (July 1998–June 2000)				LOS‡ per admission (days)	Deaths 3 years (1998–2000)	
	No.	Rate§	No.	(^)	Rate§	(^)	Median	No.	Rate§
0–4	31	1.2	74	(63)	2.9	(2.5)	4	1	0.0
5–14	8	0.1	35	(25)	0.7	(0.5)	2	1	0.0
15–24	1	0.0	31	(23)	0.6	(0.4)	2	0	-
25–59	13	0.1	193	(155)	1.0	(0.8)	3	2	0.0
60+	15	0.2	96	(63)	1.6	(1.0)	4	1	0.0
All ages‖	68	0.2	429	(329)	1.1	(0.9)	3	5	0.0

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

† Notifications where the month of onset was between January 1999 and December 2000; hospitalisations where the month of separation was between 1 July 1998 and 30 June 2000; deaths where the date of death was recorded between 1998 and 2000.

‡ LOS = length of stay in hospital.

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

‖ Includes cases with unknown ages.

^ Principal diagnosis (hospitalisations).

Table 4. Indicators of severe morbidity for hospitalised cases of *H. influenzae* type b infection, Australia, 1998 to 2000,* by age group

Age group (years)	Requiring critical care†		
	No.	% total	Median no. of hours‡
0–4	1	1.3	8
5–14	1	2.9	121
15–24	0	0	-
25–59	9	4.7	191
60+	6	6.2	114
All ages	17	4.0	120

* Hospitalisations for *H. influenzae* meningitis and acute epiglottitis where the month of hospital separation was between 1 July 1998 and 30 June 2000.

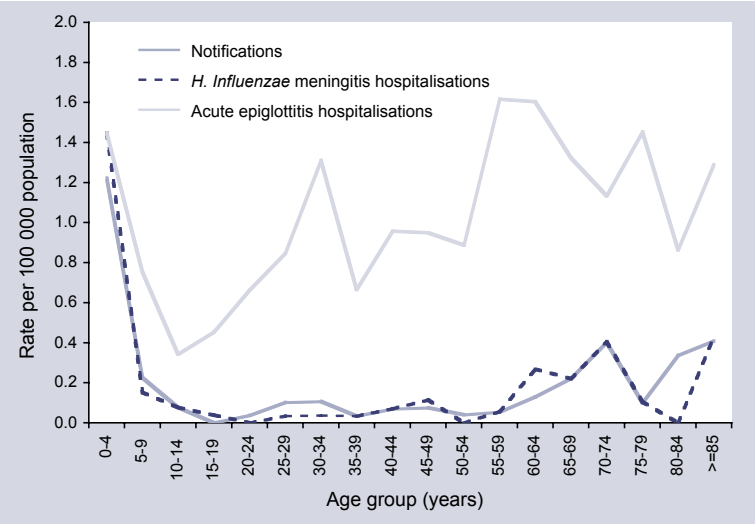
† Requiring mechanical ventilation.

‡ Of those receiving critical care.

Age and sex

All measures of Hib and *Haemophilus influenzae* disease (notifications, hospitalisations and deaths) were higher in males than females, with male:female ratios of 1.1:1, 1.6:1 and 4:1, respectively. In children aged 0–4 years, *H. influenzae* meningitis and acute epiglottitis hospitalisations were equally common (37 cases of each). Overall, children aged 0–4 years accounted for 46 per cent (31/68) of all notifications, 54 per cent (37/68) of all meningitis hospitalisations and 20 per cent (1/5) of all deaths, but only 10 per cent (37/361) of all epiglottitis hospitalisations (Figure 2). The age-specific notification rate closely matched the age-specific *H. influenzae* meningitis hospitalisation rate.

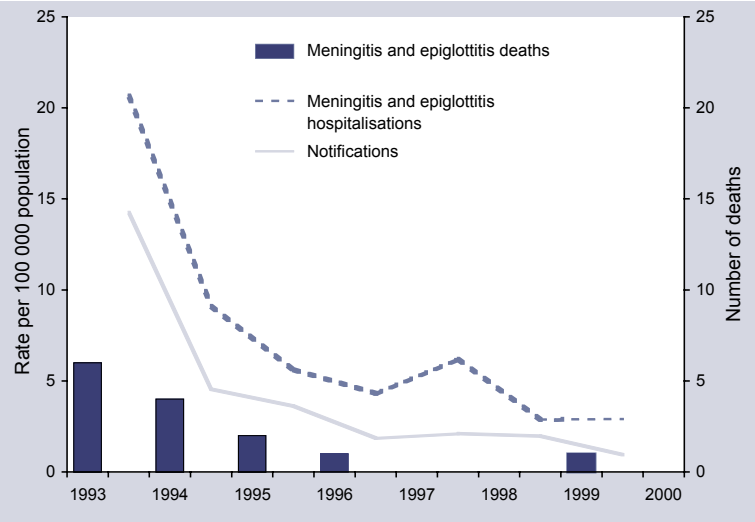
Figure 2. *H. influenzae* type b (Hib) notification and presumed Hib hospitalisation rates, Australia, 1998 to 2000,* by age at admission



* Notifications where the month of onset was between January 1999 and December 2000; hospitalisations where the month of separation was between 1 July 1998 and 30 June 2000.

Since 1993, all measures of invasive Hib disease in children aged 0–4 years have fallen (Figure 3). Despite a small rise in 1997/1998, meningitis and epiglottitis hospitalisation rates fell from a rate of 20.6 per 100 000 in 1993/1994 to 2.9 per 100 000 in 1999/2000. Six deaths were recorded in this age group in 1993 and none in 2000.

Figure 3. *H. influenzae* type b (Hib) notification and presumed Hib hospitalisation* rates and numbers of deaths for children aged 0–4 years, Australia, 1993 to 2000†



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

† Notifications with onset dates between July 1993 and June 2000; hospitalisations with separations between July 1993 and June 2000; deaths where the date of the death was recorded between 1993 and 2000.

Geographical variation

The reduction in notified cases has been seen across all States and Territories (Appendices 2 and 3).

Comment

The dramatic reduction in the incidence of invasive Hib disease seen following the introduction of conjugated vaccines in 1993 has been maintained. Hib is now a rare disease in children and deaths are very rare. Now that Hib disease is so uncommon, surveillance data require even more careful interpretation since small errors can result in big proportional changes.

Hospitalisation data probably overestimate Hib cases, because the hospitalisation codes lack specificity. 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 in adults, which may be due to organisms other than *H. influenzae*.[23] In 1993/1994, 28 per cent of acute epiglottitis hospitalisations in children aged less than 5 years were also coded as having an *H. influenzae* infection (ICD-9-CM code 041.5). In contrast, in 1998/1999 and 1999/2000 no hospitalisation coded as acute epiglottitis was also coded as having an *H. influenzae* infection (ICD-10-AM code A49.2). Hospitalisation data may overestimate incidence if cases are counted twice when a patient is transferred between hospitals. If records with the same gender, date of birth and residential area code are assumed to represent multiple hospitalisation episodes for the same person, there were 13 dual admissions and one triple admission amongst the 361 acute epiglottitis hospitalisations.

Notifications, on the other hand, probably underestimate Hib cases. First, cases of epiglottitis are probably less likely to be notified through laboratory confirmation, as they are often diagnosed on clinical grounds alone. Figure 2 indicates that clinicians may be more likely to notify cases of *H. influenzae* meningitis than cases of acute epiglottitis. Second, there is evidence from the United Kingdom that enthusiasm for reporting of Hib disease may decline following the successful implementation of an immunisation program.[24] 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.

In 2000, Australia instituted a new Hib immunisation schedule for all children, comprising PRP-OMP vaccine at 2 and 4 months of age with a booster at 12 months of age. Between 1993, when Hib immunisation commenced in Australia, and 2000, PRP-OMP vaccine had been used only for Aboriginal and Torres Strait Islander children. Other children received HbOC vaccine at 2, 4 and 6 months and a booster at 18 months of age. This recent change may further reduce the burden of Hib disease since the primary immunisation series will now be completed at 4 months as opposed to 6 months of age.

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 per cent of infections acquired before the age of 5 years are silent, with the proportion of infected individuals showing symptoms increasing to 90 per cent in adults.[13,14]

Case definitions

Notifications

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

or

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

Hospitalisations and deaths

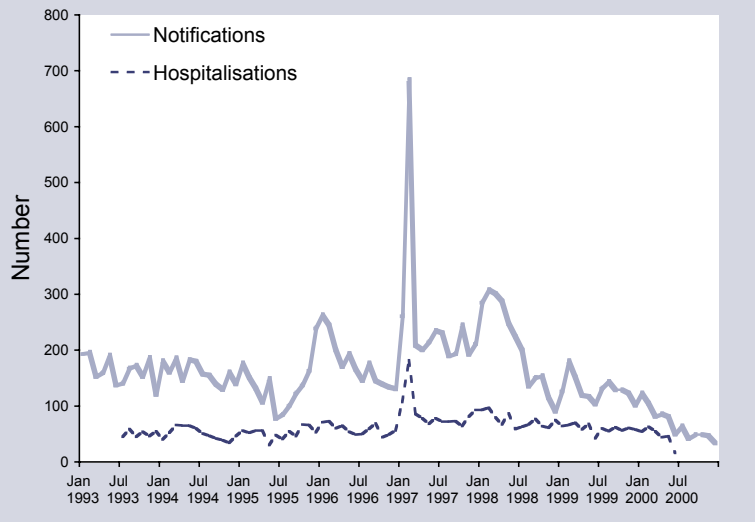
The ICD-10-AM/ICD-10 codes B15 (hepatitis A) were used to identify hospitalisations and deaths.

Secular trends

There were 2371 hepatitis A notifications in 1999 to 2000 (average annual notification rate 6.2 per 100 000) (Table 5). A median of 105 cases (range 34–181) were notified per month. There were 1432 hospitalisations (average annual hospitalisation rate 3.8 per 100 000) with a median of 61 admissions (range 16–77) per month.

Notification and hospitalisation rates declined in 1999 and again in 2000 compared with previous years (Figure 4). There was no apparent seasonality in notifications or hospitalisations.

Figure 4. Hepatitis A notifications and hospitalisations, Australia, 1993 to 2000,* by month of onset or admission



* Notifications where the month of onset was between January 1993 and December 2000, hospitalisations where the month of admission was between 1 July 1993 and 30 June 2000.

Severe morbidity and mortality

There were 8324 hospital bed days (average 4162 per year) recorded for patients with an ICD-10-AM code for hepatitis A. Hepatitis A was the principal diagnosis in 47 per cent of these hospitalisations (667 cases, average annual rate 1.8 per 100 000). The median length of stay for those aged 60 years or more was almost double that for younger age groups (Table 5). In 1998 to 2000, hepatitis A was recorded as the underlying cause of 8 deaths (0.2 per 100 000). Five deaths occurred in the 60 year and over age group and 2 in children aged 0–4 years. Both deaths in children occurred in 1998 in Queensland.

Only 2 hospitalisations coded as hepatitis A were recorded as requiring critical care (Table 6). Hepatitis A with hepatic coma (ICD-10-AM B15.0) was recorded for 11 admissions, none of which were in children aged less than 5 years.

Table 5. Hepatitis A notifications, hospitalisations and deaths, Australia, 1998 to 2000,* by age group

Age group (years)	Notifications 2 years (1999–2000)		Hospitalisations 2 years (July 1998–June 2000)				LOS† per admission (days)	Deaths 3 years (1998–2000)	
	No.	Rate‡	No.	(ǁ)	Rate‡	(ǁ)	Median	No.	Rate‡
0–4	168	6.6	40	(25)	1.6	(1.0)	3	2	0.1
5–14	438	8.3	105	(78)	2.0	(1.5)	2	0	-
15–24	521	9.6	215	(144)	4.0	(2.7)	3	0	-
25–59	1114	6.0	818	(363)	4.4	(2.0)	3	1	0.0
60+	126	2.0	254	(57)	4.2	(0.9)	5	5	0.1
All ages§	2371	6.2	1432	(667)	8.8	(1.8)	3	8	0.2

* Notifications where the month of onset was between January 1999 and December 2000; hospitalisations where the month of separation was between 1 July 1998 and 30 June 2000; deaths where the date of death was recorded between 1998 and 2000.

† LOS = length of stay.

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

§ Includes cases with unknown ages.

ǁ Principal diagnosis.

Table 6. Indicators of severe morbidity* for hospitalised cases of hepatitis A, Australia, 1998 to 2000,* by age group

Age group (years)	Requiring critical care†			Complication hepatic coma	
	No.	% total	Median no. of hours‡	No.	% total
0–4	1	2.5	8	0	0
5–14	0	0	-	2	1.9
15–24	0	0	-	3	1.4
25–59	0	0	-	2	0.2
60+	1	0.4	1222	4	1.6
All ages	2	0.1	615	11	0.8

* Measured using National Hospital Morbidity data where the month of hospital separation was between 1 July 1998 and 30 June 2000.

† Requiring mechanical ventilation.

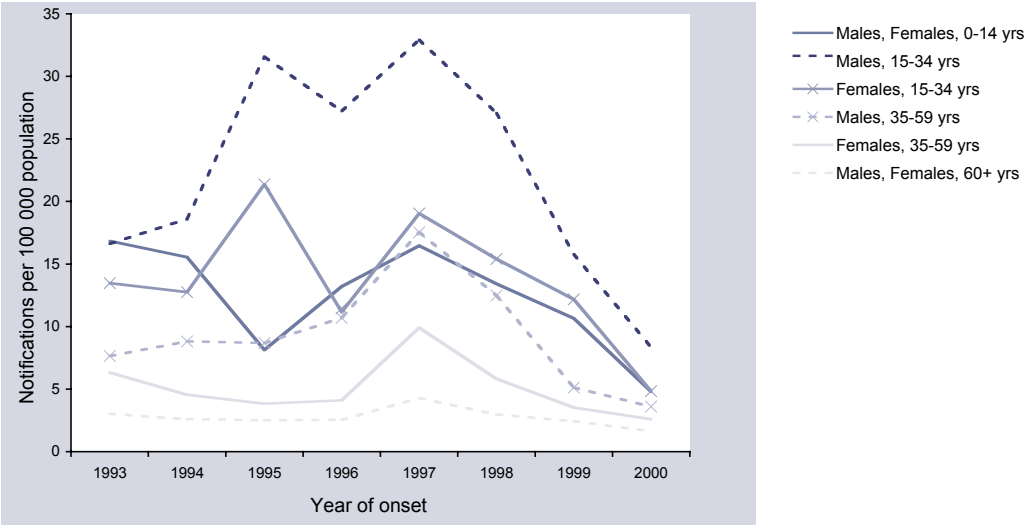
‡ Of those receiving critical care.

Age and sex distribution

The overall male:female ratio was 1.3:1 for notifications, 1.1:1 for hospitalisations and 1:3.0 for deaths. The sex ratio differed between age groups for notifications and hospitalisations. It was highest for cases aged 15–34 and 35–59 years (1.5:1 for notifications and 1.2:1 for hospitalisations for both age groups). For children under 15 years and adults over 59 years the ratio was close to 1.1:1.

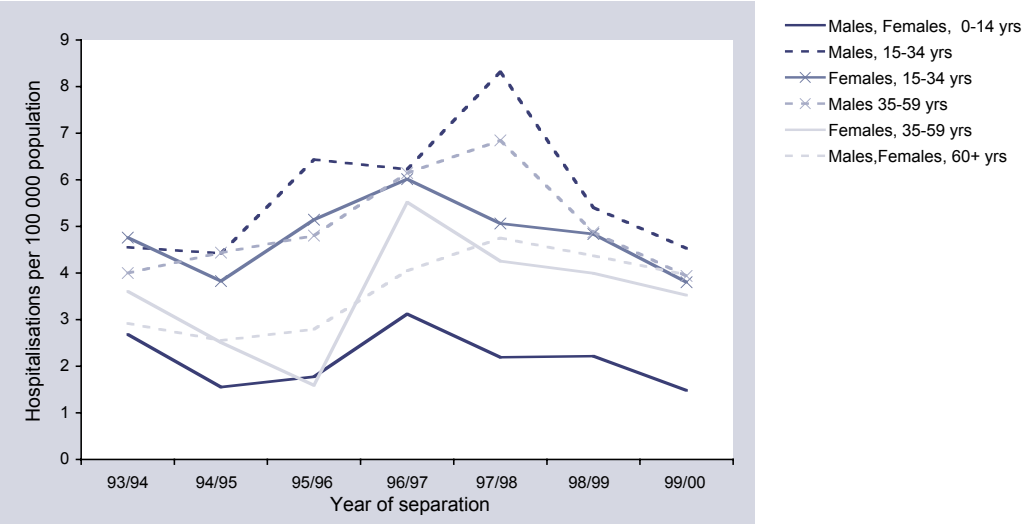
Notification and hospitalisation rates for all age/sex groups declined in the 2-year review period compared with previous years (Figures 5 and 6). The highest rates of both notification and hospitalisation occurred among males aged 15–34 years (average annual notification and hospitalisation rates were 12.6 and 5.0 per 100 000, respectively). This group and females aged 15–34 years have had the highest notification rates over the 8-year period shown in Figure 5 (1993 to 2000).

Figure 5. Hepatitis A notification rates, Australia, 1993 to 2000,* by age group, sex and year of onset



* Notifications where the month of onset was between January 1993 and December 2000.

Figure 6. Hepatitis A hospitalisation rates, Australia, 1993 to 2000,* by age group, sex and year of separation



* Hospitalisations where the month of separation was between 1 July 1993 and 30 June 2000.

Geographical distribution

Notification and hospitalisation rates varied by jurisdiction (Appendices 2 and 3). Notification rates were lower in all jurisdictions in 2000 compared with 1999, while hospitalisation rates increased in some jurisdictions. Overall, the highest rates occurred in the Northern Territory (average annual rates 34.3 per 100 000 for notifications and 8.1 per 100 000 for hospitalisations). Notification rates were also higher in Western Australia (average annual rate 12.6 per 100 000) than in Australia as a whole (Appendix 2).

Comment

In Australia, as in other industrialised countries, hepatitis A appears sporadically with epidemic peaks.[14] The increase in total hepatitis A cases as a result of the outbreak associated with consumption of Wallis Lake oysters[25] was evident in the peak in notifications and hospitalisations in February 1997. Other outbreaks that occurred between 1993 and 1999 among younger adults who used illicit drugs and men who have sex with men are also evident in the data.[26] In 1998, 2 deaths occurred in Queensland in Indigenous children aged less than 5 years;[27] 5 of the other 6 deaths in the 3 years 1998 to 2000 were in people aged 60 years or more.

Like other developed countries, Australia has seen a change in the epidemiology of hepatitis A over recent decades. Adolescents and young adults have lower seroprevalence rates than older adults.[28] Important groups at risk of acquiring hepatitis A are people who travel to countries where hepatitis A is endemic, people who use illicit drugs and men who have sex with men.

Illicit drug use is an important risk factor for hepatitis A and may account for the higher notification and hospitalisation rates among males and females aged 15–34 years.[26] This has been reported as the most likely mode of transmission in an increasing proportion of sporadic hepatitis A notifications in several jurisdictions.[29-31] The higher rate of notifications and hospitalisations for men aged 15–59 years is also related to hepatitis A outbreaks amongst men who have sex with men.[26,31]

Hepatitis A vaccines have been used to prevent disease[32] as well as to control outbreaks.[33] Vaccination is recommended for selected at-risk groups and occupations in Australia,[34] and since the deaths in Queensland in 1999 an Indigenous childhood hepatitis A vaccination program has been implemented (Hanna J, personal communication). In the USA, hepatitis A vaccine is now part of the routine vaccination schedule for States with high hepatitis A notification rates.[35] Studies in several countries have indicated that universal hepatitis A vaccination of adolescents would be cost-effective.[36,37] 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 and, rarely, fulminant hepatitis. Only a small proportion of HBV infections are clinically recognised, with less than 10 per cent of children and 30–50 per cent of adults experiencing clinical symptoms.[38] 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.[39]

Case definitions

Notifications

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

- hepatitis B core antibody (Anti-HBc) IgM;

or

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

Hospitalisations

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

As in the previous report, hospitalisations were included only where the relevant ICD code was the principal diagnosis. Acute hepatitis B was the principal diagnosis in 15 per cent of all hospitalisations with acute hepatitis B. This is a much lower proportion than for the other diseases but similar to previous analyses of hepatitis B hospitalisations.[1]

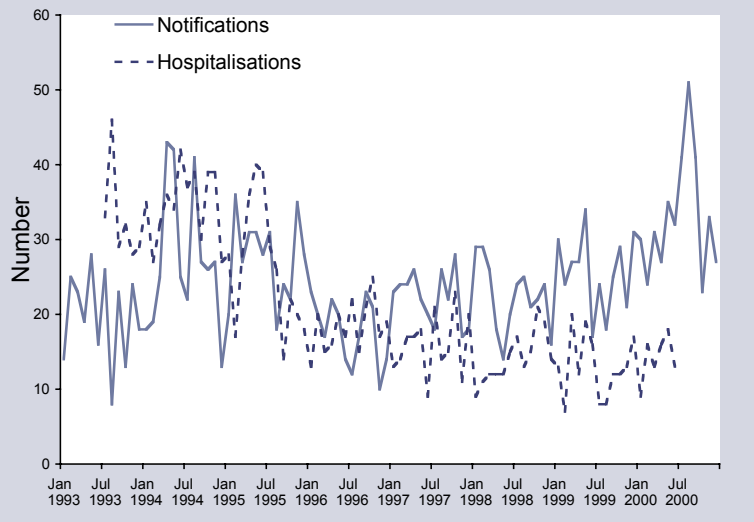
Deaths

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

Secular trends

In the 2 years 1999 and 2000, there were 702 notifications (average annual rate 1.8 per 100 000) with a median of 28 notifications per month (range 17–51) (Figure 7, Table 7). Between 1998/1999 and 1999/2000 there were 345 hospitalisations with a principal diagnosis of acute hepatitis B (average annual rate 0.9 per 100 000) with a median of 13 hospitalisations per month (range 7–21). Ninety-eight per cent (337/345) of these hospitalisations were coded as 'acute hepatitis B without delta-agent and without hepatic coma' (ICD-10-AM B16.9). In 2000, there were more notifications of acute hepatitis B than for any other year since surveillance began in most States and Territories in 1993 (Appendix 2). Except for a slight increase between 1997/1998 and 1998/1999, hospitalisations have declined every year since 1993/1994 (Appendix 3).

Figure 7. Acute hepatitis B notifications, and hospitalisations,* Australia, 1993 to 2000,† by month of onset or admission



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

† Notifications where the month of onset was between January 1993 and December 2000, hospitalisations where the month of admission was between 1 July 1993 and 30 June 2000.

Severe morbidity and mortality

For patients with a principal diagnosis of acute hepatitis B, 1796 hospital bed days (average 898 per year) were recorded. The median length of stay was 3 days, with longer stays for adults aged 60 years and over (Table 7). There were 47 deaths recorded in the 3 years 1998 to 2000, 30 in males and 17 in females. All the deaths were in individuals aged 20 years or more and 62 per cent (29/47) were aged 50 years or more. Coma and the need for critical care occurred exclusively in individuals aged over 15 years (Table 8).

Table 7. Acute hepatitis B notifications, hospitalisations and deaths, Australia, 1998 to 2000,* by age group

Age group (years)	**Notifications 2 years** (1999–2000)		**Hospitalisations 2 years** (July 1998–June 2000)		**LOS† per admission** (days)	**Deaths 3 years** (1998–2000)	
	No.	Rate‡	No.	Rate‡	Median	No.	Rate‡
0–4	2	0.0	3	0.1	2	0	-
5–14	10	0.2	8	0.1	1.5	0	-
15–24	299	5.5	84	1.6	3	1	0.0
25–59	367	2.0	226	1.2	3	29	0.1
60+	24	0.4	24	0.4	4	17	0.2
All ages§	702	1.8	345	0.9	3	47	0.1

* Notifications where the month of onset was between January 1999 and December 2000; hospitalisations where the month of separation was between 1 July 1998 and 30 June 2000; deaths where the date of death was recorded between 1998 and 2000.

† LOS = length of stay in hospital.

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

§ Includes cases with unknown ages.

Table 8. Indicators of severe morbidity* for hospitalised cases of acute hepatitis B, Australia, 1998 to 2000,* by age group

Age group (years)	Requiring critical care†			Complication hepatic coma§	
	No.	% total	Median no. of hours‡	No.	% total
0–4	0	0	-	0	0
5–14	0	0	-	0	0
15–24	2	2.4	106	0	0
25–59	1	0.4	429	5	2.2
60+	0	0	-	0	0
All ages	3	0.9	208	5	1.4

* Measured using National Hospital Morbidity data where the month of hospital separation was between 1 July 1998 and 30 June 2000.

† Requiring mechanical ventilation.

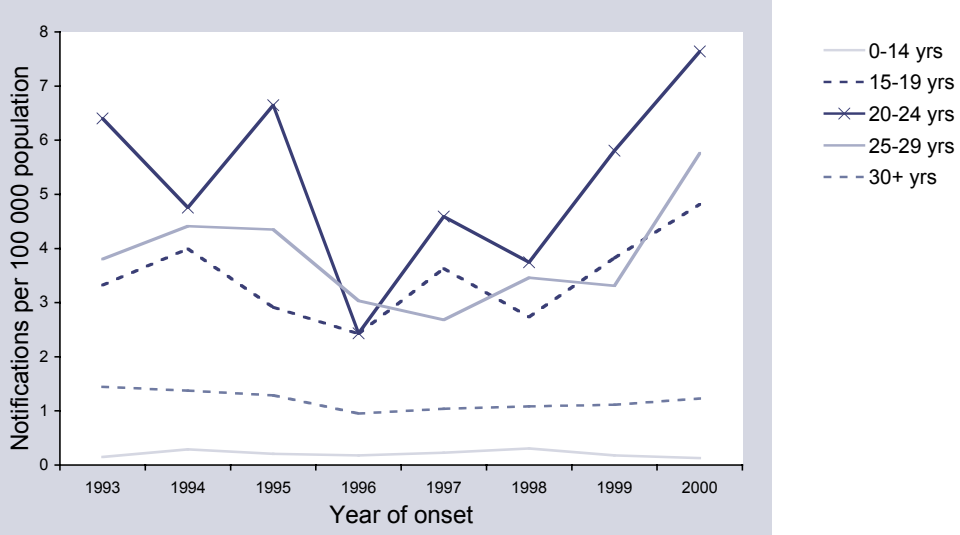
‡ Of those receiving critical care.

§ ICD-10-AM codes B16.0 and B16.2.

Age and sex distribution

In 1999 and 2000, the notification rate increased in young adults aged 15–29 years and in 2000 it was the highest ever recorded for these age groups (Figure 8). The notification rate has remained stable or has declined in other age groups. In almost all age groups there were more male than female notifications, with an overall male:female ratio of 1.7:1.

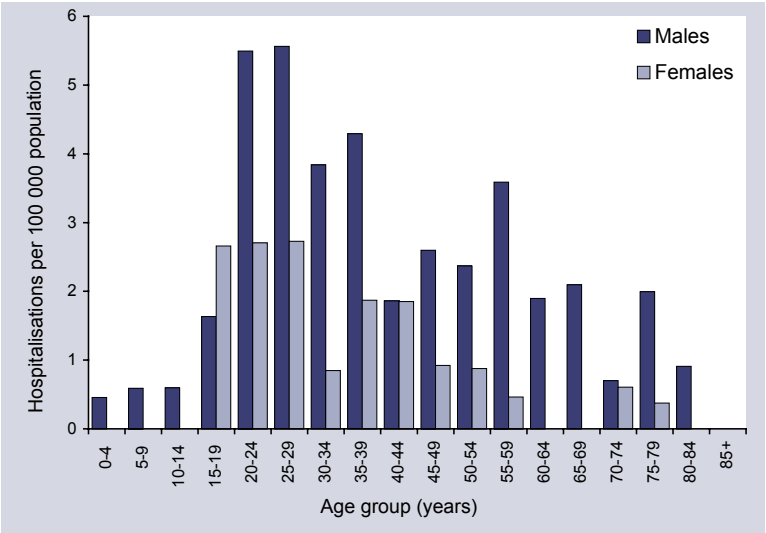
Figure 8. Acute hepatitis B notification rates, Australia, 1993 to 2000,* by age group



* Notifications where the month of onset was between January 1993 and December 2000.

During 1998/1999 and 1999/2000, hospitalisation rates were highest in adults aged between 20 and 29 years (Figure 9). Like notifications, hospitalisations occurred predominantly in males with an overall male:female ratio of 2.3:1. The male:female ratio of notifications and hospitalisations has not altered between 1993 to 1998 and the current review period.

Figure 9. Acute hepatitis B hospitalisation rates, Australia, 1998 to 2000,* by age group and sex



* Hospitalisations where the principal diagnosis was acute hepatitis B and the month of separation was between 1 July 1998 and 30 June 2000.

Geographical distribution

Victoria recorded the highest number of notifications, hospitalisations and deaths (n=20) during the review period (Appendix 2). The Northern Territory had the highest average annual notification rate at 6.5 per 100 000 and also the highest average annual hospitalisation rate at 1.6 per 100 000. The increase in notifications between 1998 and 2000 has been observed in all States and Territories except the Northern Territory, where notification rates have declined.

Comment

Overall there were more hospitalisations and deaths than would be expected given the number of notifications and the epidemiology of the disease. It is likely that this is caused by a combination of (a) misclassification of hospitalisations and deaths due to chronic infection as acute infection and (b) undernotification. Misclassification appears especially apparent in the death data, where only 5 of the 47 deaths had acute hepatitis B with hepatic coma (B16.0 or B16.2) recorded as the underlying cause of death.

The ratio of notifications to hospitalisations has changed since 1993 with notifications increasing while hospitalisations have decreased. There has been no shift in the age distribution of cases that might explain a decrease in the severity of disease. The decline in hospitalisations is likely to be a reflection of changes to coding practices. In 1998/1999 ICD-10-AM replaced ICD-9-CM, although some States/Territories continued to use ICD-9-CM in 1998/1999. The 4 ICD-9-CM codes used to select hospitalisations between 1994/1995 and 1997/1998 included 'acute or unspecified' hepatitis B, whilst ICD-10-AM can differentiate between acute and unspecified hepatitis B. The ICD-10-AM codes used in this report are therefore more specific for acute HBV disease.

The variation in notification rates between States/Territories may be due to differences in surveillance methods but could also be a real difference resulting from differences in the proportion of the population at increased risk of hepatitis B infection (eg, Indigenous people). The Australian Capital Territory and Victoria instituted enhanced surveillance of acute hepatitis B in January 2000 and July 2001 respectively, and this can be expected to influence notification rates in these jurisdictions.

The increase in acute hepatitis B notifications between 1998 and 2000 is largely confined to young adults aged 15–29 years. In young adults, acute hepatitis B infection is likely to be the result of sexual transmission or transmission associated with intravenous drug use. One possible explanation for the increased notification rate is improved reporting. Since the increase is observed in all States/Territories except the Northern Territory, any improvement in notification completeness would have to be a widespread phenomenon. Alternatively, the increase in notifications may represent a real increase in new infections, in which case attention should be focused on reducing the risk of acute hepatitis B in the current cohort of young adults. Adolescent hepatitis B immunisation commenced in Australia in 1997. Although we would hope to begin to see a decline in the notification rate in the 15–19 year age group from 1999 onwards, the effect of active adolescent immunisation programs in Victoria[40] and South Australia has yet to be observed in the notification 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 the rest of Australia 'at-risk' infants have been given hepatitis B vaccine since 1987 (except in South Australia, which began in 1996). It is therefore of interest that the Northern Territory is the only jurisdiction with an overall decrease in notification rates for acute hepatitis B. Universal infant hepatitis B immunisation was introduced in the rest of Australia in May 2000. The effect of this policy on the reported incidence of acute hepatitis B would not be expected to become apparent until the first cohort of vaccinated infants reaches adolescence (around 2015).

Acute hepatitis B is only one measure of the burden of disease caused by HBV. The prevalence of chronic HBV infection reflects historical transmission patterns and in the longer term the impact of immunisation policies will be reflected in trends in chronic infection and its sequelae, such as hepatocellular carcinoma.[41]

Influenza

Influenza A and B viruses can cause major epidemics of respiratory disease. Often indistinguishable on a clinical basis from disease caused by other respiratory viruses, symptoms can include abrupt onset of fever, myalgia, headache, sore throat and acute cough. Influenza epidemics usually occur during the Winter months causing increased hospitalisation for pneumonia and exacerbation of chronic diseases and also resulting in increased mortality, particularly among the elderly and those with chronic diseases.

Case definitions

Notifications

Influenza was not a nationally notifiable disease throughout the review period, therefore national notification data have not been included.

Hospitalisations

The ICD-10-AM codes used to identify hospitalisations were: J10 (influenza due to identified influenza virus) and J11 (influenza, virus not identified). In this report, we did not make the distinction between admissions where a virus was identified and those where it was not. Some States and Territories were still using ICD-9-CM in 1998/1999 and this does not differentiate between the two categories (see also Chapter 2).

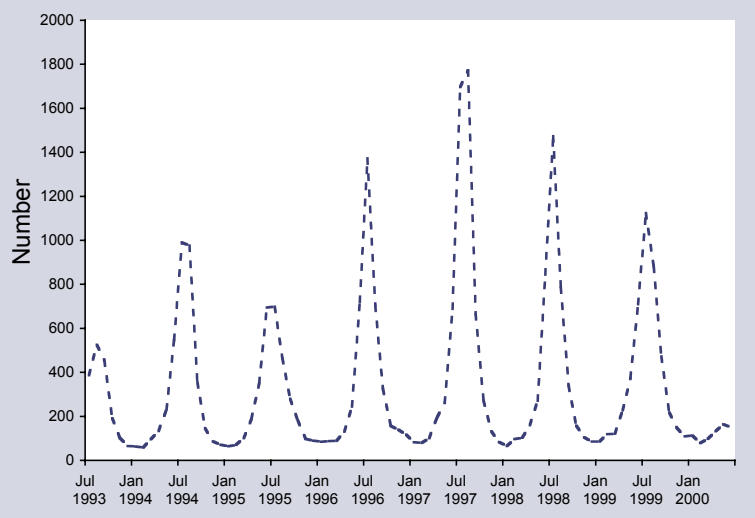
Deaths

The ICD-10 codes used to identify deaths were: J10 (influenza due to identified influenza virus) and J11 (influenza, virus not identified).

Secular trends

In 1998/1999–1999/2000 there were 8590 hospitalisations coded as influenza (an average annual rate of 22.8 per 100 000). There was a clear seasonal pattern with dramatic increases over the Winter months (Figure 10). The median number of admissions per month was 158 (range 78–1474) with maximums of 1474 and 1124 admissions occurring in July 1998 and July 1999, respectively. In the previous year, 1997, a peak occurred in August when there were 1773 admissions.

Figure 10. Influenza hospitalisations, Australia, July 1993 to June 2000, by month of admission



Severe morbidity and mortality

A total of 57 516 hospital bed days were recorded for people with an ICD-10-AM code for influenza. The median length of stay was at least 3 times higher for older people than it was for any other age group — 6 days among people aged 60 years (Table 9). Influenza was the principal diagnosis for 64 per cent of the hospitalisations. Of the 8590 hospitalisations, 103 people were recorded as having died in hospital (Table 10). Most of these deaths, 87 per cent (90/103), occurred among people aged 60 years or more.

From 1 January 1998 to 31 December 2000, there were 258 deaths for which influenza was recorded on the death certificate as the underlying cause. Of these, 221 (86%) were aged 60 years or more.

Table 9. Influenza hospitalisations and deaths, Australia, 1998 to 2000,* by age group

Age group (years)	Hospitalisations 2 years (July 1998–June 2000)				LOS† per admission (days)	Deaths 3 years (1998–2000)	
	No.	(‖)	Rate‡	(‖)	Median	No.	Rate‡
0–4	1803	(1264)	70.6	(49.5)	2	12	0.3
5–14	522	(351)	9.9	(6.6)	2	2	0.0
15–24	683	(427)	12.7	(8.0)	1	2	0.0
25–59	2808	(1679)	15.3	(9.1)	2	21	0.1
60+	2774	(1775)	45.5	(29.1)	6	221	2.4
All ages§	8590	(5496)	22.8	(14.6)	3	258	0.5

* Hospitalisations where the month of separation was between 1 July 1998 and 30 June 2000; deaths where the date of death was recorded between 1998 and 2000.

† LOS = length of stay in hospital.

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

§ Includes cases with unknown ages.

‖ Principal diagnosis.

Table 10. Indicators of severe morbidity and mortality* for hospitalised cases of influenza, Australia, 1998 to 2000,* by age group

Age group (years)	Requiring critical care†			Died in hospital	
	No.	% total	Median no. of hours‡	No.	% total
0–4	13	0.7	30	3	0.2
5–14	4	0.8	33	0	0
15–24	5	0.7	89	2	0.3
25–59	15	0.5	131	8	0.3
60+	18	0.6	119	90	3.2
All ages	55	0.6	91	103	1.2

* Measured using National Hospital Morbidity data where the month of hospital separation was between 1 July 1998 and 30 June 2000.

† Requiring mechanical ventilation.

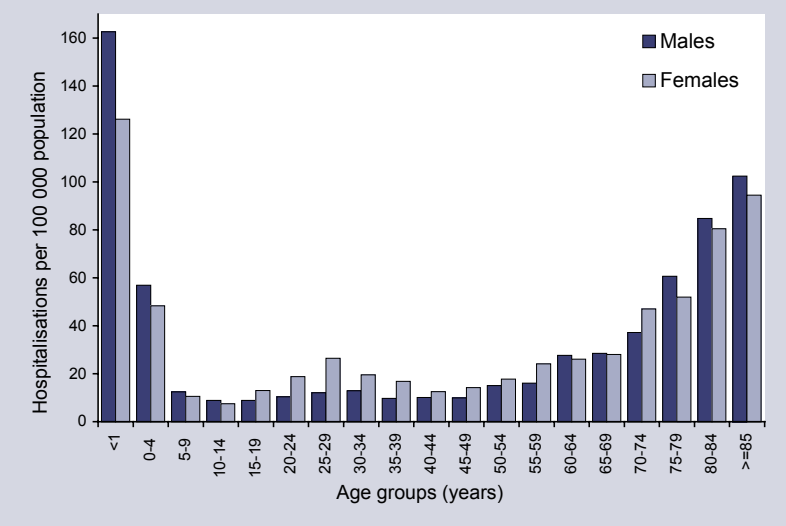
‡ Of those receiving critical care.

Age and sex distribution

Among the age groups specified in Table 9, hospitalisation rates were highest in children aged under 5 years (70.6 per 100 000). Although overall hospitalisation rates were lower among people aged 60 years or more, the rates increased with increasing age, ranging from 26.9 per 100 000 for those aged 60–64 years to 96.9 per 100 000 for those aged 85 years or more. Among children aged less than 5 years, the hospitalisation rates were highest among infants (144.8 per 100 000 population aged <1 year) (Figure 11).

The overall male:female ratio was 1:1.2; however, this was not consistent across all age groups. Males were predominant among those aged less than 5 years (male:female ratio 1.3:1.0) whereas there were more females than males among people aged 60 years or more (male:female ratio 1:1.3).

Figure 11. Influenza hospitalisation rates, Australia, 1993 to 2000,* by age group and sex



* Hospitalisations where the month of separation was between 1 July 1998 and 30 June 2000.

Geographical distribution

There was a wide variation in average crude hospitalisation rate for the 2-year review period, ranging from 4.9 per 100 000 in the Australian Capital Territory (n=30) to 38.4 per 100 000 in Western Australia (n=1420) (Appendix 3). In all States and Territories, influenza hospitalisations increased over the Winter months.

During 1993/1994–1999/2000, the Winter of 1997 was the period during which most States and Territories recorded the highest number of hospitalisations. The exceptions were Queensland and the Northern Territory, where hospital admissions were highest during the winters of 1996 and 1998, and South Australia where hospital admissions were highest during the Winter of 1998.

Comment

Laboratory confirmation plays a critical role in differentiating influenza from other respiratory pathogens. Although notification data were not available for inclusion in this report, data from sentinel sites also show influenza or influenza-like illness to be circulating at similar time periods, although the magnitude of the increases and populations affected vary.[42,43] Hospitalisation data referred to in this report are based on discharge coding and it is possible that some of those with less specific influenza codes (eg, J11) may be due to other respiratory pathogens such as respiratory syncytial virus (RSV).[44]

Influenza A and B viruses are known to cause major epidemics of respiratory disease resulting in severe morbidity and increasing numbers of deaths. Annual influenza vaccination is the primary method of prevention and is currently recommended for all people aged 65 years or more, all Aboriginal and Torres Strait Islander people aged 50 years or more, and people aged 6 months or more who are considered to be at high risk, such as those who have chronic disorders of the pulmonary or circulatory systems or other chronic illnesses requiring regular follow-up or hospitalisation.[34] Heath-care workers and others caring for or living with high risk people should also be vaccinated, not only to protect themselves, but also because they can act as a vehicle for introduction of the virus.[45]

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.[14]

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 38˚C 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

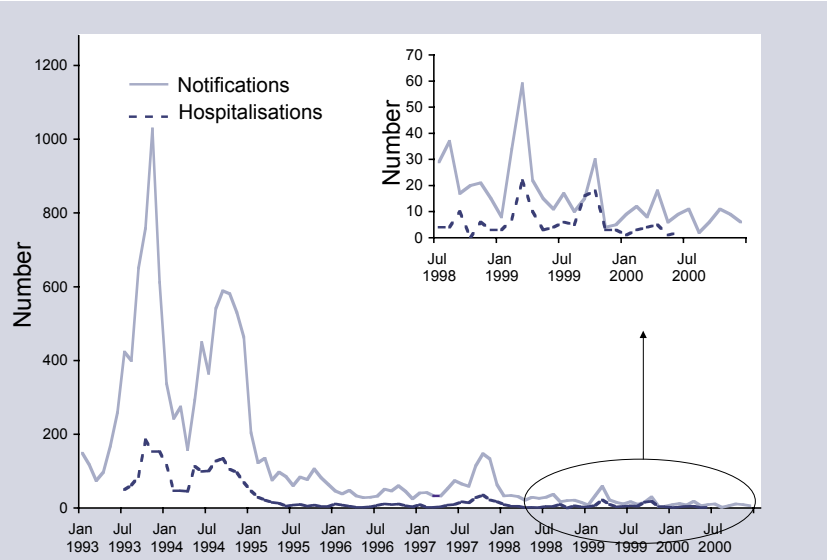
The ICD-10-AM/ICD-10 code B05 (measles) was used to identify hospitalisations and deaths. SSPE was not included in these analyses.

Secular trends

Between January 1999 and December 2000 there were 336 notified cases of measles, an average annual notification rate of 0.9 per 100 000 (Table 11). The number of notifications generally decreased over the review period (Figure 12) leading in 2000 to the lowest notification rate on record (0.6 per 100 000; Appendix 2). In the 2-year review period the median number of notifications per month was 11 (range 2–59).

In 1998/1999 and 1999/2000, there were 145 hospitalisations with the ICD-10-AM code B05 (measles). In each of these 2 years the hospitalisation rate was 0.4 per 100 000, similar to that seen in the 2 years prior to 1997/1998 (Appendix 3). The median number of hospitalisations per month was 4 (range 0–22). Like the notifications, the number of hospitalisations peaked in March and October of 1999.

Figure 12. Measles notifications and hospitalisations, Australia, 1993 to 2000,* by month of onset or admission



* Notifications where the month of onset was between January 1993 and December 2000, hospitalisations where the month of admission was between 1 July 1993 and 30 June 2000.

Severe morbidity and mortality

In the 2-year review period, hospital separations for measles accounted for 483 hospital bed days. The median length of stay (LOS) was 3 days, but adults and adolescents aged at least 15 years tended to stay in hospital longer than younger people (Table 11). Of the 145 hospitalisations, 111 (77%) had measles recorded as the principal diagnosis. Complications arising from measles infection were recorded for 28 (19%) separations. Seven (5%) hospitalisations were coded as having neurological complications (6 as encephalitis, 1 as meningitis), 11 (8%) as pneumonia, 3 (2%) as otitis media and 9 (6%) as intestinal or other complications (Table 12). Multiple complications were recorded for 2 hospitalisations.

There were no deaths recorded from measles between 1998 and 2000 (Table 11).

Table 11. Measles notifications, hospitalisations and deaths, Australia, 1998 to 2000,* by age group

Age group (years)	Notifications 2 years (1999–2000)		Hospitalisations 2 years (July 1998–June 2000)				LOS† per admission (days)	Deaths 3 years (1998–2000)	
	No.	Rate‡	No.	(‖)	Rate‡	(‖)	Median	No.	Rate‡
0–4	109	4.3	55	(42)	2.2	(1.6)	2	0	-
5–14	49	0.9	23	(20)	0.4	(0.4)	2	0	-
15–24	107	2.0	38	(29)	0.7	(0.5)	4	0	-
25–59	69	0.4	28	(19)	0.2	(0.1)	3.5	0	-
60+	1	0.0	1	(1)	0.0	(0.0)	1	0	-
All ages§	336§	0.9	145	(111)	0.4	(0.3)	3	0	-

* Notifications where the month of onset was between January 1999 and December 2000; hospitalisations where the month of separation was between 1 July 1998 and 30 June 2000; deaths where the date of death was recorded between 1998 and 2000.

† LOS = length of stay in hospital.

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

§ Includes cases with unknown ages.

‖ Principal diagnosis (hospitalisations).

Table 12. Indicators of severe morbidity* for hospitalised cases of measles, Australia, 1998 to 2000,* by age group

Age group (years)	Requiring critical care†			Measles encephalitis		Measles pneumonia	
	No.	% total	Median no. of hours‡	No.	% total	No.	% total
0–4	0	0	-	0	0	6	11
5–14	0	0	-	1	4	2	9
15–24	0	0	-	2	5	3	9
25–59	0	0	-	3	11	0	0
60+	0	0	-	0	0	0	0
All ages	0	0	-	6	4	11	8

* Measured using National Hospital Morbidity data where the month of hospital separation was between 1 July 1998 and 30 June 2000.

† Requiring mechanical ventilation.

‡ Of those receiving critical care.

Age and sex distribution

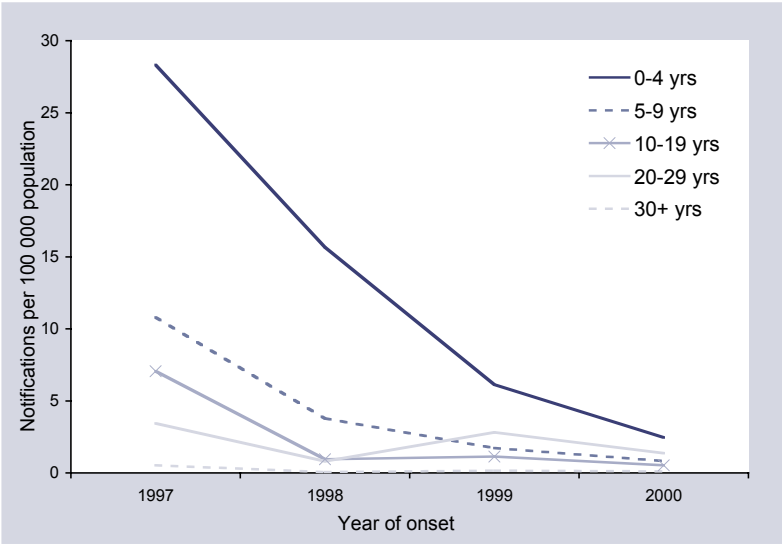
As in the previous review period, measles notification and hospitalisation rates were highest in 0–4 year olds (Figures 13 and 14) especially those less than 2 years of age. However, rates for 0–4 year olds have been decreasing since 1997, and in the most recent year reviewed were the lowest on record (notification rate for 2000: 2.5 per 100 000; hospitalisation rate for 1999/2000, 2.0 per 100 000). The proportion of notifications in the 0–4 year age group in 1999/2000 was 32 per cent; this has been declining since 1998 when it was 66 per cent. The proportion of hospitalisations in this age group in 1998/1999–1999/2000 was 38 per cent, similar to that in the previous 5-year review period (42%).

Notification rates for 5–19 year olds have also been declining since 1997 and in 2000 were the lowest ever reported (0.6 per 100 000, Figure 13). Similarly, hospitalisation rates for 5–9 year olds were lower in both 1998/1999 (0.4 per 100 000) and 1999/2000 (0.5 per 100 000) than in the previous 5 years combined (5.0 per 100 000). The 10–19 year age group had its lowest hospitalisation rate on record in 1999/2000 (0.3 per 100 000), while rates for 5–9 year olds, although the lowest on record in 1998/1999 (0.2 per 100 000, 3 hospitalisations), increased in 1999/2000 (1.0 per 100 000, 13 hospitalisations, Figure 14). Over the 2-year review period, 5–9 year olds accounted for 23 per cent of both notifications and hospitalisations for measles, which is in contrast with the previous review period when they accounted for a much greater proportion (58% of the notifications and 43% of the hospitalisations).

Adults aged 20–29 years accounted for considerably more of the notifications (35%) and hospitalisations (26%) in this review period than in the previous report period (9% of notifications, 10% of hospitalisations). In both 1999 and 2000, the 20–24 year age group had the second highest notification rate (4.0 per 100 000 in 1999 and 1.7 per 100 000 in 2000). This age group also had a higher hospitalisation rate than 5–9 year olds in 1998/1999 (Figure 14).

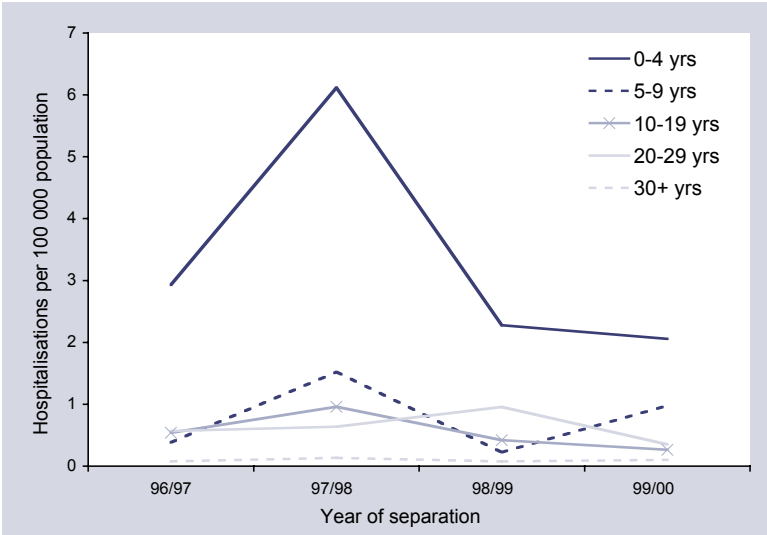
Over the 2-year review period there were slightly more notifications for females than males (male:female ratio 1:1.1). Conversely, there were more hospitalisations of males than females (male:female ratio 1.2:1) especially in the 0–4 year age group (male:female ratio 2.2:1).

Figure 13. Measles notification rates, Australia, 1997 to 2000,* by age group and year of onset



* Notifications where the month of onset was between January 1997 and December 2000.

Figure 14. Measles hospitalisation rates, Australia, 1996/1997–1999/2000* by age group and year of separation



* Hospitalisations where the month of separation was between 1 July 1996 and 30 June 2000.

Geographical distribution

Notification and hospitalisation rates in most States and Territories continued to decline from a peak in 1997 (Appendices 2 and 3). The notable exception was Victoria, which experienced a large outbreak in February 1999 and 2 smaller outbreaks in August and September of the same year.[7] Victoria contributed 48 per cent of the notifications and 38 per cent of the hospitalisations in 1999 and had its highest notification rates since 1995 and its highest hospitalisation rates since 1993/1994. The decline in notification rates for Australia between 1999 and 2000 was predominantly due to an 81 per cent reduction in the number of cases from Victoria in 2000 compared with the previous year.

Despite the high proportion of notifications from Victoria, the Northern Territory had more than twice the rate of any other State or Territory in 1999 (notification rate 5.2 per 100 000). In the following year all States and Territories had notification rates below 1 per 100 000. For both 1998/1999 and 1999/2000, hospitalisation rates for each State and Territory were below 0.7 per 100 000. The exception was the Northern Territory in 1999/2000, which had 14 hospitalisations coded as measles, a rate of 7.3 per 100 000. The high notification and hospitalisation rates for the Northern Territory in 1999 were due to measles in refugee children from East Timor who came to Darwin in September 1999; all were hospitalised for care and isolation. Only two Darwin residents developed measles (Selvey C, personal communication).

Comment

In 2000 numbers of measles notifications and hospitalisations in Australia were at their lowest level ever recorded, and there has not been a death from measles since 1995. In 2000 the notification rate was 0.6 per 100 000: less than half the rate reported for 1999 and considerably lower than the rates in 1994 (27.0 per 100 000) and during the most recent peak in 1997 (4.6 per 100 000). Hospitalisation rates have shown the same downward trend, although the rate differences are less marked.

The low levels of measles are the result of several vaccination initiatives in Australia. In 1994 a second dose of measles-mumps-rubella (MMR) vaccine was introduced for 10–16 year olds and in 1998 the age for this dose was lowered first to 4–5 years and then to 4 years.[2] This change occurred at the same time as the Australian Measles Control Campaign (MCC) was conducted. The Campaign involved vaccinating 1.7 million primary school children with a dose of MMR vaccine regardless of their past vaccination history.[46] As a result, immunity to measles among these children increased from 84 per cent to 94 per cent.[47] Parental and provider incentives have also been established to improve vaccination coverage,[12] and coverage for one year olds with the MMR vaccine (measured at 2 years of age, according to the ACIR) has increased to 93 per cent in 2001.[48]

The most dramatic impact of these initiatives has been on the burden of measles in children. In 2000, notification rates for 0–19 year olds were the lowest on record, and this age group contributed a significantly smaller proportion of both notifications and hospitalisations than previously. Conversely, a higher proportion of notifications and hospitalisations were from the 20–29 year age group. This group of young adults, especially those aged 20–24 years, had the second highest notification rate in 1999 to 2000, and hospitalisation rate in 1998/1999. As incorrect clinical diagnosis of measles is much more of a problem in young children,[49,50] it is possible that currently the true incidence of measles in 20–24 year olds is much higher than in 0–4 year olds. Serological surveys conducted in Victoria and nationally have also shown that young adults, born in the latter half of the 1970s, are at risk of measles.[51,52] This is likely to be due to a lower exposure to measles than older cohorts, together with a lower likelihood of immunisation both in infancy[53] and in adolescence than younger cohorts.[2] The increased proportion of cases in young adults has prompted the Australian Government to allocate funding to provide free MMR vaccine to 18–30 year olds.[54] Currently no data are available for coverage achieved under this program.

The changing pattern of measles epidemiology in Australia is similar to that seen in other countries with high childhood vaccination coverage. The United Kingdom and USA have reported record low numbers of confirmed measles cases for 2000 (101 and 86 cases, respectively),[55,56] while Finland has eliminated the disease.[57] Enhanced measles surveillance data from Western Australia[58] and Victoria[49,59,60] indicate that Australia may now be in a similar situation to the USA, where a high percentage of cases arise from imported strains and there is limited indigenous spread from these importations.[55] Improvements to the NNDSS notification system should enhance measles surveillance at a national level so that progress towards measles elimination in Australia can be monitored. Genotyping all measles virus isolates will also be important to confirm the absence of endemic measles, as it is difficult to epidemiologically link every case to its imported source.[55]

Meningococcal disease

Meningococcal disease is defined as isolation of *Neisseria meningitidis* from cerebrospinal fluid (CSF), blood and other normally sterile sites including skin lesions. Clinical manifestations include meningitis, meningococcaemia without meningitis (which varies in presentation from fulminant to chronic) and septic arthritis. In culture-negative cases with a compatible clinical picture, a diagnosis of meningococcal disease can be supported by a range of laboratory evidence. This includes the identification of Gram-negative intracellular diplococci or meningococcal antigen in blood or CSF, the identification of nucleic acid from *Neisseria meningitidis* in body fluids or demonstration of a serological response to *Neisseria meningitidis.*

Case definitions

Notifications

In jurisdictions apart from New South Wales and the Northern Territory, a notification of meningococcal disease requires supportive laboratory evidence, although the nature of this varies. In New South Wales and the Northern Territory, a clinical diagnosis of meningococcal disease without laboratory evidence is accepted as a presumptive or probable case, respectively. The serogroup of meningococcal cases is not currently routinely available from notification data but is reported annually by the National Neisseria Network in *Communicable Diseases Intelligence.*

Hospitalisations

The ICD–10–AM code used to identify hospitalisations was A39 (meningococcal infection). This includes meningococcal meningitis (A39.0), Waterhouse-Friderichsen syndrome (A39.1), acute meningococcaemia (A39.2), chronic meningococcaemia (A39.3), meningococcaemia unspecified (A39.4), meningococcal heart disease (A39.5), other meningococcal infections (A39.8), and meningococcal infection unspecified (A39.9). As all cases with one of these codes, not just principal diagnoses, were included, cases were identified in a hierarchical fashion to avoid double counting. First, those with code A 39.0 ('meningitis'), then those without A 39.0 but with A39.1 or A39.2 or A39.3 or A39.4 ('septicaemia without meningitis'), then those with none of these codes but with codes in any other subsection of A39 were selected.

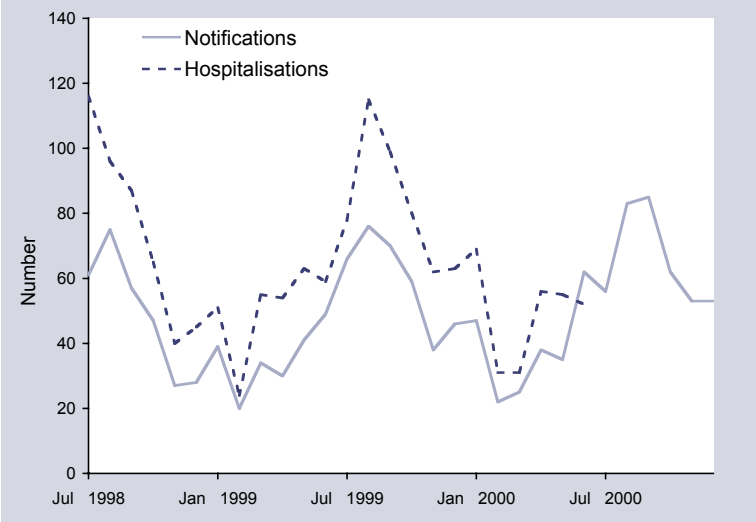
Deaths

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

Secular trends

There were 1189 notifications of meningococcal disease in the 2 years 1999 to 2000, an average annual notification rate of 3.1 per 100 000 (Table 13). A median of 47 cases was notified each month, with a range of 20 to 83 cases. There were 1566 hospital separations recorded as ICD code A39 (average annual rate 4.2 per 100 000), and a median of 57 cases (range 18–116) per month. A clear seasonal pattern was apparent, with the highest number of notifications and hospitalisations between June and September each year (Figure 15).

Figure 15. Meningococcal notifications and hospitalisations, Australia, 1998 to 2000,* by year of onset or admission



* Notifications where the year of onset was between July 1998 and December 2000, hospitalisations where the month of separation was between 1 July 1998 and 30 June 2000.

Severe morbidity and mortality

Over the 2-year review period, 12 004 hospital bed days were recorded for patients with an ICD-10-AM code A39, of which 51 per cent were coded as meningitis (A39.0). For all categories of meningococcal disease, the hospitalisation and notification rates were greatest among 0–4 and 15–24 year olds, who accounted for 65 per cent of cases. In 0–4 year olds, the hospitalisation rate for meningitis was 10.9 per 100 000, and 23.0 per 100 000 when all disease categories were considered (Table 13). Meningitis was the principal diagnosis in 256 separations for 0–4 year olds, and 89 per cent of all separations coded as meningitis (Table 13). For all foci of infection, length of stay, the proportion recorded as receiving critical care and the duration of critical care increased with age. At the extremes of age, adults aged at least 60 years required a median duration of critical care of 163.5 hours for meningitis and 223 hours for all meningococcal disease compared with 25 and 40 hours for children less than 5 years (Table 14).

There were 103 deaths with meningococcal disease recorded as the underlying cause of death over the 3 years 1998 to 2000. The majority of these (80%) were coded as septicaemia without meningitis.

Table 13. Meningococcal notifications, hospitalisations and deaths, Australia, 1998 to 2000* by age group

Age group (years)	Notifications 2 years (1999–2000)		Hospitalisations 2 years (July 1998–June 2000)				LOS† per admission (days)	Deaths 3 years (1998–2000)	
	No.	Rate‡	No.	(‖)	Rate‡	(‖)	Median	No.	Rate‡
0–4	394	15.5	587	(549)	23.0	(21.5)	5	33	0.9
5–14	155	2.9	209	(195)	4.0	(3.7)	6	8	0.1
15–24	361	6.7	430	(388)	8.0	(7.2)	7	25	0.3
25–59	218	1.2	244	(204)	1.3	(1.1)	8	28	0.1
60+	54	0.9	96	(59)	1.6	(1.0)	9	9	0.1
All ages§	1189	3.1	1566	(1395)	4.2	(3.7)	6	103	0.2

* Notifications where the month of onset was between January 1999 and December 2000; hospitalisations where the month of separation was between 1 July 1998 and 30 June 2000; deaths where the date of death was recorded between 1998 and 2000.

† LOS = length of stay in hospital.

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

§ Includes cases with unknown ages.

‖ Principal diagnosis.

Table 14. Indicators of severe morbidity* for hospitalised cases of meningococcal disease, Australia, 1998 to 2000,* by age group

Age group (years)	Requiring critical care†		
	No.	% total	Median number of hours‡
0–4	17	2.9	40
5–14	8	3.8	85
15–24	33	7.7	47
25–59	20	8.2	49
60+	7	7.3	223
All ages	85	5.4	51

* From National Hospital Morbidity data where the month of hospital separation was between 1 July 1998 and 30 June 2000.

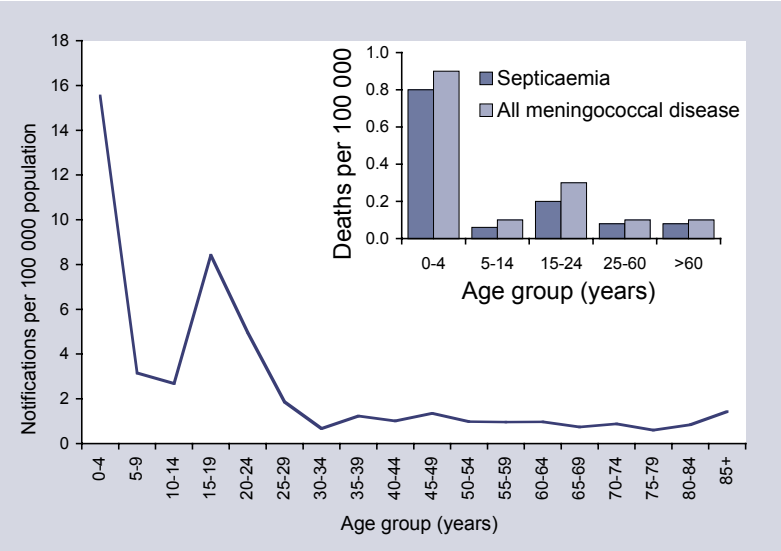
† Requiring mechanical ventilation.

‡ Of those receiving critical care.

Age and sex distribution

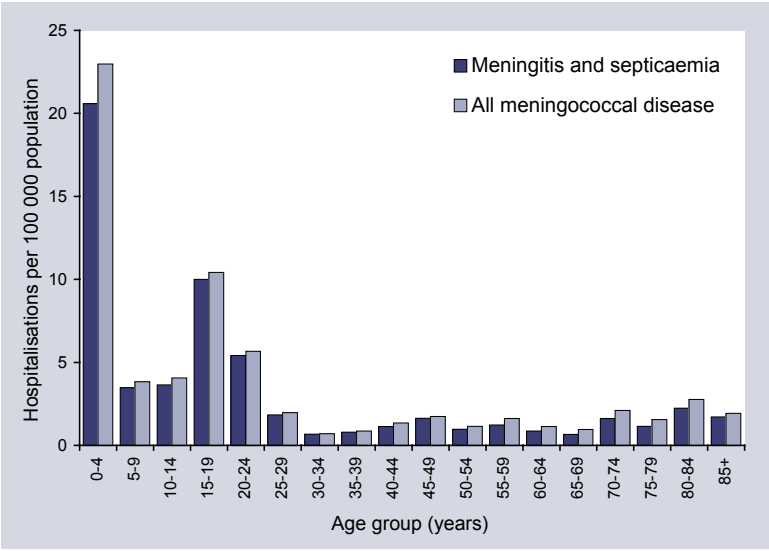
Overall there was a predominance of male cases (male:female ratio 1.2:1). However, among adults 50 years and over, there were more females (male:female ratio 0.6:1). Among children under 5 years of age (n=394), those under one year of age had the highest rate of notification (30.9 per 100 000) and hospitalisation (27.1 per 100 000). There was a second peak in both notification (Figure 16) and hospitalisation rates (Figure 17) among 15–19 year olds (8–10 per 100 000). The pattern of mortality paralleled other measures of meningococcal disease, with 32 per cent of deaths occurring in children less than 5 years old and 17 per cent in adolescents aged 15–19 years. Of all deaths, 89 per cent occurred in people less than 50 years of age (Figure 16).

Figure 16. Meningococcal disease notification and death rates, Australia, 1998 to 2000,* by age group



* Notifications where the month of onset was between January 1999 and December 2000, deaths where the date of death was recorded between 1998 and 2000.

Figure 17. Meningococcal disease hospitalisation rates, Australia, 1998 to 2000,* by age group



* Hospitalisations where the month of separation was between 1 July 1998 and 30 June 2000.

Geographical distribution

The pattern of notification and hospitalisation rates varied across the country, with the Northern Territory having the highest average annual notification (4.4 per 100 000) and hospitalisation (7.3 per 100 000) rates, followed by Western Australia (4.2 and 6.3 per 100 000) (Appendices 2 and 3). The Australian Capital Territory had the lowest rates of both notifications and hospitalisations (1.6 and 1.1 per 100 000, respectively).

Comment

The incidence of meningococcal disease in Australia based on notifications has increased steadily from 1.6 per 100 000 in 1991 to 3.1 per 100 000, a doubling over the past decade.[61] The Northern Territory consistently has the highest overall notification rate (range 4.1–9.5 per 100 000), followed by Western Australia. As these two jurisdictions have a relatively high proportion of Aboriginal people, it is likely that the higher incidence is related to disproportionate rates in this group, as recently reported from enhanced surveillance in Queensland.[62]

The age-specific notification rate is higher in infants under one year of age and overall in 0–4 year olds, though declining rapidly after the age of 2 years. A second lower peak occurs in later adolescence and young adulthood (15–24 years), with rates in 15–19 year olds (9 per 100 000) similar to those in 1–4 year olds. These patterns are also reflected in hospitalisation data. The hospitalisation rates shown here are an overestimate of admission rates for individual cases because of inter-hospital transfers and readmissions. More detailed studies, that used multiple data sets where this was corrected for, showed that hospitalisation data actually underestimated the true numbers of cases.[63,64] In Victoria, hospitalisation data were estimated to include only 77 per cent of cases, primarily because of allocation to non-specific codes for meningitis and septicaemia. Notifications were estimated to under-enumerate meningococcal cases by some 18 per cent, a finding likely to be relevant to other jurisdictions. Length of hospital stay and requirement for critical care increased with age. In contrast, mortality rates per 100 000 population, based on certification of underlying cause of death, indicated that the highest mortality rate is among 0–4 year olds. As in notifications, a second but lower peak in mortality rate occurs among 15–24 year olds.

There is considerable heterogeneity across the country in the incidence and serogroup distribution of meningococcal disease, with some recent rapid changes.[65,66] Currently, neither hospitalisation nor notification data give serotype-specific information, although this should be available nationally for notifications from 2001 through enhanced surveillance. Serotype-specific data are important for vaccine policy, as conjugate vaccines are now available, providing good protection which is likely to be long-lived against serogroup C strains.[67] The National Neisseria Network has published reports on serotype-specific data since 1994, showing that the proportion of serogroup C varies widely by jurisdiction and age group.[65,68] In 1999 to 2000, serogroup C emerged as the predominant serogroup among older children and adolescents in Victoria.[63] In 2000, in people above 5 years of age serogroup C was more common than B in all jurisdictions.[65,68] Serogroup B predominates among children under 5 years and among all age groups in jurisdictions other than Victoria and New South Wales.

As found elsewhere, in Australia serogroup C meningococcal disease is associated with a higher mortality than serogroup B.[65,68] In contrast, the United Kingdom, prior to the introduction of a conjugate serogroup C meningococcal vaccine program, had both an overall incidence of meningococcal disease 3–5 times higher and a much higher proportion of deaths due to serogroup C.[67] The recent program to give conjugate C vaccine to all 0–18 year olds in the United Kingdom has been associated with a dramatic decrease in cases and deaths due to serogroup C in this age group. No effect was seen in those over 18 years, consistent with a vaccine effect.[67] Conjugate meningococcal serogroup C vaccines were approved for use in Australia in 2001. The most appropriate use of these vaccines in Australia is currently being evaluated by the Australian Technical Advisory Group on Immunisation.

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.[14]

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).

Notes: In New South Wales only laboratory confirmed cases [(a) or (b)] are notifiable. Mumps was not notifiable in Queensland between July 1999 and June 2001.

Hospitalisations

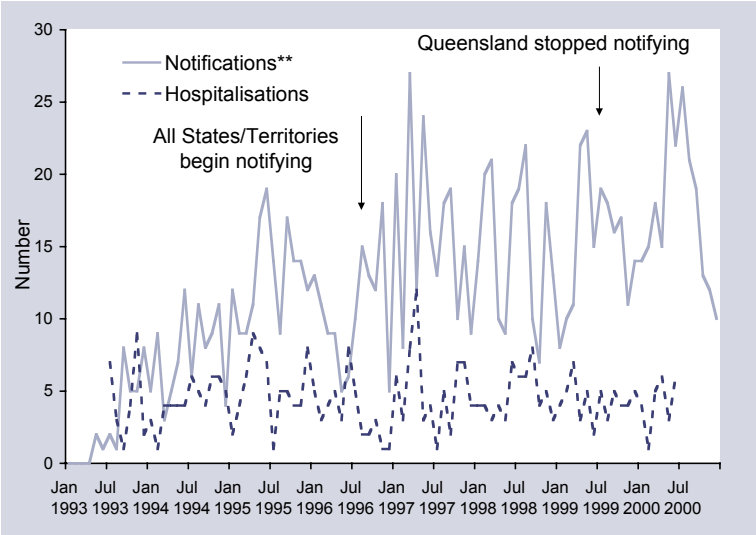
The ICD-10-AM/ICD-10 code B26 (mumps) was used to identify hospitalisations and deaths.

Secular trends

During the 2 years from 1999 to 2000 there were 384 notifications of mumps (an average annual notification rate of 1.2 per 100 000) (Table 15). The notification rate in 2000 (1.4 per 100 000) was higher than in 1999 (1.1 per 100 000) and in past years (Figure 18, Appendix 2). Monthly numbers of notifications varied considerably, with a median of 15.5 (range 8–27) notifications per month. As in previous years this variation did not appear to be seasonal; however, 61 per cent of the cases notified in 1999 to 2000 had onset dates between April and September.

From July 1999 to June 2000 there were 112 hospitalisations coded as due to mumps, an average annual hospitalisation rate of 0.3 per 100 000 (Table 15). Annual numbers and rates of hospitalisations have remained fairly constant since 1993 (Appendix 3), in contrast to the upward trend for notifications. However, like the notification data, the number of admissions each month varied (median 5, range 1–8 per month).

Figure 18. Mumps notifications and hospitalisations, Australia, 1993 to 2000,* by month of onset or admission



* Notifications where the month of onset was between January 1993 and December 2000, hospitalisations where the month of separation was between 1 July 1993 and 30 June 2000.

** Note that the number of jurisdictions notifying mumps increased over the review period until July 1996 when mumps became notifiable in all States and Territories. From July 1999 mumps became not notifiable in Queensland. Only the Australian Capital Territory, New South Wales and Victoria notified for the entire review period.

Severe morbidity and mortality

There were 494 hospital bed days (average 247 per year) recorded for patients with the ICD-10-AM code for mumps (Table 15). Of the 112 hospitalisations, 83 (74%) had mumps recorded as the principal diagnosis (average annual rate 0.2 per 100 000). Complications arising from mumps infection were recorded for 24 hospitalisations (21%). The most commonly reported complication was orchitis. There were 12 (11%) hospitalised cases coded with orchitis; 10 of whom were between 17 and 45 years of age (Table 16). Four hospitalisations (4%) were coded as neurological complications (2 encephalitis, 2 meningitis) and no hospitalisation had multiple complications. The median length of stay (LOS) in hospital was 2.5 days, but adults aged at least 60 years had a much longer median LOS compared with younger age groups (Table 15). Children aged 0–4 years accounted for 19 per cent of the hospitalisations for mumps and had the highest hospitalisation rates. However, adults aged 15 years and over accounted for 61 per cent of total hospitalisations, 71 per cent of the hospitalisations with a mumps-related complication, and most hospital bed days (58%).

Mumps was recorded as the underlying cause of death in two adults, both aged at least 80 years and recorded in 2000. In the previous decade (1987–1997) there were 4 deaths where mumps was recorded as the underlying cause of death.

Table 15. Mumps notifications, hospitalisations and deaths, Australia, 1998 to 2000,* by age group

Age group (years)	Notifications 2 years (1999–2000)		Hospitalisations 2 years (July 1998–June 2000)				LOS† per admission (days)	Deaths 3 years (1998–2000)	
	No.	Rate‡	No.	(‖)	Rate‡	(‖)	Median	No.	Rate‡
0–4	54	2.6	21	(15)	0.8	(0.6)	2	0	-
5–14	90	2.1	23	(19)	0.4	(0.4)	2	0	-
15–24	97	2.2	21	(17)	0.4	(0.3)	2	0	-
25–59	124	0.8	31	(23)	0.2	(0.1)	2	0	-
60+	18	0.4	16	(9)	0.3	(0.1)	7	2	0.0
All ages§	384	1.2	112	(83)	0.3	(0.2)	2.5	2	0.0

* Notifications where the month of onset was between January 1999 and December 2000; hospitalisations where the month of separation was between 1 July 1998 and 30 June 2000; deaths where the date of death was recorded between 1998 and 2000.

† LOS = length of stay in hospital.

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

§ Includes cases with unknown ages.

‖ Principal diagnosis.

Table 16. Indicators of severe morbidity* for hospitalised cases of mumps, Australia, 1998 to 2000,* by age group

Age group (years)	Requiring critical care†			Mumps meningitis or encephalitis		Mumps orchitis		Mumps pancreatitis		Mumps with other complications	
	No.	% total	Median no. of hours‡	No.	% total	No.	% total	No.	% total	No.	% total
0–4	0	0	-	1	4.8	0	0	0	0	2	9.5
5–14	0	0	-	0	0	1	4.3	2	8.7	1	4.3
15–24	0	0	-	2	9.5	6	28.6	0	0	1	4.8
25–59	0	0	-	1	3.2	4	12.9	0	0	1	3.2
60+	0	0	-	0	0	1	6.3	0	0	1	6.3
All ages	0	0	-	4	3.6	12	10.7	2	1.8	6	5.4

* Measured using national hospital morbidity data where the month of hospital separation was between 1 July 1998 and 30 June 2000.

† Requiring mechanical ventilation.

‡ Of those receiving critical care.

Age and sex distribution

The pattern of notifications in 1999 and hospitalisations in 1998/1999 by age was similar to that seen in the previous review period: notification rates were highest in those aged less than 10 years and hospitalisation rates were highest in the under-15 year age groups (Figures 19 and 20). Unlike previous years, however, there was also a secondary peak in the 25–29 year age group for both notifications and hospitalisations.

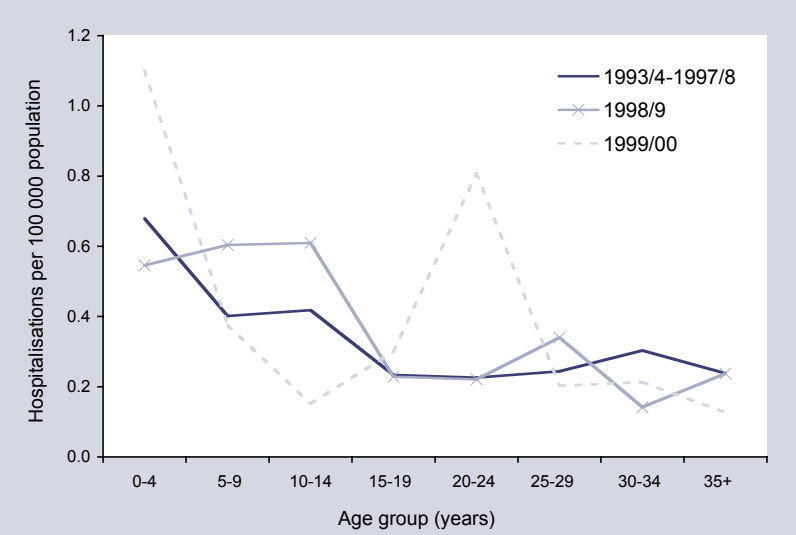
In the most recent year reviewed there was a marked change. Notification rates in 2000 were highest in the 20–24 (3.8 per 100 000) and 15–19 (3.2 per 100 000) year age groups, with rates for the 30–34 year age group (1.7 per 100 000) also higher than in past years. The under-10 year age groups had the lowest notification rates on record. In contrast, hospitalisation rates in 0–4 year olds were the highest since 1995/1996 (1.1 per 100 000). This increase was entirely due to higher numbers of males. As with notifications, there was a secondary peak in hospitalisation rates for young adults aged 20–24 years (0.8 per 100 000).

Over the 2-year review period the male:female ratio was 1.2:1 for notifications and 1.5:1 for hospitalisations. The ratio tended to be higher for children, especially those aged 0–4 years, and was close to one for adults aged 20–24 years.

Figure 19. Mumps notifications rates, Australia, 1993 to 2000,* by age group and year of onset

* Notifications where the month of onset was between January 1993 and December 2000.

Figure 20. Mumps hospitalisation rates, Australia, 1993 to 2000,* by age group and year of separation



* Hospitalisations where the month of separation was between 1 July 1993 and 30 June 2000.

Geographical distribution

In 1999 Victoria had an increased number of mumps notifications compared with the previous 3 years and accounted for 42 per cent of all notifications in that year (Appendix 2). In 2000, New South Wales accounted for most of the notifications (43%) — more than double the number of notifications recorded in any previous year.

These same trends were not reflected for the two-year review period for hospitalisation data (Appendix 3). The number of hospitalisations in each State and Territory were similar to those reported annually for the previous 5-year review period, with New South Wales contributing the majority (51%).

Comment

The notification rate for mumps (adjusted for States and Territories not reporting) increased in this review period. In 2000 the national rate was 1.4 per 100 000, which is above the WHO elimination target of <1 per 100 000 and the highest annual rate since national surveillance began in 1991. The upward trend is in contrast to that seen for measles and rubella in Australia, and in contrast to the recent epidemiology of mumps in the USA[69] and Finland (where mumps has been eliminated).[70] On the other hand, there has been a resurgence of mumps in both England and Northern Ireland since 1999, especially amongst secondary school aged children.[56]

The higher notification rate in Australia is predominantly due to increased numbers of adult cases, particularly in the 15–24 year age group from New South Wales in 2000. These people may have low levels of immunity to mumps because they have missed being vaccinated as children (use of the measles-mumps vaccine commenced in 1982)[2] or as adolescents (MMR vaccine was used in 10–16 year olds only in 1994–1998),[2] and have grown up during a period when the incidence of mumps was lower than in the pre-vaccine era. The increased incidence in adults appears real as it occurred in New South Wales, where notifications must have supporting laboratory evidence.

It will be important to monitor the incidence of mumps in adults as they are prone to more severe manifestations of mumps than are children. This is reflected in their longer hospital stays and relatively high proportion of complications. The campaign to deliver free MMR vaccine to 18–30 year olds should improve immunity in this age group[54] although currently no data are available for coverage achieved under this program.

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.[14]

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 immunofluorescence with history of a clinically compatible illness.

or

c) An illness lasting 2 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-10-AM/ICD-10 code A37 (whooping cough) was used to identify hospitalisations and deaths.

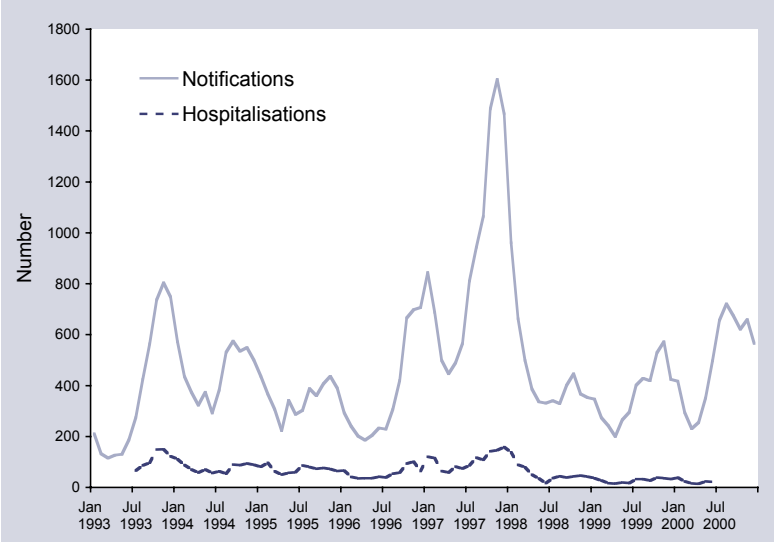
Secular trends

There were 10 339 notifications of pertussis received by the NNDSS with dates of onset in 1999 to 2000 (average annual rate 27.1 per 100 000) (Table 17). A median of 418 cases was notified each month (range 200–721). The notification rate in 2000 (31.0 per 100 000) was the highest since 1997 (58.9 per 100 000) (Figure 21, Appendix 2).

There were 745 hospital separations coded as pertussis during the review period (Table 17). The median number of pertussis hospitalisations per month was 33 (range 14–47). The average annual national hospitalisation rate was 2.0 per 100 000 compared with 5.3 per 100 000 for the 5 years from 1993/1994 to 1997/1998 (Figure 21, 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. Epidemic peaks occurred every 3 to 4 years.

Figure 21. Pertussis notifications and hospitalisations, Australia, 1993 to 2000,* by month of onset or admission



* Notifications where the month of onset was between January 1993 and December 2000, hospitalisations where the month of admission was between 1 July 1993 and 30 June 2000.

Severe morbidity and mortality

For people with an ICD-10-AM code for pertussis, 4417 hospital bed days (average 2209 days per year) were recorded between July 1998 and June 2000. The median length of stay per admission was 3 days (Table 17). Of the 745 hospitalisations, 604 (81%) had a principal diagnosis of pertussis (average annual rate 1.6 per 100 000). The discharge diagnosis code A37.0 (*B. pertussis*) was recorded for 254 (34%) hospitalisations and was the principal diagnosis for 195 (26%) of these. *B. parapertussis* was recorded for 9 hospitalisations, and other *Bordetella* species for 14 hospitalisations. The remaining 468 (63%) hospitalisations were coded as whooping cough (organism unspecified), and this was the principal diagnosis for 396 (53%) of these.

For the 3 years 1998 to 2000, only one death was recorded where pertussis was the underlying cause (Table 17). This occurred in 2000 in a 2-month old child. Between 1993 and 1997 there were 9 deaths attributed to pertussis: all were less than 12 months of age; 6 occurred in 1997.[1] Five of the 7 hospitalised cases recorded as requiring critical care were 0–4 years of age (median of 42 hours of critical care) (Table 18).

Table 17. Pertussis notifications, hospitalisations and deaths, Australia, 1998 to 2000,* by age group

Age group (years)	Notifications 2 years (1999–2000) No.	Rate‡	Hospitalisations 2 years (July 1998–June 2000) No.	(‖)	Rate‡	(‖)	LOS† per admission (days) Median	Deaths 3 years (1998–2000) No.	Rate‡
0–4	730	28.8	478	(426)	18.7	(16.7)	3	1	0.0
5–14	3 225	60.8	84	(63)	1.6	(1.2)	2	0	-
15–24	1 245	23.0	16	(8)	0.3	(0.1)	2	0	-
25–59	4 169	22.3	96	(63)	0.5	(0.3)	3	0	-
60+	959	15.4	71	(44)	1.2	(0.7)	7	0	-
All ages§	10 339	27.1	745	(604)	2.0	(1.6)	3	1	0.0

* Notifications where the month of onset was between January 1999 and December 2000; hospitalisations where the month of separation was between 1 July 1998 and 30 June 2000; deaths where the date of death was recorded between 1998 and 2000.

† LOS = length of stay in hospital.

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

§ Includes cases with unknown ages.

‖ Principal diagnosis.

Table 18. Indicators of severe morbidity* for hospitalised cases of pertussis, Australia, 1998 to 2000,* by age group

Age group (years)	Requiring critical care† No.	% total	Median number of hours‡
0–4	5	1.0	42
5–14	1	1.2	48
15–24	0	0	-
25–59	0	0	-
60+	1	1.4	331
All ages	7	0.9	48

* Measured using National Hospital Morbidity data where the month of hospital separation was between 1 July 1998 and 30 June 2000.

† Requiring mechanical ventilation.

‡ Of those receiving critical care.

Age and sex distribution

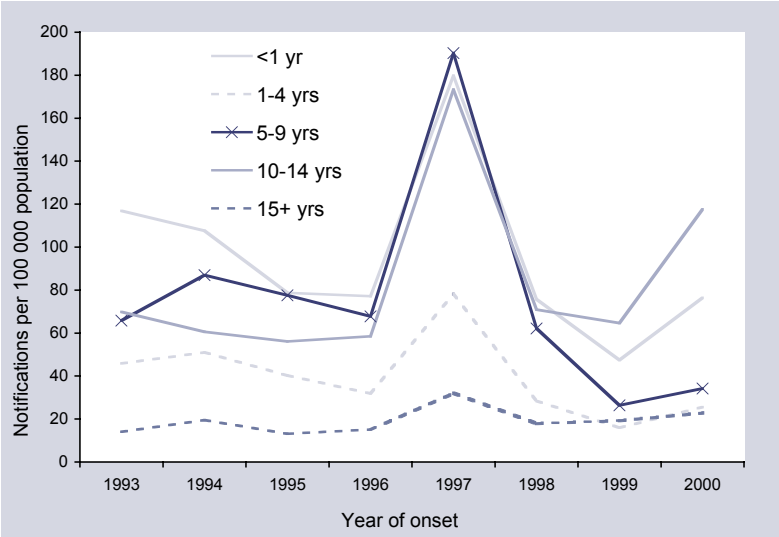
There was an increase in notifications in all age groups in 2000 compared with 1999. The largest increases were seen in the 0–4 and 10–14 year age groups (Figure 22). In 1999 to 2000, the highest notification rates were in infants aged less than one year and in adolescents 10–14 years of age (average annual rate 61.9 and 91.3 per 100 000, respectively). Notifications of infants aged less than one year accounted for 3 per cent of all notifications and 55 per cent of hospitalisations (average annual rate 82 per 100 000) in the 2-year review period (Figure 23).

The 10–14 year age group accounted for 23 per cent of pertussis notifications in 1999 to 2000, an average annual rate of 91.3 per 100 000. This compares with 6 per cent of all hospitalisations (average annual rate 1.7 per 100 000). The 10–14 year old age group had higher notification rates than any other 5-year age group and 3 times those of the 5–9 year age group (average annual rate 30.4 per 100 000). This contrasts with 1994 and 1995, when the rates for 5–9 year olds were approximately 40 per cent higher than the rates for 10–14 year olds (Figure 22).

People aged 15 years or more (adults) accounted for 62 per cent of notifications in 1999 to 2000 compared with 46 per cent of notifications for 1993 to 1998. The median age of pertussis notifications increased from 13–15 years in 1993–1997 to 24 years in 1999 to 2000.

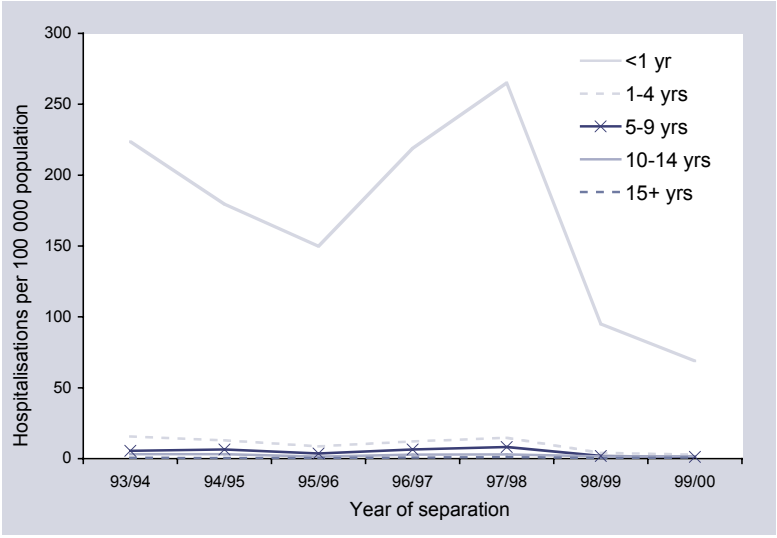
The overall male:female ratio was 1:1.3 for notifications and 1:1.1 for hospitalisations. Higher rates among females were apparent in all age groups.

Figure 22. Pertussis notification rates, Australia, 1993 to 2000,* by age group



* Notifications where onset was between 1 January 1993 and 31 December 2000.

Figure 23. Pertussis hospitalisation rates, Australia, 1993 to 2000,* by age group



* Hospitalisations where the month of separation was between 1 July 1993 and 30 June 2000.

Geographical distribution

There was a large variation in notification (Appendix 2) and hospitalisation rates (Appendix 3) between regions and years. The highest notification rate occurred in Tasmania in 1999 at 130 per 100 000. The rates for the other jurisdictions ranged from 1.0 to 27.4 per 100 000 population for the Northern Territory and Queensland, respectively. In 2000, the highest notification rates were in the Australian Capital Territory and New South Wales (66.9 and 57.0 per 100 000, respectively) with the lowest in the Northern Territory (2.6 per 100 000).

Comment

Over the period 1993 to 2000, pertussis caused the greatest morbidity of any disease preventable by vaccines recommended for children on the Australian Standard Vaccination Schedule. The highest numbers of pertussis notifications and hospitalisations were seen in 1997, with most jurisdictions experiencing an epidemic in that year.[1] The 2000 Spring peak in notifications was the highest since 1997. The largest increases were in the 0–4 and 10–14 year age groups. The high proportion of hospitalised infants aged less than one year demonstrated the increased morbidity of pertussis in this age group. The only death recorded for pertussis was in a 2 month old child, while five children aged 0–4 years who were hospitalised with pertussis required critical care.

Notification rates are known to underestimate incidence — this was illustrated by the finding that hospitalisations in infants aged less than one year exceeded notifications. The notification and hospitalisation patterns in young children were similar to those reported in New Zealand from June 1995 to May 1997,[71] and Spain 1995–1998.[72] It is noteworthy that the hospitalisation rate for infants was lower in the 1999 to 2000 inter-epidemic period than in the previous inter-epidemic period 1993–1995 (Figure 23). This may be an early indication of an impact from higher coverage with acellular vaccines, which were introduced in 1999 in infants, but confirmation of this will have to await data from the next epidemic period.

The temporal pattern seen in the reduction in notification rates in Australian children aged 5–9 years coinciding with an increase in rates in 10–14 year olds strongly suggests an effect from the introduction in 1994 of the fifth dose of pertussis vaccine for preschoolers, who are now in the 5–9 year old age group. The increased proportion of notifications among adolescents since 1998, relative to other age groups, and the increased median age of notified cases in Australia, raises the question of the need for an additional pertussis booster in adolescence. An acellular vaccine was approved for use in people over the age of 8 years in Australia in 2001. The potential need for an adolescent dose is highlighted by the experience in the USA, where a 5-dose schedule has been in place for over 40 years. In Massachusetts, between 1989 and 1998, the incidence of pertussis in 11–19 year olds increased from 13 to 71 per 100 000, while rates in younger children remained relatively constant.[73] Issues surrounding the control of pertussis by vaccination are under consideration internationally[74] and will be reviewed in Australia in 2002.

Pneumococcal disease

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

Case definitions

Notifications

Invasive pneumococcal disease has been notifiable in Queensland and the Northern Territory since 1997. For this review period (1999 to 2000), IPD was not nationally notifiable. From January 2001, invasive pneumococcal disease became notifiable Australia wide.

Hospitalisations

The ICD-10-AM codes used to identify hospitalisations were: G00.1, pneumococcal meningitis; A40.3, pneumococcal septicaemia and J13, pneumococcal pneumonia. To avoid double counting, cases were identified in a hierarchical fashion. First, all those with code G00.1 were classified as meningitis. Then those without G00.1 but with A40.3 were classified as septicaemia without meningitis. Together these groups were considered to be a proxy or invasive pneumococcal disease. Those with neither of these codes but with code J13 were counted as pneumococcal pneumonia.

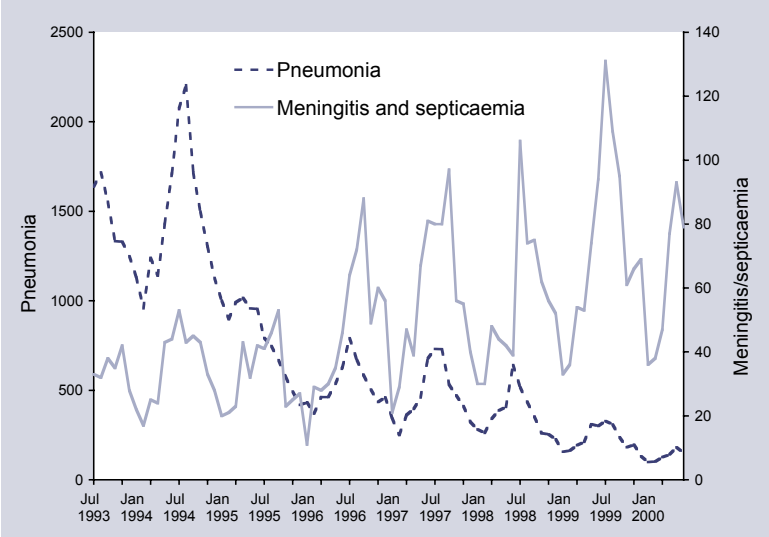
Deaths

ICD-10 codes G00.1, A40.3 and J13 were used to select deaths from IPD.

Secular trends

The total number of hospitalisations for meningitis, septicaemia or pneumonia for the 2-year review period 1999 to 2000 was 7480, an average annual rate of 19.8 per 100 000 (Table 19). Hospitalisations coded as meningitis or septicaemia accounted for 23 per cent of total episodes, a rate of 4.5 per 100 000. The median number of hospitalisations per month was 70 for meningitis or septicaemia (predominantly septicaemia) and ranged from 33 to 131. For pneumococcal pneumonia the median number of hospitalisations per month was 232 and ranged from 99 to 518. Meningitis and septicaemia showed a clear Winter peak each year, which was also present but less evident for pneumonia (Figure 24).

Figure 24. Pneumococcal disease hospitalisations, Australia, 1993 to 2000*, by month of admission



Note varying scales between pneumonia and meningitis/septicaemia hospitalisations.

* Hospitalisations where the month of admission was between 1 July 1993 and 30 June 2000.

Severe morbidity and mortality

A total of 74 032 hospital bed days (average 37 016 days per year) was recorded for hospital separations with an ICD-10-AM code corresponding to pneumococcal meningitis, septicaemia or pneumonia. Length of stay increased with age in all categories of infection (Table 19). The average length of stay for pneumococcal meningitis was 11 days in all age groups, more than double that for septicaemia or pneumonia in younger age groups. Although meningitis accounted for only 4 per cent of hospital separations, at least 10 per cent of meningitis cases required critical care, compared with 5 per cent for septicaemia and 3 per cent for pneumonia. Adults aged at least 60 years had the longest median duration of critical care, both for all categories of infection (168 hours, Table 20) and for meningitis (408 hours, data not shown).

Table 19. Pneumococcal pneumonia, meningitis and septicaemia hospitalisations and deaths, Australia, 1998 to 2000,* by age group

Age group (years)	Hospitalisations 2 years (July 1998–June 2000)				LOS† per admission (days)		Deaths 3 years (1998–2000)			
	No.§	(M/S)	Rate‡	(M/S)	Median§	(M/S)	No.§	(M/S)	Rate‡§	(M/S‡)
0–4	1037	(583)	40.6	(22.8)	3	(3)	17	(15)	0.7	(0.6)
5–14	227	(79)	4.3	(1.5)	3	(4)	1	(1)	0.0	(0.0)
15–24	295	(47)	5.5	(0.9)	4	(6)	1	(0)	0.0	(-)
25–59	2306	(400)	12.5	(2.2)	5	(8)	34	(14)	0.2	(0.1)
60+	3614	(592)	59.2	(9.7)	8	(9)	57	(17)	0.9	(0.3)
All ages‖	7480	(1702)	19.8	(4.5)	6	(6)	110	(47)	0.3	(0.1)

* Hospitalisations where the month of separation was between 1 July 1998 and 30 June 2000; deaths where the date of death was recorded between 1998 and 2000.

† LOS = length of stay in hospital.

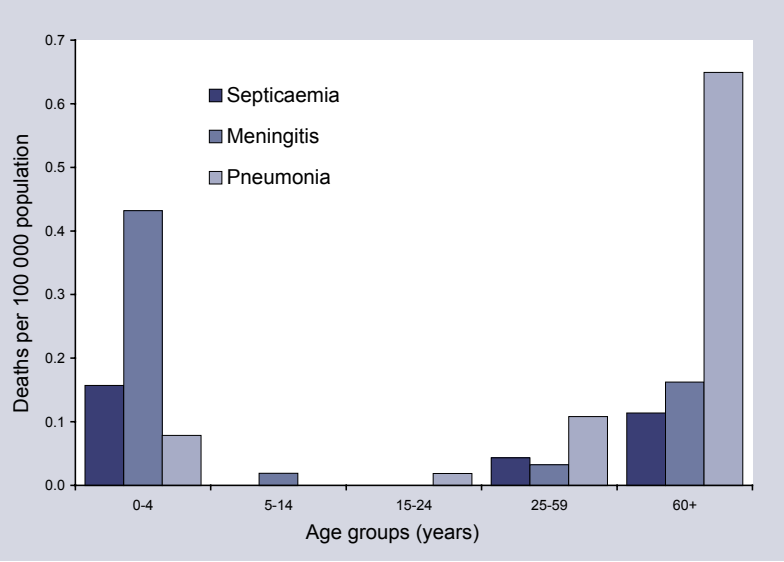
‡ Average annual age-specific rate per 100 000 population.

§ All pneumococcal disease, (M/S) = meningitis and septicaemia.

‖ Includes cases with unknown ages.

The total number of deaths where pneumococcal meningitis or septicaemia was recorded as the underlying cause of death on death certificates (n=47, Table 19), differed substantially from the number of hospitalisations coded as these diseases where death was recorded as the mode of separation (n=206, Table 20). The mortality rate for meningitis and septicaemia from death certificate data (Table 19) was highest in young children (0.6 per 100 000), whereas when pneumococcal pneumonia was included, the mortality rate was higher in people over 60 years (Table 19, Figure 25).

Figure 25. Pneumococcal meningitis, septicaemia and pneumonia death rates, Australia, 1998 to 2000,* by age group



* Measured using AIHW Mortality data where the date of death was recorded between 1998 and 2000.

When cases where death was the mode of separation from hospital were examined, the age-specific picture altered (Table 20). Among 292 meningitis hospitalisations, 7 per cent (10/153) of children under 5 years were recorded as dying in hospital, the proportion increasing to 21 per cent (6/52) in people over 60 years. In contrast, deaths were uncommon (4/430, 1%) among 0–4 year olds coded as having septicaemia without meningitis, giving a total of 14 deaths coded as meningitis or septicaemia for 0–4 year olds. Overall, the proportion of separations coded as septicaemia or meningitis recorded as dying in hospital rose in a linear fashion with age to 24 per cent among those over 60 years. In hospitalisations coded as pneumonia without septicaemia or meningitis, death was less commonly recorded as the mode of separation at all ages (1–8%), but accounted for the highest absolute number of deaths (n=301, data not shown).

Table 20. Indicators of severe morbidity and mortality* for hospitalised cases of pneumococcal meningitis and septicaemia, Australia, 1998 to 2000,* by age group

Age group (years)	Requiring critical care†			In hospital death (2 years)	
	No.	% total	Median number of hours‡	No.	% total
0–4	23	3.9	68.0	14	2.4
5–14	0	0.0	-	0	0.0
15–24	2	4.5	59.5	2	4.3
25–59	34	8.5	143.5	49	12.5
60+	39	6.6	168.0	141	23.8
All ages	98	5.8	143.5	206	12.1

* Measured using National Hospital Morbidity data where the month of hospital separation was between 1 July 1998 and 30 June 2000.

† Requiring mechanical ventilation.

‡ Of those receiving critical care.

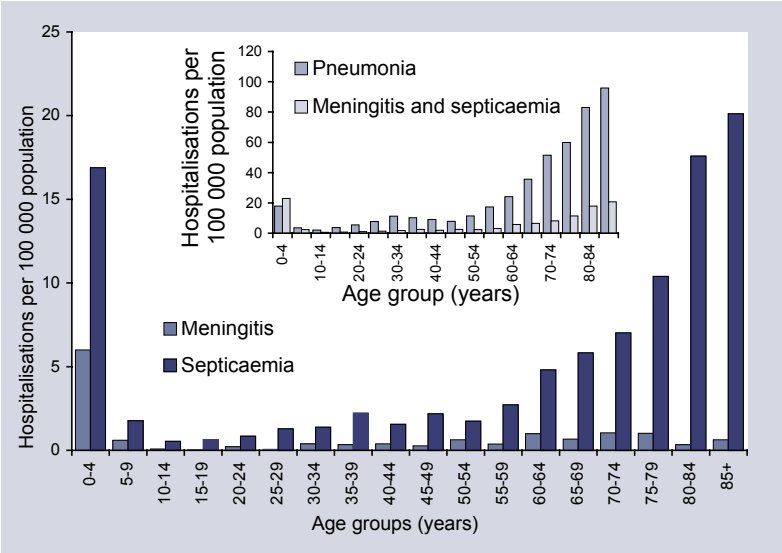
Age and sex distribution

The hospitalisation rate for each age group varied with the focus of infection (Figure 26). For meningitis, children 0–4 years had the highest hospitalisation rate (6.0 per 100 000), with those less than one year of age having an incidence 5 times higher (17.6 per 100 000) than those 1–4 years of age (3.3 per 100 000). The annual hospitalisation rate for meningitis was lower among 5–9 year olds (0.6 per 100 000) and did not increase to this level again until over 60 years of age. By contrast, the incidence of hospitalisation for septicaemia without meningitis increases dramatically from the age of 60 years, so that the total incidence of septicaemia and meningitis was highest in those over 80 years.

Overall, 28 per cent of hospitalisations coded as pneumococcal septicaemia were also coded as pneumonia. The proportion varied with age, with 5 per cent of hospitalisations coded as septicaemia without meningitis also coded as pneumonia among 0–4 year olds, rising to 20–30 per cent from the age of 15 years.

When total hospitalisations (meningitis, septicaemia and pneumonia) were considered, adults aged 60 years or more had the highest total rate of hospitalisation (59.2 per 100 000, Table 19). The male:female ratio varied with age. There was a strong predominance of male cases coded as meningitis or septicaemia for ages 0–64 years (male:female ratio 1.4:1), but among those 65 years and over the male:female ratio was 0.91. However, when calculated as rates, males over the age of 65 years had a hospitalisation rate of 18.1 per 100 000, compared with 12.5 per 100 000 among females.

Figure 26. Pneumococcal meningitis, septicaemia and pneumonia hospitalisation rates, Australia, 1998 to 2000,* by age group



* Hospitalisations where the month of separation was between 1 July 1998 and 30 June 2000.

Geographical distribution

In this review period, the Northern Territory had an average annual hospitalisation rate for meningitis or septicaemia (25.3 per 100 000) which was more than fourfold higher than any other jurisdiction (Appendix 3). The average annual hospitalisation rate for other States and Territories ranged from 3.0 to 5.8 per 100 000.

Comment

Recommendations for the use of pneumococcal vaccines changed significantly in 2001, when a public-funded conjugate pneumococcal vaccine program commenced for children at high risk (Aboriginal and Torres Strait Islander children under 2 years and children with predisposing medical conditions under 5 years of age). Polysaccharide pneumococcal vaccine has been recommended and funded for Aboriginal and Torres Strait Islander people over the age of 50 years since 1997. It is also recommended for non-Aboriginal people 65 years and older, but is funded only in Victoria.[75] Invasive pneumococcal infection has become notifiable in all jurisdictions from the beginning of 2001.

The hospitalisation rates reported here, based on a narrow case definition, continue to underestimate the true incidence of invasive pneumococcal disease. However, the all-age rate of hospitalisation for pneumococcal meningitis or septicaemia has increased from an average of 2.8 per 100 000 in the 5 years 1993 to 1998 to 4.5 per 100 000 in the current review period. The increase in hospitalisations coded as pneumococcal meningitis or septicaemia is likely to reflect changes in diagnostic and/or coding practices rather than an actual increase in incidence. First, it is still well below the incidence estimated from active laboratory surveillance in urban New South Wales (14 per 100 000)[76] or Victoria (8 per 100 000).[77] Second, the rate of hospitalisation for meningitis has remained the same as the average for 1993 to 1998 and is similar to estimates from active surveillance. Estimates of overall incidence from laboratory surveillance in comparable industrialised countries range from 9 to 22 per 100 000 per year.[78] Nevertheless, the hospitalisation data indicate the relative incidence of pneumococcal disease by age and jurisdiction, as well as the age distribution of significant pneumococcal infection. Estimates of pneumococcal pneumonia are particularly likely to be affected by coding and diagnostic practices, as diagnosis is often largely clinical. This is the likely explanation for the dramatic fall in the number of hospitalisations coded as pneumococcal pneumonia, without

septicaemia, since 1993 (Figure 24). As all-cause pneumonia hospitalisations 1993 to 2000 (data not shown) show a constant number of hospitalisations over this period, a true decrease in pneumococcal pneumonia, as opposed to a change in diagnostic classification, seems unlikely. However, this clearly makes the interpretation of changes in hospitalisations coded as pneumococcal pneumonia problematic, at least prior to the introduction of the ICD-10-AM.

The well-known variation in mortality from pneumococcal disease with category of infection and age is reflected in the hospitalisation and death certification data. The death rate per 100 000 population from meningitis is highest in children under the age of 5 years and especially in infants. By contrast, the likelihood of death with various categories of pneumococcal infection shows a dramatic rise with increasing age, consistent with more detailed data sources.[76,78] The difference between number of deaths with pneumococcal septicaemia or meningitis certified as the underlying cause (Table 19) and deaths in hospitalised cases (Table 20) is likely to be related to other conditions, rather than pneumococcal infection, being considered the underlying cause of death on the death certificate record, and different rules related to assignment of underlying conditions as principal or additional diagnoses. The close correspondence between the two data sources in the number of deaths associated with a meningitis or septicaemia code among 0–4 year olds, where other underlying conditions are much less likely (n=15, Table 19 and n=14, Table 20), supports this contention.

The Northern Territory had the highest rate of hospitalisation for both pneumococcal septicaemia and meningitis as well as pneumococcal pneumonia. Specific data from active laboratory surveillance in the Northern Territory show that this excess of hospitalisations is almost entirely due to a high incidence among Aboriginal people.[79] Aboriginal people are also known to have high rates of pneumococcal disease in Western Australia,[80] but this does not seem to be reflected in the data presented here. This high disease burden is recognised in both the adult polysaccharide vaccine program, recently shown to be effective in Far North Queensland,[81] and in the conjugate vaccine program among Aboriginal and Torres Strait Islander children under 2 years of age. A significant impact of the latter initiative in areas where Aboriginal people represent a high proportion of the population, such as the Northern Territory, should be evident from enhanced surveillance of invasive pneumococcal disease in 2002–2003. Hospitalisation data may also prove useful, if these data are sufficiently specific and the effect sufficiently large, in evaluating the impact of the conjugate vaccine program on the incidence of pneumonia and otitis media, where only some cases are due to pneumococcal infection and there is no sterile site isolate. However, it is unlikely that any impact of the high-risk program will be evident in other areas, as the targeted group constitute only a small proportion of the population.

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 (AFP) occurs in less than 1 per cent of infections. More than 90 per cent 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.[14]

Vaccine-associated paralytic poliomyelitis (VAPP) is acute flaccid paralysis due to a Sabin-like poliovirus (i.e., a virus similar to that used in the live oral Sabin vaccine).

Case definitions

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

The ICD-10-AM code A80 (acute poliomyelitis) was used to identify hospitalisations.

Notes: This code includes VAPP and specific codes for indigenous and imported wild-type polio virus infection, whereas the code used in the last report (ICD-9-CM code 045, acute poliomyelitis) did not.

In 1998/1999 Queensland, South Australia, Western Australia and Tasmania were still using ICD-9-CM codes with these codes mapped to ICD-10-AM codes. See also Chapter 2.

Deaths

The ICD-10 code A80 (acute poliomyelitis) was used to identify deaths.

Notifications, hospitalisations and deaths

No notifications or deaths were recorded for poliomyelitis in 1999 or 2000. From July 1998 to June 2000 there were 90 hospitalisations with a diagnosis of acute poliomyelitis (Appendix 3). Most (77%) of these were in 1998/1999. Only 3 hospitalisations (all adults aged at least 35 years) were recorded as having a principal diagnosis of poliomyelitis. Among the 75 hospitalisations from those States and Territories that used ICD-10-AM, 3 adults were recorded as VAPP and none as acute paralytic poliomyelitis due to wild-type poliovirus.

Comment

It is unclear exactly when the last case of locally acquired poliomyelitis occurred in Australia. The last laboratory confirmed case was in 1967. Three clinically compatible cases were notified in 1972; however, no additional information is currently available.[82] All cases notified since 1972 have been fully investigated with subsequent reclassification as VAPP. The most recent case of VAPP was in 1995.[83] The last recorded case of wild poliovirus in the Western Pacific Region was reported in Cambodia in 1997, and in October 2000 the World Health Organization certified the Western Pacific Region polio free.[84]

As there have been no reports of indigenous wild-type poliovirus transmission in Australia for at least 30 years, the hospitalised cases reported here are almost certainly not missed notifications of acute wild-type polio infection. Some hospitalisations could represent cases of acute flaccid paralysis where polio could not be excluded, but most are likely to be adults with late effects of poliomyelitis rather than acute cases. At the time of writing this report, hospitalisations for Victoria were being reviewed by the Department of Human Services as they believe them to be incorrect.

Although Australia has been declared polio free, high vaccination coverage and continued active surveillance of acute flaccid paralysis are required until global certification is achieved. High quality acute flaccid paralysis surveillance will enable the detection any imported cases of wild-type polio infection, such as occurred in 1999 in China.[85] In addition, any cases of VAPP will be detected, including those due to 'backmutated' strains. In 2000 the Dominican Republic and Haiti experienced an outbreak of poliomyelitis due to a 'backmutated' poliovirus type 1 vaccine strain in an inadequately immunised population.[86] More recently, 3 cases of polio due to VAPP were reported from the Philippines in 2001.[86]

As live oral polio vaccine has the potential to cause vaccine-associated disease, the USA has recently replaced it with inactivated polio vaccine (IPV). The place of IPV in the immunisation schedule is currently under consideration by experts in Australia and by those involved in the world-wide eradication campaign.[86]

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).[14]

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 rise 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

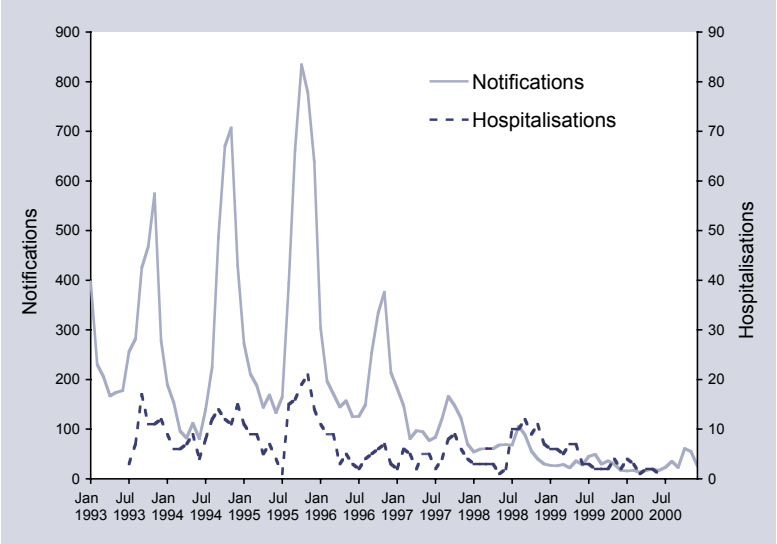
The ICD-10-AM/ICD-10 code B06 (rubella [German measles]) was used to identify hospitalisations and deaths.

Congenital rubella cases were not included in this report. The notification of congenital rubella is mandatory in only 5 of the 8 States/Territories.[87] Reviews of congenital rubella cases recorded by the Australian Paediatric Surveillance Unit between 1993 and 2000 are available elsewhere.[87,88]

Secular trends

During 1999 and 2000, 697 notifications of rubella were recorded (an average annual rate of 1.8 per 100 000) (Table 21). Between July 1998 and June 2000, 72 hospitalisations were coded as being due to rubella (an average annual rate of 0.2 per 100 000). Notification and hospitalisation rates have declined during the period analysed, continuing the downward trend from a peak seen in the Spring of 1995 (Figure 27, Appendices 2 and 3). Peaks seen in the Spring months of each year 1993 to 1998 were less pronounced in 1999 and 2000.

Figure 27. Rubella notifications and hospitalisations, Australia, 1993 to 2000,* by month of onset or admission



Note: varying scales between notifications and hospitalisations.

* Notifications where the month of onset was between January 1993 and December 2000, hospitalisations where the month of admission was between 1 July 1993 and 30 June 2000.

Severe morbidity and mortality

Two hundred and fifty-eight hospital bed days (average 129 per year) were recorded for patients with an ICD-10-AM code for rubella. Of the 72 hospital separations, 38 (53%) had a principal diagnosis of rubella (average annual rate 0.1 per 100 000). The median length of stay in hospital was 2 days, but varied with age (Table 21). In 1998 to 2000, there were no deaths with rubella recorded as the underlying cause.

Complications arising from rubella infection were recorded for 17 (24%) hospitalisations (Table 22). Five of these 17 were recorded as neurological complications.

Table 21. Rubella notifications, hospitalisations and deaths, Australia, 1998 to 2000,* by age group

Age group (years)	Notifications 2 years (1999–2000)		Hospitalisations 2 years (July 1998–June 2000)				LOS† per admission (days)	Deaths 3 years (1998–2000)	
	No.	Rate‡	No.	(‖)	Rate‡	(‖)	Median	No.	Rate‡
0–4	148	5.8	33	(23)	1.3	(0.9)	2	0	-
5–14	61	1.1	5	(4)	0.1	(0.1)	4	0	-
15–24	281	5.2	8	(4)	0.1	(0.1)	2	0	-
25–59	191	1.0	23	(5)	0.1	(0.0)	2	0	-
60+	12	0.2	3	(2)	0.1	(0.0)	10	0	-
All ages§	697	1.8	72	(38)	0.2	(0.1)	2	0	-

* Notifications where the month of onset was between January 1999 and December 2000; hospitalisations where the month of separation was between 1 July 1998 and 30 June 2000; deaths where the date of death was recorded between 1998 and 2000.

† LOS = length of stay in hospital.

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

§ Includes cases with unknown ages.

‖ Principal diagnosis.

Table 22. Indicators of severe morbidity* for hospitalised cases of rubella, Australia, 1998 to 2000,* by age group

Age group (years)	Requiring critical care†			Complication neurological		Complication other	
	No.	% total	Median no. of hours‡	No.	% total	No.	% total
0–4	0	0.0	-	2	6.1	4	12.1
5–14	0	0.0	-	0	0.0	2	40.0
15–24	0	0.0	-	1	12.5	0	0.0
25–59	0	0.0	-	2	8.7	5	21.7
60+	0	0.0	-	0	0.0	1	33.3
All ages	0	0.0	-	5	6.9	12	16.7

* Measured using National Hospital Morbidity data where the month of hospital separation was between 1 July 1998 and 30 June 2000.

† Requiring mechanical ventilation.

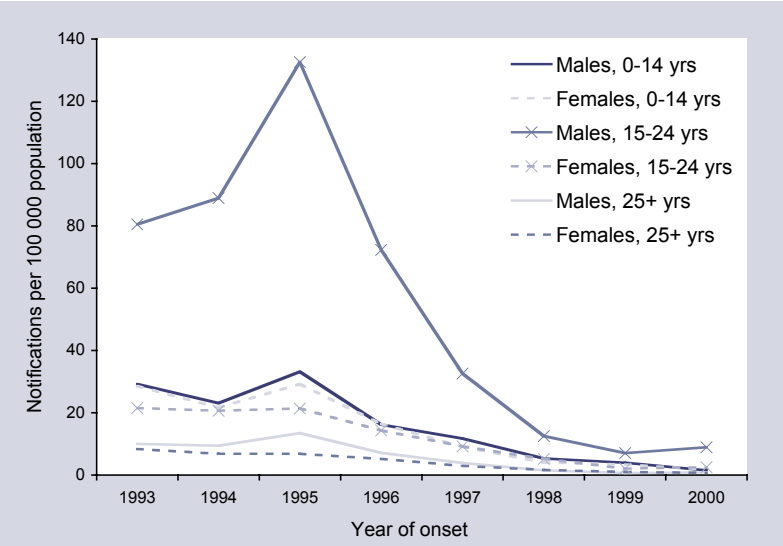
‡ Of those receiving critical care.

Age and sex distribution

Notification rates were highest in the 0–4 and 20–24 year age groups (average annual rate 5.8 and 5.6 per 100 000, respectively). In contrast, hospitalisation rates were highest in children aged 0–4 years (average annual rate 1.3 per 100 000). Children aged 0–4 years made up 46 per cent of the hospitalisations reviewed while accounting for only 21 per cent of the notifications.

Notification and hospitalisation rates were higher for males than females, particularly in the under 25 year age groups (Figures 28 and 29). Males aged 15–24 years had the highest notification rate (average annual rate 8.0 per 100 000). Notification rates for this group decreased considerably after 1995, becoming closer to those of other age/sex groups by 1998.

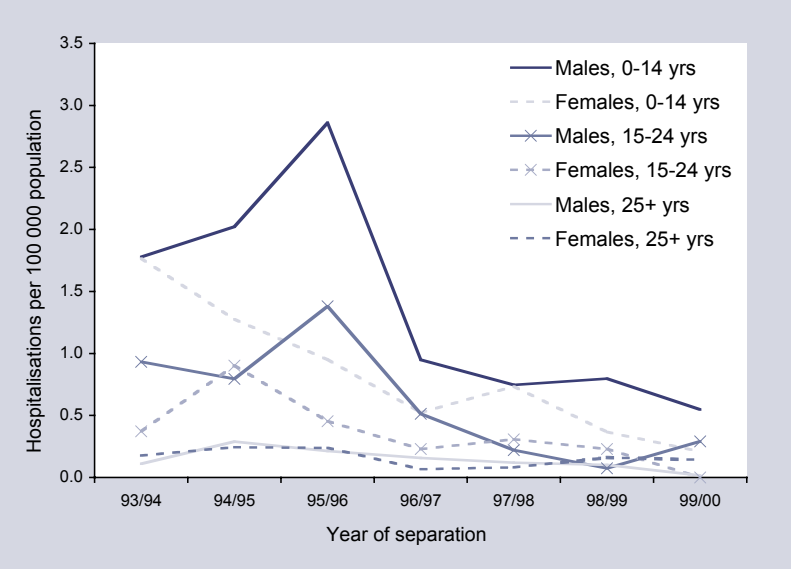
Figure 28. Rubella notification rates, Australia, 1993 to 2000,* by age group, sex and year of onset



* Notifications where onset was between 1 January 1993 and 31 December 2000.

The male:female ratio was 2.0:1 for notifications and 1.2:1 for hospitalisations but varied by age. For notifications, the highest male:female ratio was in the 15–24 year age group (2.3:1), while the ratio for hospitalisations peaked in the 0–4 year age group (3.0:1). The sex ratio has narrowed over time as notification and hospitalisation rates among males have declined. In Spring of 1995, when rates peaked, the sex ratio for notifications was 2.6:1 and for hospitalisations 2.3:1, compared with 2.0:1 and 1.2:1, respectively, for 2000.

Figure 29. Rubella hospitalisation rates, Australia, 1993 to 2000,* by age group, sex and year of separation



* Hospitalisations where separation date was between 1 July 1993 and 30 June 2000.

There were 148 notified cases of rubella in women of child bearing age (15–44 years) in 1999 and 2000 (average annual rate 1.7 per 100 000). The rate has decreased considerably compared with the 7-year period 1993 to 1998 (average annual rate 9.6 per 100 000).

Geographical distribution

Notification and hospitalisation rates varied between States/Territories and over time (Appendices 2 and 3). Queensland and Victoria experienced increased notifications of rubella in the middle of 1999 while New South Wales had high numbers of notifications in the second half of 2000. In 2000, the notification rate for New South Wales was four times higher than in the previous year while all other States except South Australia continued to show a downward trend from a peak in 1995 (Appendix 2).

Hospitalisation rates for each State and Territory were similar to or lower than in the previous review period (Appendix 2). New South Wales, Queensland, South Australia and Victoria had similar average annual rates for the 2-year review period, with other jurisdictions having lower rates. Most of the decline between 1998/1999 and 1999/2000 was due to lower numbers of hospitalisations from New South Wales in the second financial year.

Comment

In 1999 to 2000, notification and hospitalisation rates for rubella fell for both sexes and across all age groups compared with the previous review period (1993 to 1998). The sex ratio narrowed as a result of the reduction in male rates. Notification rates decreased most notably in males aged 15–24 years. Reductions were also evident in notification rates for females aged 15–44 years and hospitalisation rates in children aged 0–4 years. Most hospitalised patients were children aged 0–4 years, even though most notified cases were young adult males. The preponderance of hospitalisations among children is surprising, as children generally have a milder illness and a lower likelihood of complications, with the exception of thrombocytopenia, compared with adults.[89]

The significant decline in rubella notification and hospitalisation rates in recent years can be attributed to the impact of changes in the rubella vaccination schedule. Adolescent female vaccination commenced in 1971 and MMR for all children at 12 months in 1989.[2] In 1993/1994 a second dose of combined MMR vaccine was introduced for both male and female adolescents. In 1998, as part of the Measles Control Campaign, the age of the second dose of MMR was lowered from 10–16 years to 4 years. At the same time, 1.7 million doses of MMR were given to primary school aged children.

It is likely that rubella notification and hospitalisation rates will continue to decline as a result of these changes in the vaccination schedule. Provided the current high MMR coverage is maintained, indigenous rubella and congenital rubella syndrome could be eliminated from Australia. However, only about half the world's countries can afford to use rubella vaccine, so imported cases will continue to occur.[90] Opportunities exist for a staged global elimination process by linking rubella with the WHO measles program whenever possible.[91]

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 per cent, with the highest rates in infants and the elderly.[14]

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.

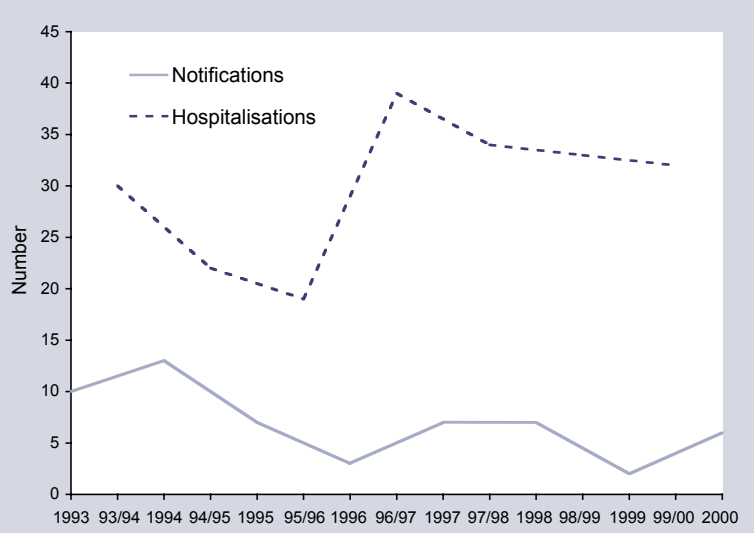
Hospitalisations and deaths

The ICD-10-AM/ICD-10 code A35 (tetanus) was used to identify hospitalisations and deaths.

Secular trends

There were 8 notifications of tetanus in the 1999 to 2000 review period (an average annual notification rate of <0.1 per 100 000). However, in the period July 1998–June 2000, there were 65 hospitalisations coded as tetanus (an average annual rate of 0.2 per 100 000). Numbers of notifications for tetanus have been declining in recent years while the number of hospitalisations has remained relatively constant since 1996/1997 (Figure 30).

Figure 30. Tetanus notifications and hospitalisations, Australia, 1993 to 2000,* by year of onset or admission



* Notifications where the year of onset was between January 1993 and December 2000, hospitalisations where the month of admission was between 1 July 1993 and 30 June 2000.

Severe morbidity and mortality

One thousand and fifty-eight hospital bed days were recorded for patients with an ICD-10-AM code for tetanus. Of the 65 separations, 36 (55%) had tetanus recorded as the principal diagnosis (average annual rate 0.1 per 100 000). The median length of stay in hospital was 6 days and varied depending on age. Adults aged at least 60 years had longer median lengths of stay and accounted for the majority of hospitalisations (52%) and hospital bed days (53%) (Table 23).

Table 23. Tetanus notifications, hospitalisations and deaths, Australia, 1998 to 2000,* by age group

Age group (years)	Notifications 2 years (1999–2000)		Hospitalisations 2 years (July 1998–June 2000)				LOS† per admission (days)	Deaths 3 years (1998–2000)	
	No.	Rate‡	No.	(‖)	Rate‡	(‖)	Median	No.	Rate‡
0–4	1	0.0	1	(1)	0.0	(0.0)	1	0	-
5–14	0	-	1	(1)	0.0	(0.0)	1	0	-
15–24	0	-	5	(3)	0.1	(0.1)	1	0	-
25–59	1	0.0	24	(12)	0.1	(0.1)	5.5	1	0.0
60+	6	0.1	34	(19)	0.6	(0.3)	13	3	0.0
All ages§	8	0.0	65	(36)	0.2	(0.1)	6	4	0.0

* Notifications where the month of onset was between January 1999 and December 2000; hospitalisations where the month of separation was between 1 July 1998 and 30 June 2000; deaths where the date of death was recorded between 1998 and 2000.

† LOS = length of stay in hospital.

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

§ Includes cases with unknown ages.

‖ Principal diagnosis.

Only adults aged 25 years or older required critical care (11%, Table 24). Adults aged at least 60 years generally required more hours of critical care. The median duration of critical care for adults aged at least 60 years was 696 hours compared with 94 hours in the 25–59 year age group.

In the review period (1998 to 2000) there were 4 deaths with tetanus recorded as the underlying cause. All were in people aged at least 50 years (Table 24) and there were no data on their vaccination status.

Table 24. Indicators of severe morbidity* for hospitalised cases of tetanus, Australia, 1998 to 2000,* by age group

Age group (years)	Requiring critical care†		
	No.	% total	Median number of hours‡
0–4	0	0.0	-
5–14	0	0.0	-
15–24	0	0.0	-
25–59	3	12.0	94
60+	4	11.0	696
All ages	7	11.0	329

* Measured using National Hospital Morbidity data where the month of hospital separation was between 1 July 1998 and 30 June 2000.

† Requiring mechanical ventilation.

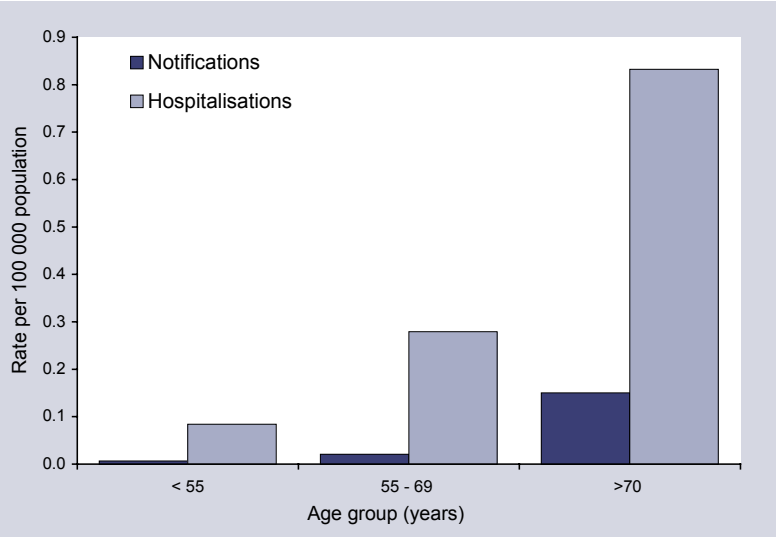
‡ Of those receiving critical care.

Age and sex distribution

Most notified (5/8, 63%) and hospitalised (27/65, 42%) cases were aged at least 70 years. There were 3 times as many females notified with tetanus compared with males (male:female ratio 1:3). In contrast, the male:female ratio for hospitalisations was closer to one (ratio 1:1.2). In the 70 years and over age group, most of the notifications were of females (4/5, 80%), but hospitalisations involved similar numbers of both sexes (11/27 males, 41%).

For both notifications and hospitalisations, rates increased with increasing age (Figure 31). Females aged at least 70 years had the highest average annual notification rate (0.2 per 100 000) while both males and females had similarly high rates of hospitalisation (0.8 per 100 000 for both males and females).

Figure 31. Tetanus notification and hospitalisation rates, Australia, 1998 to 2000,* by age group



* Notifications where the month of onset was between January 1999 and December 2000, hospitalisations where the month of separation was between 1 July 1998 and 30 June 2000.

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

There has been an overall downward trend in tetanus notification rates since 1993, while hospitalisation rates have remained constant since 1996/1997. Hospitalisation rates were higher than notification rates — this discrepancy could be due to under-reporting of cases, multiple admissions for the same case 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 undernotification is likely.

Tetanus has become a disease of older adults. The current tetanus notification rate in Australia reflects that of other developed countries.[92,93] Booster doses of tetanus are thought to be poorly implemented in adults, primarily only after an injury has occurred.[94] From 2000, the Australian Standard Vaccination Schedule (2000) no longer recommends boosters every 10 years. A tetanus booster is recommended at age 50 unless a booster has been documented within 10 years.[34] The data presented in this report suggest that this is an appropriate recommendation.

Varicella

Varicella (chickenpox) is a highly contagious infection caused by the varicella-zoster virus. Varicella 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 per cent of cases are subclinical. Acute varicella may be complicated by cerebellitis, aseptic meningitis, transverse myelitis, thrombocytopenia and pneumonia.[14]

Case definitions

Notifications

Varicella is not a notifiable disease.

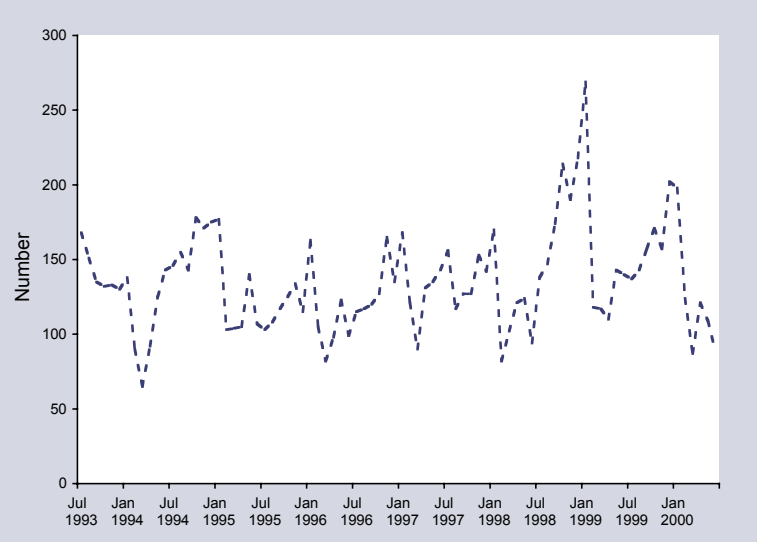
Hospitalisations and deaths

The ICD-10-AM/ICD-10 code B01 (varicella [chickenpox]) was used to identify hospitalisations and deaths.

Secular trends

There were 3725 hospitalisations (average annual hospitalisation rate 9.9 per 100 000) for varicella between 1 July 1998 and 30 June 2000 (Table 25). A median of 143 cases (range 87–269) was hospitalised per month (Figure 32). There was a definite indication of seasonality with hospitalisations peaking in January and dropping between February and March.

Figure 32. Varicella hospitalisations, Australia, 1993 to 2000,* by month of admission



* Hospitalisations where the month of admission was between 1 July 1993 and 30 June 2000.

Severe morbidity and mortality

For patients with an ICD-10-AM code for chickenpox 15 646 hospital bed days (average 7823 per year) were recorded. Of the 3725 varicella hospitalisations, 2241 (60%) had a principal diagnosis of varicella (average annual rate 5.9 per 100 000) (Table 25). Complications arising from varicella infection were recorded for 1120 hospitalisations (30%). Of all varicella hospitalisations, 97 (3%) were coded as having encephalitis and 283 (8%) were coded as having pneumonitis (Table 26). Five cases had both encephalitis and pneumonitis. Although most hospitalisations were in the youngest age group, people 60 years and older had the longest median length of stay. There were 20 deaths recorded with varicella as the underlying cause, 15 (75%) of them for people 60 years and older. The highest death rate was also recorded in people 60 years and older.

Table 25. Varicella hospitalisations and deaths, Australia, 1998 to 2000,* by age group

Age group (years)	Hospitalisations 2 years (July 1998–June 2000)				LOS† per admission (days) Median	Deaths 3 years (1998–2000)	
	No.	(‖)	Rate‡	(‖)		No.	Rate‡
0–4	1586	(964)	62.1	(37.7)	2	1	0.0
5–14	694	(416)	13.1	(7.9)	2	0	-
15–24	382	(249)	7.1	(4.6)	2	2	0.0
25–59	911	(542)	5.0	(2.9)	3	2	0.0
60+	152	(70)	2.5	(1.1)	7	15	0.2
All ages§	3725	(2241)	9.9	(5.9)	2	20	0.0

* Hospitalisations where the month of separation was between 1 July 1998 and 30 June 2000; deaths where the date of death was recorded between 1998 and 2000.

† LOS = length of stay.

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

§ Includes cases with unknown ages.

‖ Principal diagnosis (hospitalisations).

Table 26. Indicators of severe morbidity* for hospitalised cases of varicella, Australia, 1998 to 2000,* by age group

Age group (years)	Requiring critical care†			Varicella encephalitis		Varicella pneumonitis	
	No.	% total	Median no. of hours‡	No.	% total	No.	% total
0–4	10	0.6	23.5	27	1.7	51	3.2
5–14	0	0	-	42	6.1	17	2.5
15–24	0	0	-	5	1.3	46	12.0
25–59	8	0.9	146.5	18	2.0	152	16.7
60+	2	1.3	261.5	5	3.3	18	11.2
All ages	20	0.5	56	97	2.6	283	7.6

* Measured using National Hospital Morbidity data where the month of hospital separation was between 1 July 1998 and 30 June 2000.

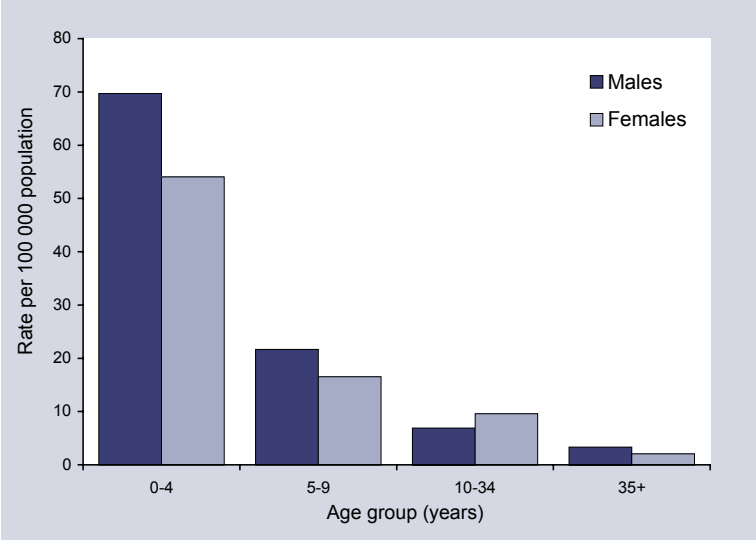
† Requiring mechanical ventilation.

‡ Of those receiving critical care.

Age and sex distribution

The highest number and rate of varicella hospitalisations occurred in the youngest age groups, especially the 0–4 years age group (Table 25, Figure 33). 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 20–34 year age group. The male:female ratio for deaths due to varicella was 1:1.5.

Figure 33. Varicella hospitalisations, Australia, 1998 to 2000,* by age group and sex



* Hospitalisations where the month of separation was between 1 July 1998 and 30 June 2000.

Geographical distribution

The Northern Territory had the highest average annual hospitalisation rate (Appendix 3). The only jurisdiction that showed a distinct change over the 2-year time period of investigation was South Australia, where the hospitalisation rate halved over the 2 years.

Comment

Hospitalisations for varicella were not uncommon with an average of 1800 separations per year in 1999 to 2000. The very young were most commonly hospitalised while the elderly had the longest length of stay. In our data, 30 per cent of hospitalised cases had a recorded complication. A more detailed study found a similar level of complications (20%).[95] Varicella hospitalisations occurred throughout Australia, with the Northern Territory having a notably higher rate than any other jurisdiction and the rate in South Australia decreasing by half over the 2-year period. Varicella vaccine is included in the routine childhood vaccination schedule in Canada and the USA. In regions of the USA where an active immunisation program for varicella is delivered and there is active disease surveillance, the incidence of varicella has been noted to decline. This is evident in all age groups, and is most marked among those aged 1–4 years.[96] 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.

4 - Vaccination coverage

Australian Standard Vaccination Schedule 1998 to 2001

The Australian Standard Vaccination Schedule (ASVS) for children aged 0–6 years changed in the second half of 1998 with the second dose of measles-mumps-rubella (MMR) vaccine (previously given at 12–13 years) moved to 4 years. More changes were made in May 2000 with the introduction of a new ASVS with 2 distinct paths for children born on or after 1 May 2000.[34] For the immunisations at 2, 4, 6 and 12 months, two options for the use of combination vaccines are recommended. The full schedule and changes to it are outlined in Table 27. Pathway 1 uses hepatitis B vaccine in a combination with diphtheria-tetanus-acellular pertussis (DTPa) vaccine, while Pathway 2 uses it in combination with *Haemophilus influenzae* type b (Hib) vaccine. From May 2000, full vaccination at 12 months of age (first milestone) requires 3 doses of DTP and oral poliomyelitis (OPV) vaccines, and immunisation against Hib and hepatitis B. Full Hib immunisation at 12 months now requires 2 doses of PRP-OMP (*Haemophilus influenzae* type b polysaccharide conjugated to the outer membrane protein of *Neisseria meningitidis*). Full hepatitis B immunisation at 12 months requires either 3 doses of combined DTPa-hepatitis B (Pathway 1) or 2 doses of combined Hib-hepatitis B vaccine (Pathway 2). The neonatal dose (scheduled for all newborns since May 2000) is not yet accounted for in ACIR coverage estimates. In the second year of life, a dose of MMR vaccine is scheduled at 12 months of age as well as booster doses of DTP (at 18 months) and Hib vaccine (at 12 months) — for Pathway 2 this Hib vaccine is given with hepatitis B vaccine.

Table 27. Australian Standard Vaccination Schedule 1998 to 2001 for children

Age	Vaccine				
2 months	DTP[1,2]		Hib[3,4]	Hep B[2,4]	OPV[†]
4 months	DTP[1,2]		Hib[3,4]	Hep B[2,4]	OPV
6 months	DTP[1,2]			Hep B[2]	OPV
12 months		MMR[‡]	Hib[3,4]	Hep B[4]	
18 months	DTP[§]				
4 years	DTP[§]	MMR			OPV

1 Acellular diphtheria-tetanus-pertussis vaccine from 1999.
2 Acellular diphtheria-tetanus-pertussis/hepatitis B vaccine from May 2000 (Pathway 1).
3 Hib PRP-OMP (Pathway 1).
4 Hib PRP-OMP/hep B from May 2000 (Pathway 2).
† Oral poliomyelitis vaccine.
‡ Measles-mumps-rubella vaccine.
§ Acellular pertussis vaccines were generally used at 18 months and 4 years from 1998.

Vaccination coverage estimates from the ACIR 1996 to 2001

The methodology for calculating cohort-based vaccination coverage from the ACIR was published with the first coverage estimates in 1998.[9] Using this method, a cohort of children is defined by date of birth in 3-month groups, the first cohort being born between 1 January 1996 and 31 March 1996.[3] The vaccination status of each cohort is assessed at the 2 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.[9] It is assumed that notification of receipt of a later vaccine dose implies receipt of earlier doses, even if no earlier vaccination is recorded ('third dose assumption').[3] A child is now defined as 'fully vaccinated' at 12 months of age if he or she has received a third dose of DTPa and poliomyelitis vaccine (oral or inactivated), a second dose of Hib vaccine (PRP-OMP), and either a second or a third dose of hepatitis B vaccine, depending on the pathway taken on the new schedule. ACIR coverage estimates (using the 'assumption') for the first vaccination milestone (the first 3 scheduled doses of DTP, OPV, Hib and, recently, 2 or 3 doses of hepatitis B and only 2 doses of Hib) have been reported in *Communicable Diseases Intelligence* since 1998.[9] The coverage for MMR has been reported in *Communicable Diseases Intelligence* since 1998.[97]

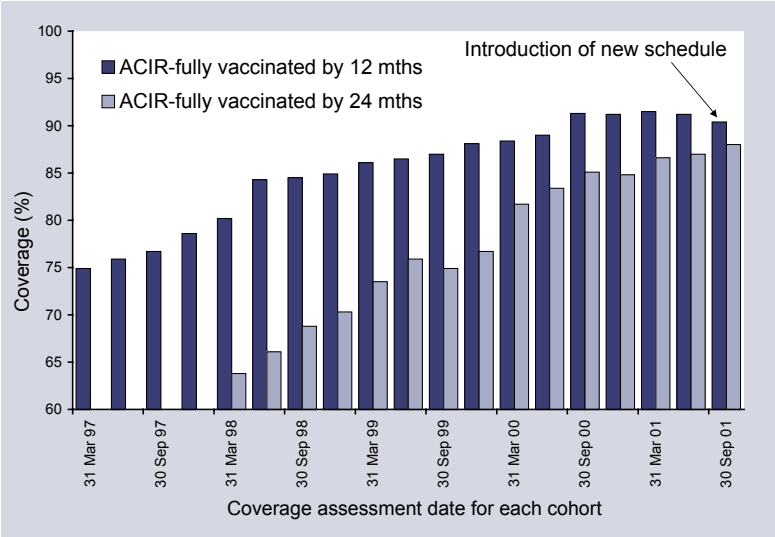
Trends in vaccination coverage estimates from the ACIR

Vaccines scheduled in the first year of life

The trends in childhood vaccination coverage in Australia for 3 doses of DTP, OPV and Hib assessed at one year, and for 4 doses of DTP and Hib, 3 doses of OPV, and 1 dose of MMR assessed at 2 years, are shown in Figure 34. Coverage was calculated for 19 consecutive 3-month cohorts born from 1 January 1996 to 30 September 2000. For all vaccines due by one year of age, coverage estimates increased steadily from 75 per cent for the first cohort, to 90 per cent by the nineteenth cohort, assessed on 30 September 2001. For all vaccines due by 2 years of age, coverage estimates also increased steadily from 64 per cent for the first cohort to 88 per cent by September 2001.

Coverage estimates for the 12-month age group did, however, decrease in the last quarter of 2001 by 0.8 per cent compared with the previous quarter. This decrease, the largest drop in coverage since the ACIR began, should not be a consequence of the introduction of hepatitis B vaccination on the new schedule, as hepatitis B is combined with DTP or Hib vaccine in all jurisdictions. If the decrease is due to data problems, they would be most likely with Hib vaccines as the dose requirements for the new schedule by 12 months (2 doses of PRP-OMP) differ from the previous schedule for non-Indigenous children (3 doses of HbOC). However, it is noteworthy that this cohort is the first 3-month cohort assessed according to the new schedule. It is possible that changes in the administration and timing of the Hib and DTP vaccines from May 2000 may have influenced either parents' decisions to immunise or, more likely, providers' understanding of the vaccines required.

Figure 34. Trends in vaccination coverage estimates from the Australian Childhood Immunisation Register for 1 and 2 year olds*

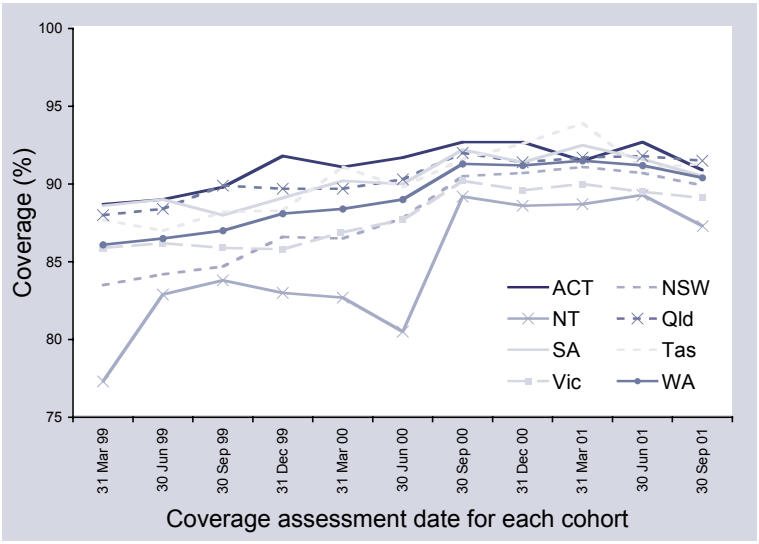


Source: Australian Childhood Immunisation Register.

* By 3-month birth cohorts born between January 1996 and September 2000. Coverage assessment date was 12 months or 24 months after the last birth date of each cohort.

Differences between estimates of the proportion of children classified as 'fully vaccinated' by State/Territory are shown in Figure 35. 'Fully vaccinated' coverage for consecutive cohorts increased over the 2 and a half year assessment period for all jurisdictions. However, the rate of increase in coverage is slowing. The greatest increases in coverage over the 2-year period were seen in the Northern Territory and New South Wales (10% and 6.4%, respectively). Over the past year, almost all jurisdictions reached the *Immunise Australia Program* target of 90 per cent coverage for the first milestone vaccines. The Northern Territory is the exception, but coverage for this jurisdiction is very close to the target and is likely to be greater than 90 per cent when problems with data transmission are taken into account.[98,99]

Figure 35. Trends in vaccination coverage estimates by jurisdiction: children fully vaccinated for 3 doses of DTP, OPV and Hib at the age of 1 year*

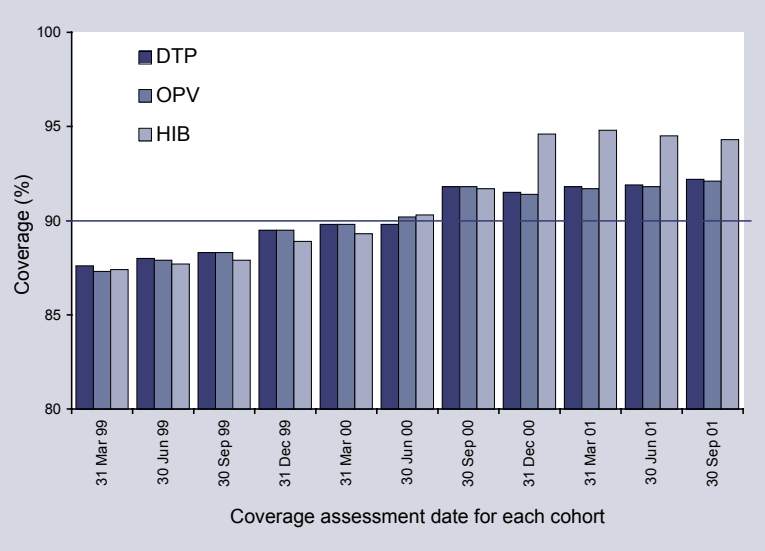


Source: Australian Childhood Immunisation Register.

* By 3-month birth cohorts born between January 1998 and September 2000. Coverage assessment date was 12 months after the last birth date of each cohort.

The trends in childhood vaccination coverage in Australia for individual vaccines (DTP, OPV and Hib assessed at 1 year) are shown in Figure 36, calculated for 11 consecutive 3-month cohorts born from 1 January 1998 to 30 September 2000. Coverage estimates for all individual vaccines due by one year of age increased steadily from 87 per cent for the cohort assessed in March 1999 to 92 per cent for the cohort assessed in September 2000. However, there were no further increases in coverage for DTP and OPV for the last 4 quarters (December 2000–September 2001). This is in contrast with coverage estimates for Hib, which increased to almost 95 per cent nationally and even more for some jurisdictions. There was a sudden increase in Hib vaccine coverage in the cohort report of December 2000, maintained over the following 3 reports. Although the new schedule was not introduced until May 2000 for children born after this date, this change in Hib coverage is probably due to interim changes in Hib vaccine coverage reporting by the Health Insurance Commission (HIC). From around December 2000, the HIC accepted 2 or 3 doses of HbOC as evidence of 'fully immunised' for Hib for children born before May 2000 who were on the old schedule (Williams K, personal communication).

Figure 36. Trends in vaccination coverage estimates for individual vaccines: children vaccinated for 3 doses of DTP, OPV and Hib at the age of 1 year*



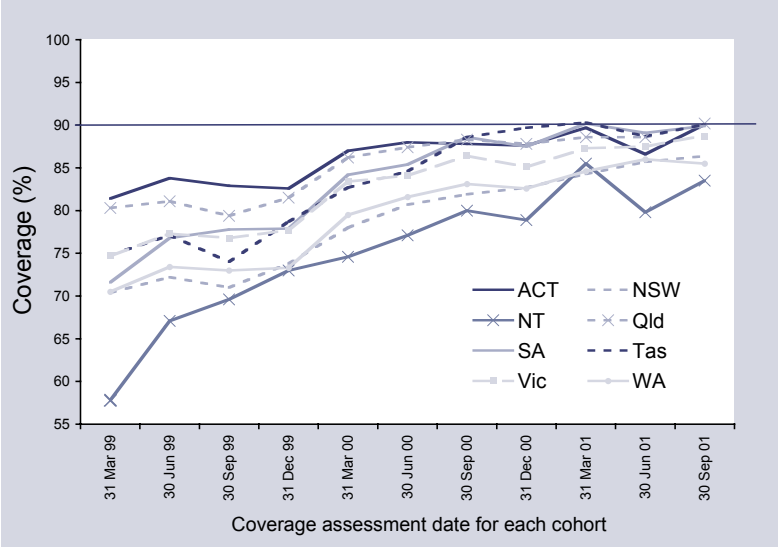
Source: Australian Childhood Immunisation Register.

* By 3-month birth cohorts born between January 1998 and September 2000. Coverage assessment date was 12 months after the last birth date of each cohort.

Vaccines scheduled in the second year of life

Differences between estimates of the proportion of children classified as 'fully vaccinated' at 2 years of age by State/Territory are shown in Figure 37. 'Fully vaccinated' coverage at 2 years of age for consecutive cohorts increased over the 2 and a half year assessment period for all jurisdictions. However, as with estimates for one year olds, the rate of increase in coverage is slowing. A number of jurisdictions including Tasmania, Queensland, South Australia, and the Australian Capital Territory reached 90 per cent coverage over the past year. The greatest increases in coverage were in the Northern Territory and Western Australia where increases of 26 per cent and 15 per cent, respectively, were seen over the 2 and a half year period. This is likely to be related to intensive data cleaning efforts in those jurisdictions.

Figure 37. Trends in vaccination coverage estimates, by jurisdiction: children fully vaccinated for 4 doses of DTP and Hib, 3 doses of OPV and 1 dose of MMR at the age of 2 years*

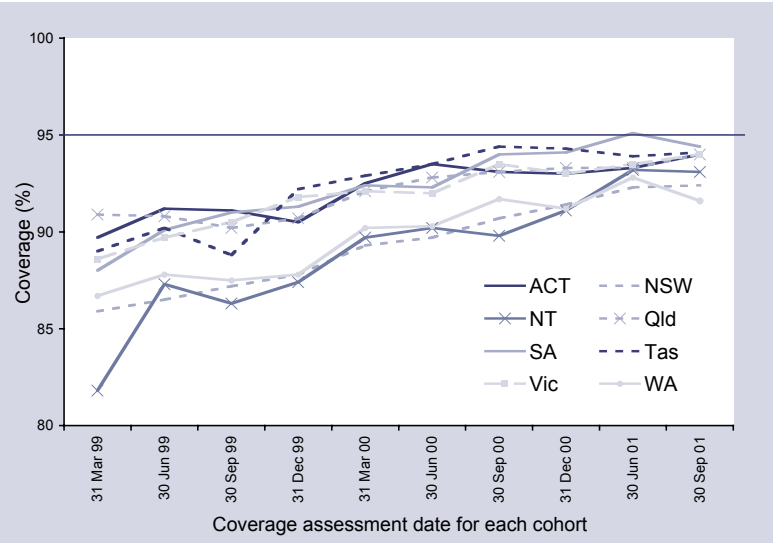


Source: Australian Childhood Immunisation Register.

* By 3-month birth cohorts born between 1 January 1997 and 30 September 1999. Coverage assessment date was 24 months after the last birth date of each cohort.

Figure 38 shows trends in MMR1 (first dose of MMR) coverage at 2 years of age by jurisdiction, with assessment dates up to 30 September 2001. MMR coverage increased for all jurisdictions over the 2 and a half year assessment period. Only one jurisdiction, South Australia, had reached the Immunise Australia program target of 95 per cent coverage (at June 2001) although all other jurisdictions were within 3 per cent of the target.

Figure 38. Trends in MMR1 vaccination coverage estimates for 2 year olds, by jurisdiction*



Source: Australian Childhood Immunisation Register.

* By 3-month birth cohorts born between 1 January 1997 and 30 September 1999. Coverage assessment date was 24 months after the last birth date of each cohort.

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, although the first cohort of children born since the ACIR commenced has now reached 4–5 years of age. Coverage estimates for this cohort will be published for the first time in 2002/3. 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%).[11,100]

Comment

Estimates of vaccination coverage in Australia for all jurisdictions have increased steadily since the ACIR commenced in 1996. There have been increases in coverage for both one year olds and 2 year olds, with 'fully immunised' coverage for 1 year olds reaching the *Immunise Australia Program* target of 90 per cent coverage for the first milestone vaccines.

Limitations of the ACIR database, related to reliance on provider notification and the currency of Medicare registration, mean that official estimates of coverage are unlikely to rise significantly above current levels, unless mechanisms are put in place to further improve notification to the ACIR. Increases in actual coverage will also be difficult to achieve from this point, as there are probably 2–3 per cent of parents who are opposed to immunisation.

To maintain the current high levels and to achieve further increases in coverage, efforts need to be directed at improving reporting by providers (and subsequent data cleaning), and at immunisation of the small group of children now not up to date with their immunisations. The latter will require carefully targeted initiatives, which may include efforts to further improve access to services for disadvantaged groups and specific educational initiatives for those parents and providers concerned about contraindications to immunisation.

In addition, there are several national, publicly funded, targeted immunisation programs for which systematically collected data on vaccine coverage are not currently available. These include hepatitis B vaccine for adolescents, MMR vaccine for 18-30 year olds, influenza and pneumococcal vaccines for Aboriginal and Torres Strait Islander persons over 50 years of age and influenza vaccine for persons over the age of 64 years. While data are available from surveys in local subpopulations[40] or national special purpose surveys[101] for three of these programs, lack of widely applicable data inhibits planning and evaluation at the regional and national level. As the number and scope of immunisation programs increases, extension of the ACIR to collect data for some or all of the other age groups targeted by vaccines merits active consideration.

5 - Discussion

Changes in vaccination practice

The years 1999 to 2000 have again marked a period of rapid change in vaccination policy and practice in Australia, with major changes to the schedule and continued improvement in vaccination coverage and reporting. In 1999, the movement of the second dose of measles-mumps-rubella vaccine to 4 years of age was implemented following the successful Measles Control Campaign.[46,47] In 2000, the Australian Standard Vaccination Schedule (ASVS) was substantially altered (see Chapter 4, Table 27). Fully funded universal infant vaccination against hepatitis B, including a dose at birth, and the use of only one type of Hib vaccine for infants commencing the schedule was implemented in May 2000.[34] The Australian Childhood Immunisation Register has become an even more essential pillar of immunisation in Australia over the past 2 years. A number of policies and programs now depend on linkage to the ACIR to ascertain eligibility for payment. These include maternity allowance and childcare assistance payments to parents, and payment for notification to the ACIR by providers. Additional payments are made to general practitioner providers for notification to the ACIR and achievement of practice coverage targets.

These vaccine policy and program changes represent a large investment in public health. Australia, together with other industrialised countries, is faced with the challenge of maintaining high immunisation coverage and public confidence in immunisation, along with increasingly complex decisions about the introduction of new vaccines into the ASVS for both children and adults. Evaluation of the impact of current programs, as well as prioritising and planning for future programs, is informed by the integration of multiple data sources (notification, hospitalisation and mortality data) contained in this report. The report includes data on meningococcal disease and influenza for the first time.

Current and comparative morbidity from vaccine preventable diseases

A summary of the relative morbidity and mortality due to the diseases covered in the 5 years prior to the current report (1993 to 1998) is shown in Table 28 and for 1999 to 2000 in Table 29. While the limitations of notification, hospitalisation and death data should be borne in mind (see Chapter 2) and may be especially evident for rare diseases or diseases which lack a specific diagnostic test, together these data provide an informative overview of disease burden and changes to it in Australia over the past several years.

Table 28. Average annual morbidity and mortality from vaccine preventable diseases in Australia for 5 years 1993/1994–1997/1998*

Disease†	Hospitalisations (average no.)		Hospitalisation rate/100 000 (average rate)		Hospital bed days (average no.)	Neurological complications** (average no.)	Deaths (average no.)	
	Age 0–4 yr	All ages	Age 0–4 yr	All ages			Age 0–4 yrs	All ages
Diphtheria	0.4	4	0.0	0.0	||	¶	0.0	0.0
Hib§	119	164	9.2	4.2	806	59	1.6	2.0
Hepatitis A	28	755	2.2	4.2	4217	11.6	0.6	3.2
Hepatitis B‡	1.2	283	0.1	1.6	1112	6.6	0††	39††
Measles	189	447	14.6	2.5	1676	5.8	0.4	1.2
Mumps	8.8	54	0.7	0.3	234	4.4	0.0	0.4
Pertussis	685	961	52.9	5.3	3916	¶	1.8	1.8
Pneumococcal disease (invasive)#	188	503	14.5	2.8	556	159	4.4	14.4
Polio‡	¶	3.2	0.0	0.0	||	¶	0.0	0.0
Rubella	41.4	89	3.2	0.5	325	5.8	0.0	0.0
Tetanus	¶	129	-	0.2	598	¶	0.0	1.6
Varicella	631	1532	48.7	8.5	6535	40.4	1.7	7.2

* Hospitalisation data, Australian Institute of Health and Welfare, July 1993–June 1998; death data, Australian Bureau of Statistics, January 1994–December 1998.

† See Chapter 3 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.

¶ ICD-10-AM 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.

Includes pneumococcal meningitis and septicaemia only.

Table 29. Average annual morbidity and mortality from vaccine preventable diseases in Australia for 2 years 1998/1999–1999/2000*

Disease†	Hospitalisations (average no.)		Hospitalisation rate/100 000 (average rate)		Hospital bed days (average no.)	Neurological complications** (average no.)	Deaths (average no.)	
	Age 0–4 yr	All ages	Age 0–4 yr	All ages			Age 0–4 yrs	All ages
Diphtheria	0.5	1	0.0	0.0	3	¶	0	0
Hib§	37	54	2.9	1.1	260	39	0	0.5
Hepatitis A	20	716	1.6	3.8	4162	5.5	0	1.5
Hepatitis B‡	1.5	172	0.1	0.9	898	2.5	0	15
Influenza	902	4295	70.6	22.8	28758	¶	1.5	69
Measles	27	73	2.2	0.4	242	3.5	0	0
Meningococcal disease	293	783	23.0	4.2	6002	384	10.5	35
Mumps	10.5	56	0.8	0.3	247	2	0	1
Pertussis	239	372	18.7	2.0	2209	¶	0.5	0.5
Pneumococcal disease (invasive)††	291	851	22.8	4.5	9069	146	5	17
Polio‡	0	1.5	-	0.0	‖	¶	0	0
Rubella	16.5	36	1.3	0.2	129	2.5	0	0
Tetanus	0.5	32	0.0	0.2	529	¶	0	1
Varicella	783	1863	62.1	9.9	7823	48.5	0.5	7

* Hospitalisation data, Australian Institute of Health and Welfare (AIHW), July 1998–June 2000; and death data, AIHW National Mortality Database, January 1999–December 2000.

† See Chapter 3 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.

¶ ICD-10-AM codes for these diseases do not specify neurological complications.

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

†† Includes pneumococcal meningitis and septicaemia only.

In children under 5 years of age (the main target of the current childhood program), some important changes in relative disease burden have occurred in 1999 to 2000. Among diseases currently targeted by immunisation, hospitalisations due to measles, rubella and Hib disease have all decreased substantially. Hospitalisations due to pertussis also decreased, but this should be treated with caution as the financial years 1999 to 2000 did not include an epidemic period. Two diseases not included in the previous report (influenza and meningococcal disease) and another not currently included in the ASVS (varicella) accounted for the largest numbers of hospitalisations in those under the age of 5 years. Outside this age group, the 3 most common causes of hospitalisation also included influenza and varicella, but hepatitis A was the third most common cause of hospitalisation. Similarly, the impact of improved control of measles and rubella was evident in the hospitalisation data from older age groups. By contrast with the hospitalisation data, meningococcal and pneumococcal disease were the most prominent causes of death and central nervous system manifestations (potentially associated with long-term disability) in all age groups. The implications of these data are discussed below, first with respect to vaccines included in the ASVS during the review period and second with respect to vaccines available in Australia but not included in the ASVS up to the end of 2000.

Diseases on the Australian Standard Vaccination Schedule in 2000

Measles

During 1999 to 2000, the pattern of measles changed dramatically following the Measles Control Campaign in the latter half of 1998. No epidemics occurred, and levels of notification and hospitalisation for measles among children under 19 years were at a record low in all jurisdictions. In contrast, measles cases among young adults (20–29 years) have been prominent, especially in Victoria in 1999.[49] Together with serosurveillance data showing that susceptibility to measles is highest in this age group,[51] this prompted the provision of national funding for MMR vaccine for 18–30 year olds.[54] It is now likely that indigenous transmission of measles in Australia has been interrupted, with current cases arising from importations. Continued high childhood vaccine coverage for two doses of MMR will be required to maintain this status. Immunity has been compromised recently in the United Kingdom by linkage of MMR vaccine to autism spectrum disorders,[102] resulting in falling MMR coverage.[103,104] Australia needs good communication strategies to emphasise the benefits of measles control as well as the lack of data to support concerns about links between MMR vaccine and neurodevelopmental disorders.[105]

Rubella and mumps

Rubella notifications have continued the decline from a peak in 1996, especially in 15–24 year old males, in 1999 and 2000 in all jurisdictions apart from New South Wales. As for measles, it is likely that many cases in young children being notified as rubella are misdiagnoses of other viral exanthems.[50] Notifications among females of child bearing age continue to be low, with no cases of congenital rubella in 1999 to 2000.[88] Mumps surveillance data are more difficult to interpret because of differences in notification requirements between jurisdictions. However, the previously reported trend to increased notifications in young adults (20–29 years) has continued in 1999 to 2000. This appears to be real, as it also seen in hospitalisations as well as notifications from the only jurisdiction where laboratory confirmation is required for notification (New South Wales). This age peak in young adults corresponds to that for measles and is likely to also be related to relatively poor vaccine coverage in childhood. The re-emergence of mumps adds weight to the value of the MMR campaign in 18–30 year olds as well as additional challenges in targeting males in this age group for any medical intervention.

Hib disease

The virtual disappearance of invasive Hib disease among children less than 5 years old remains the greatest success story for vaccination in the past decade. The notification rate for 0–4 year olds, the main age group at risk of Hib disease, has continued to fall since 1998 (Figure 3). Although the reduction in hospitalisations coded as *Haemophilus influenzae* meningitis or epiglottitis was less dramatic, the available 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. While it is likely that notifications underestimate incidence of Hib, hospitalisations will overestimate incidence. Continued enhanced surveillance for Hib is important to evaluate any changes in epidemiology following movement to a program using PRP-OMP exclusively. Universal use of PRP-OMP has not been adopted in any other country except New Zealand.

Pertussis

Of the diseases with well-established vaccination programs, pertussis again stands out as causing the greatest morbidity in 1999 to 2000, as in the previous review period. Although notification, hospitalisation and mortality rates have decreased by more than 50 per cent compared with the previous 5 years (Tables 28 and 29), this may be misleading, as the previous period included the 1993 and 1997/1998 epidemics, whereas no epidemic occurred in 1999 to 2000. It is encouraging that there is clear evidence of an impact from the fifth dose of pertussis vaccine, introduced at 4 years of age from 1995 (Figure 22). The cohort which has been eligible for the fifth dose is now 5–9 years of age and has a notification rate comparable to 1–4 year olds, the other highly immunised group, with neither group showing any increase in incidence during the epidemic beginning in late 2000. This may be related to a longer duration of immunity as well as higher efficacy from acellular vaccines. It will be important to determine whether the low rates of pertussis in the 5–9 year old cohort persist into their adolescence and to assess the likely impact of a booster at high school entry.

Influenza

Inactivated influenza vaccines have been provided free of charge annually to all people 65 years of age and over since 1999, except in Victoria where funding occurred in 1998. This makes influenza vaccine a large, recurrent and therefore costly part of the overall immunisation program. The data presented in this report indicate that the disease burden from influenza is also large, with the highest number of hospitalisations and bed days, both for children under 5 years of age and for older age groups. Influenza was the underlying cause of death more frequently than any other disease under review, with 85 per cent of deaths attributed to influenza occurring among people over 60 years of age (Table 9). Recent coverage estimates derived from national telephone surveys indicate that 78 per cent of the ambulatory population over 64 years of age had received an influenza vaccination in the past 3 years.[101] Vaccine availability is also the subject of planning for the possibility of much higher disease rates should a novel strain result in pandemic influenza. The impact of influenza vaccine is difficult to measure at the population level, because of varying circulation of influenza from year to year and place to place and varying specificity of case definitions. A current NHMRC funded study of elderly people hospitalised with pneumonia in Victoria should provide guidance as to how hospitalisation data, such as those presented here, are best interpreted. The high disease burden from influenza among young children (Table 29) is similar to that described in the United States of America.[106] It is likely that circulation of influenza among young children is responsible for much of the transmission to other age groups, so universal use of nasally administered vaccines in young children[106] is a strategy under active consideration in industrialised countries. In the meantime, the outcome of the world's first universal influenza immunisation program (for all ages) in Ontario, Canada will be of great interest.

Hepatitis B

Although vaccines against hepatitis B first became available in 1982, and have been used consistently in high-risk groups since then, they were not included in the ASVS until 2000, with the exception of the Northern Territory which has had routine vaccination since 1990. The long incubation of hepatitis B infection means that the impact of infant immunisation takes many years to become evident. Again, young adults (aged 20–29 years) have consistently had the highest notification rates for acute hepatitis B, and an upward trend is suggested by data from the last 2 years. However, these higher rates are still less than those for the same age group in the USA.[69] The Northern Territory is the only jurisdiction with an overall decrease in notification rates for acute hepatitis B, in contrast to the almost universally higher notification rates in the Northern Territory for other vaccine preventable diseases (Appendix 2). While based on small numbers, it is suggestive of an impact from hepatitis B vaccination in a region with high risk for hepatitis B on the one hand and the longest duration of routine vaccination on the other.

Rare vaccine preventable diseases (tetanus, diphtheria and poliomyelitis)

Cases of tetanus continue to occur, despite tetanus toxoid being available for more than 60 years. In the most recent 2 years, the first notification of childhood tetanus (in a 2 year old) occurred since a case in a 10 year old in 1992. However, most cases and all deaths were in adults, predominantly women over the age of 60 years. No cases of diphtheria have been notified since 1992, but the occurrence of a case in New Zealand in an unimmunised child from an imported strain[17] highlights the need for vigilance, already emphasised by the experience in Eastern Europe. The recent change in not recommending 10-yearly boosters for diphtheria and tetanus until age 50 will require close monitoring through seroprevalence and notification data. Australia and the Western Pacific region have been declared polio free,[84] but high vaccination coverage and continued active surveillance for acute flaccid paralysis will be required until global certification is achieved.

Vaccine preventable diseases not on the Australian Standard Vaccination Schedule in 2000

Varicella

Varicella was responsible for the greatest number of hospitalisations attributed to any disease not currently in the ASVS reviewed in this report, both in young children and across all age groups (Table 29). The hospitalisation rate for varicella in children 0–4 year olds in 1999 to 2000 was similar to that for Hib disease in this age group before immunisation. Although varicella is less severe than Hib, one death and 69 cases of encephalitis were recorded in 0–14 year olds in Australia in 1999 to 2000 (Tables 25 and 26). If varicella vaccine is included in the ASVS, there should be a rapid, relatively uniform increase in population coverage. This will be a different scenario to the USA, where implementation of varicella immunisation was patchy over time and across regions.[96] As marked disease reductions should be expected, development of more sensitive and timely surveillance of both varicella and herpes zoster than is possible from hospitalisation data will be required, at least in selected sentinel regions of Australia.

Pneumococcal disease

Notification of invasive pneumococcal disease was instituted nationally in 2001 and implemented in full in 2002 to accompany the introduction of conjugate pneumococcal vaccine for high-risk children. The hospitalisation data presented here are the only source of representative data prior to the commencement of notification nationally. Hospitalisation data are highly consistent with other data sources for meningitis, for which the data are scant but probably reliable. Septicaemia and pneumonia codes are more subject to misclassification and underestimation, but probably give an accurate reflection of national trends and age-related differences (Figure 26). Although this is adequate for examining disease burden prior to vaccine introduction, enhanced surveillance including serogroup, risk factor and immunisation status data will be essential for evaluating program impact. The data presented here show that invasive pneumococcal disease causes a similar number of hospitalisations but only half as many deaths as meningococcal disease in 0–4 year olds and across all age groups (Table 29). The impact of the conjugate vaccine program in high-risk infants, which commenced in the Northern Territory in June 2001 and subsequently in other jurisdictions, will be awaited, as will the outcome of general use of conjugate pneumococcal vaccine in infants in the USA, which commenced in late 2000.

Meningococcal disease

Meningococcal disease ranked behind influenza, invasive pneumococcal disease and varicella in terms of total hospital bed days in 1999 to 2000 (Table 29). It accounted for the highest number of hospitalisations with neurological involvement and therefore potential disability, the highest number of childhood deaths and, after influenza, the second highest number of deaths in all ages. As deaths from meningococcal disease predominantly occur in the young, it is likely that it accounts for more life years lost than influenza. However, only a small proportion of meningococcal disease (that due to serogroups A, C, W135 and Y) is vaccine-preventable, with a range from 10–40 per cent depending on age group and region. A protein conjugate vaccine protective against serogroup C meningococcal disease has been available in Australia since the beginning of 2002. These vaccines have been used in a universal program for children 2 months to 18 years of age in the United Kingdom, with dramatic reductions in cases and deaths due to serogroup C, compared with age groups not targeted for vaccination.[67] Australia has an incidence of meningococcal disease (overall and due to type C meningococci) which is intermediate between the high rates seen in the United Kingdom[67] and the rates of 1 per 100 000 population or less generally seen in North America.[107] The overall intermediate disease incidence and the diversity of the Australian population with respect to serogroup-specific incidence of meningococcal disease[68] make decisions on the place of conjugate serogroup C meningococcal vaccines in the ASVS complex. This is under review by a working group of ATAGI in 2002. Vaccines effective against serogroup B meningococci are under development but must be tailored to specific subtypes. The subtype of serogroup B meningococcal disease currently causing a prolonged epidemic in Auckland, New Zealand[108] although present in Australia, has not been responsible for any disease outbreaks to date.

Hepatitis A

Hepatitis A, in 1999 to 2000, accounted for the fifth highest number of hospitalisations among diseases reviewed, similar to those related to meningococcal and invasive pneumococcal disease (Table 29). However, overall morbidity (as measured by total bed days, neurological complications and deaths), were orders of magnitude below those measures for meningococcal and invasive pneumococcal disease, varicella and influenza. Hospitalisations occurred predominantly in males 15–59 years, and both deaths and hepatic coma were seen predominantly among people aged 60 years and over. The Northern Territory had more than double the notification and hospitalisation rates for hepatitis A of any other jurisdiction both overall and for most years, presumably related to high disease rates in the Aboriginal and Torres Strait Islander population. In the USA, hepatitis A vaccine is now part of the routine schedule for States with annual notification rates above 20 per 100 000.[69] Hepatitis A vaccination was implemented routinely among indigenous children in Far North Queensland in 1999. The results of this initiative will help inform the costs and benefits of introducing such a scheme in other areas of Australia (such as the Northern Territory and north west Western Australia) with similar high rates, in a manner comparable with the USA recommendations.

Vaccine preventable disease notification rates compared with other industrialised countries

The most recent notification rates for the 5 most frequently occurring vaccine preventable diseases compared with the rates in New Zealand, the USA, Canada and England, are shown in Table 30. Notifications of invasive Hib disease were low in all countries, reflecting the excellent results of Hib vaccination programs. Australia has moved closer to the situation in North America with respect to measles eradication, with notification rates decreasing from 1.7 in 1998 to 0.6 per 100 000 in 2000. It is likely that true levels of measles would be substantially lower than this if laboratory confirmation was sought as frequently as it is in England (Table 30). Pertussis notification rates in Australia remain much higher than in the other countries shown in Table 30, except Canada. Comparisons with other countries are difficult because of differences in notification case definitions and the availability of serology. Nevertheless, it is likely that Australia has a comparatively high pertussis disease burden, including disease and deaths in infants. Children with the highest notification rates in 1999 to 2000 (10–14 years of age) were born at a time when the level of completed pertussis immunisation was relatively low and have not been eligible for a pertussis booster before school entry.

Table 30. Most recent* notification rates per 100 000 population for frequently notified vaccine preventable diseases, by country of residence

Disease	Australia	New Zealand[109]	USA[69]	Canada[110]	England[56]
Hib†	0.2	0.4	0.4	0.2	0.2
Measles	0.6	4.9	< 0.05	< 0.05	4.7 (0.1)‡
Mumps	1.4	2.4	0.2	0.4	3.3 (0.8)§
Pertussis	31.0	4.3	2.6	25.1	2.2
Rubella	1.7	1.6	0.1	0.2	3.8 (0.1)‖

* Australia 2000; New Zealand 1998; USA 1999; Canada 1998; England 1999.

† *Haemophilus influenzae* type b.

‡ Incidence corrected for proportion serologically confirmed = 3 per cent.

§ Incidence corrected for proportion serologically confirmed = 23 per cent.

‖ Incidence corrected for proportion serologically confirmed = 4 per cent.

Future surveillance priorities

For this biannual report, access to and the scope of the data available from the AIHW National Hospital Morbidity Database and Causes of Death Collection have been enhanced by NCIRS' relationship with the AIHW as a collaborating centre. On the NNDSS database, some additional important fields, such as laboratory confirmation and immunisation status, are becoming available through enhanced surveillance initiatives. These already apply to Hib disease, for which the enhanced surveillance data are managed by NCIRS, invasive pneumococcal disease and meningococcal disease. Enhanced surveillance for measles, with routine performance of specific laboratory tests for validation, remains incompletely implemented, in part due to logistic difficulties at a State and Territory level. The Communicable Diseases Network Australia is currently undertaking a comprehensive revision of case definitions, including those for vaccine preventable diseases, which will set the scene for some years to come.

Future vaccination priorities

Table 29 provides a number of measures of morbidity for comparison of disease burden relevant to current general or targeted programs as well as potential future vaccination programs. For most VPDs, the notification and hospitalisation rates are highest in children under 5 years. Immunisation programs targeting this age group are probably nearing their highest practically achievable targets, as measured by the Australian Childhood Immunisation Register and supported by a range of parent and provider incentives. For other VPDs, there is either a greater disease burden in older age groups, such as hepatitis A and B, pertussis (although rates in infants remain high) and tetanus, or important secondary age peaks, such as 20–29 year olds for measles and mumps and 15–19 year olds for meningococcal disease.

With respect to immunisation programs targeting diseases currently included in the ASVS, measles and pertussis in young adults and adolescents, respectively, stand out as priorities. The former issue is presently the subject of a program to supply a second dose of MMR vaccine free of charge to older teenagers and young adults. Approaches to adolescent pertussis must have the twin focus of morbidity in adolescents themselves and projected impact on disease transmission to infants. Moves to assess this are currently under way both nationally and internationally.

There are four diseases, not included in the ASVS in 2000, for which vaccines approved for use in Australia are now available. These are varicella, invasive pneumococcal disease in children under the age of 2 years, meningococcal disease due to serogroup C and hepatitis A. From Table 29 it is evident that varicella has the highest hospitalisation rate among these conditions, while meningococcal disease accounts for most deaths. However, deaths due to meningococcal serogroup C disease account for only a proportion of the total and vary by age and geography, with the largest disease burden in Victoria and in adolescents. When this is taken into account among children under 5 years, it is likely that the number of deaths potentially preventable in the general population by the currently available pneumococcal and meningococcal conjugate vaccines is similar. A crucial issue is the extent of the additional impact of pneumococcal conjugate vaccine on non-invasive pneumococcal disease, for which additional data from long term follow-up of the original efficacy trial[111] and post-marketing surveillance in the USA are awaited.

Currently, IPD and hepatitis A have identified high-risk groups who are the subject of targeted programs. For IPD, the high-risk groups are Indigenous children and non-Indigenous children with certain medical conditions. For hepatitis A, the only high-risk group included is Indigenous children in North Queensland. In the case of varicella and meningococcal disease due to serogroup C, no particular high-risk groups have been identified. An economic evaluation of various scenarios for use of varicella vaccine in Australia concluded that general infant immunisation combined with immunisation of adolescents without a history of varicella would be cost-effective.[112] At the time of writing this report, the place of varicella, hepatitis A, meningococcal and pneumococcal conjugate vaccines in the ASVS are at various stages of evaluation. Australia, along with other industrialised countries, is now entering an era when the increasing array of new vaccines will have less easily defined benefits and greater costs than programs to date. Careful evaluation of the additional benefits of new programs as well as continued efforts to maintain current programs will be required to sustain the success of immunisation in Australia over the first decade of the 21st Century.

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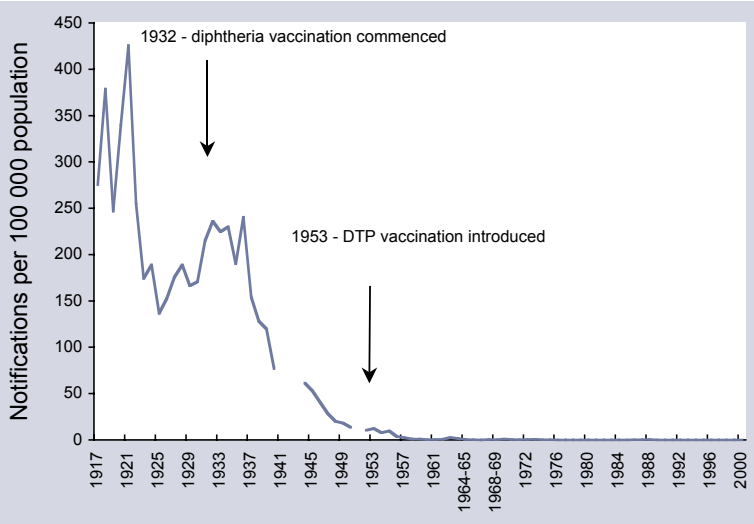
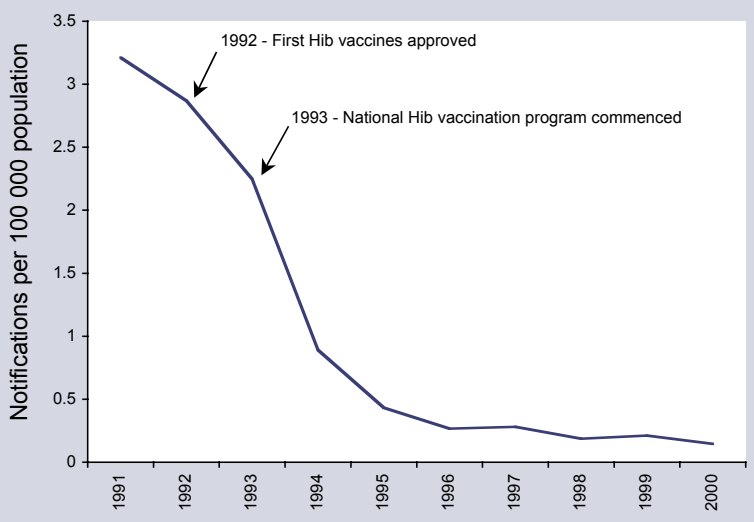
Appendix I Historical charts of notifications of vaccine preventable diseases

Historical charts of notifications of vaccine preventable diseases

Diphtheria, 1917–2000



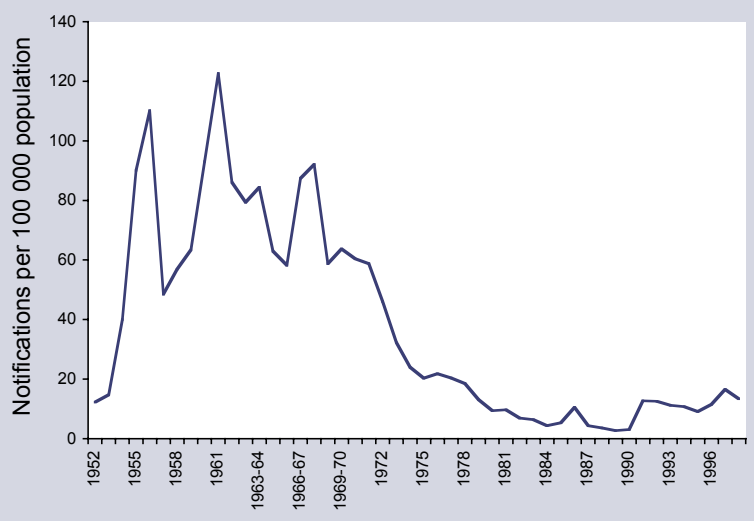
Haemophilus influenzae type b disease, 1991–2000



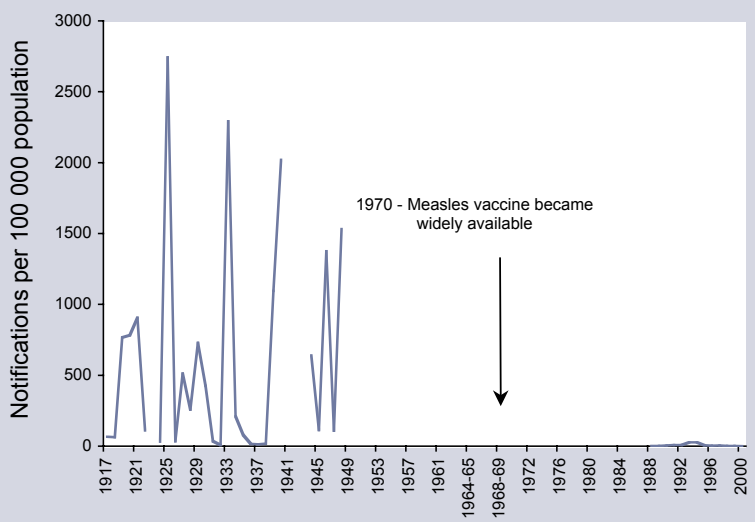
↓ Indicates major change in vaccination policy.

1993; Source: Hall R. Notifiable disease surveillance, 1917 to 1991. Commun Dis Intell 17:226-36.
Updated with NNDSS data 1992–2000.

Hepatitis A, 1952–2000



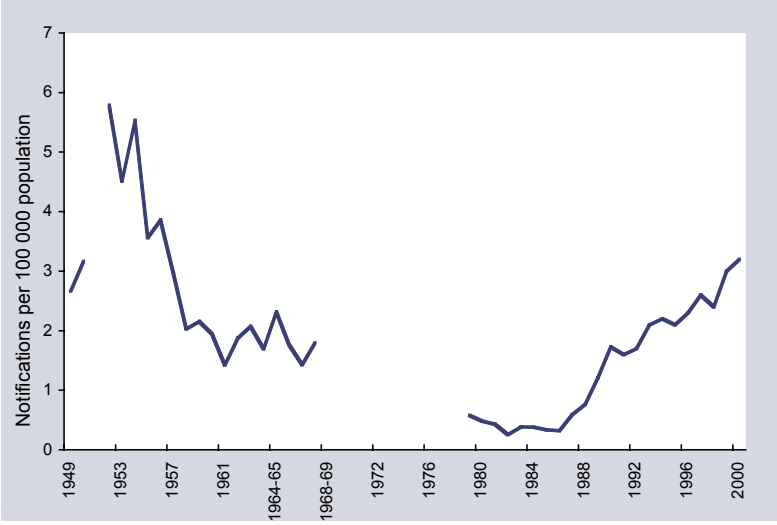
Measles, 1917–2000



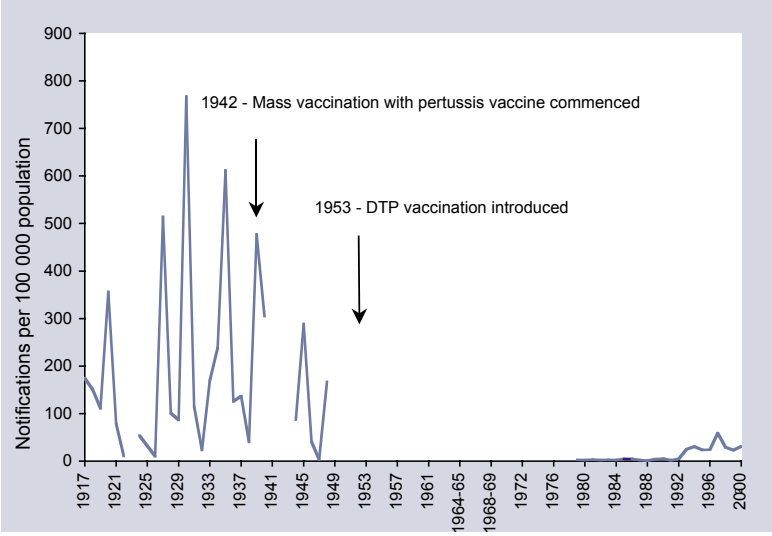
↓ Indicates major change in vaccination policy.

1993; Source: Hall R. Notifiable disease surveillance, 1917 to 1991. Commun Dis Intell 17:226-36.
Updated with NNDSS data 1992–2000.

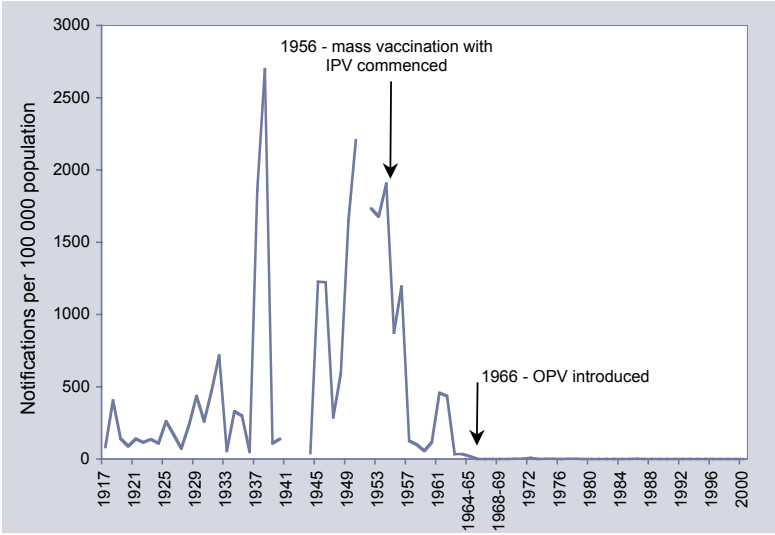
Meningococcal disease (invasive), 1949–2000



Pertussis, 1917–2000



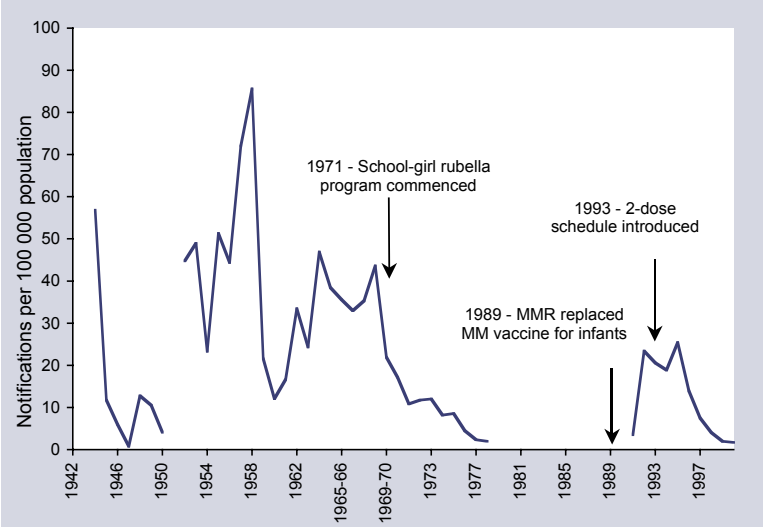
Poliomyelitis, 1917–2000



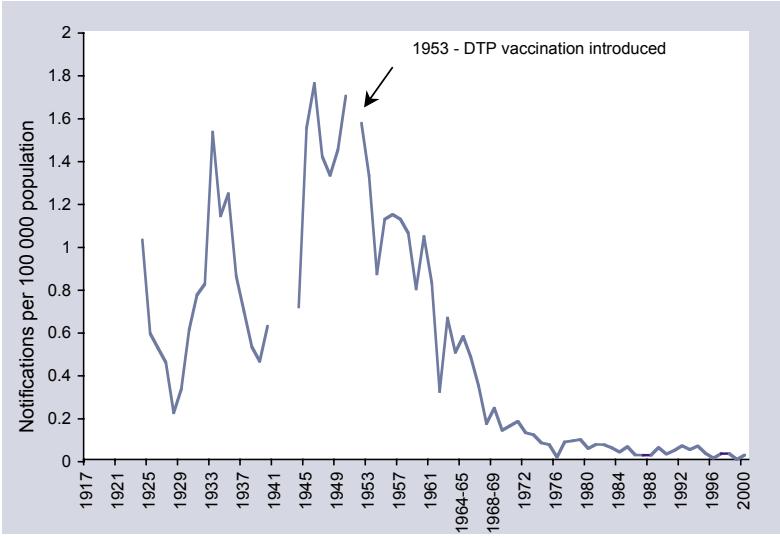
↓ Indicates major change in vaccination policy.

1993; Source: Hall R. Notifiable disease surveillance, 1917 to 1991. Commun Dis Intell 17:226-36.
Updated with NNDSS data 1992–2000.

Rubella, 1917–2000



Tetanus, 1917–2000



↓ Indicates major change in vaccination policy.

1993; Source: Hall R. Notifiable disease surveillance, 1917 to 1991. Commun Dis Intell 17:226-36. Updated with NNDSS data 1992–2000.

Appendix 2 Notifications by State/Territory and year (January 1995–December 2000)

Table 31. Notifications by State/Territory and year (January 1995–December 2000)

		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**
Diphtheria	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	-	-	-	-	-	-	-	-	-
	1999	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-
	2000	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)	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	-	0.9	6.0	1.6	0.7	1.9	0.7	0.8	1.0
	1998	0	11	0	7	1	2	1	5	27	-	0.8	-	0.9	0.3	2.0	0.1	1.3	0.7
	1999	1	8	2	6	2	0	3	3	25	1.5	0.6	4.0	0.8	0.7	-	0.3	0.8	0.6
	2000	0	4	0	7	1	0	2	0	14	-	0.3	-	0.9	0.3	-	0.2	-	0.4
	Total*	4	68	13	49	18	9	34	16	211	1.0	0.9	4.3	1.1	1.0	1.5	0.6	0.7	0.9
Hepatitis A	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
	1999	8	415	89	360	121	5	269	292	1559	2.6	6.5	46.1	10.2	8.1	1.1	5.7	15.7	8.2
	2000	5	200	44	133	54	3	193	180	812	1.6	3.1	22.5	3.7	3.6	0.6	4.0	9.6	4.2
	Total*	192	4604	391	3308	440	37	1710	1019	11 701	10.4	12.2	34.8	16.1	4.9	1.3	6.1	9.4	10.5
Hepatitis B (acute)	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	-	0.9	8.9	1.4	1.2	1.3	1.9	1.8	1.4
	1999	3	68	19	55	19	5	93	45	307	1.0	1.1	9.9	1.6	1.3	1.1	2.0	2.4	1.6
	2000	3	96	6	56	30	18	114	72	395	1.0	1.5	3.1	1.6	2.0	3.8	2.4	3.8	2.1
	Total*	24	382	81	299	134	45	606	211	1782	1.3	1.0	7.2	1.5	1.5	1.6	2.2	1.9	1.6

* Total cases for 6-year period and average annual rate per 100 000 population.

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
Measles	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
	1999	5	32	10	33	5	11	110	23	229	1.6	0.5	5.2	0.9	0.3	2.3	2.3	1.2	1.2
	2000	3	35	0	26	11	1	21	10	107	1.0	0.5	-	0.7	0.7	0.2	0.4	0.5	0.6
	Total*	173	1245	126	654	68	160	496	259	3181	9.3	3.3	11.2	3.2	0.8	5.6	1.8	2.4	2.8
Meningococcal disease	1995	11	115	8	96	26	8	76	41	381	3.6	1.9	4.5	2.9	1.8	1.7	1.7	2.4	2.1
	1996	8	162	9	90	18	11	92	31	421	2.6	2.6	4.9	2.7	1.2	2.3	2.0	1.8	2.3
	1997	9	222	15	71	22	8	100	37	484	2.9	3.5	8.0	2.1	1.5	1.7	2.2	2.1	2.6
	1998	3	184	18	93	26	14	59	56	453	1.0	2.9	9.5	2.7	1.7	3.0	1.3	3.1	2.4
	1999	5	220	8	85	27	13	138	72	568	1.6	3.4	4.1	2.4	1.8	2.8	2.9	3.9	3.0
	2000	5	253	9	60	32	15	162	85	621	1.6	3.9	4.6	1.7	2.1	3.2	3.4	4.5	3.2
	Total*	41	1156	67	495	151	69	627	322	2928	1.7	2.3	4.6	1.8	1.3	1.8	1.7	2.3	2.0
Mumps	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
	1999	8	33	3	(12)†	12	4	73	39	172	2.6	0.5	1.6	NN	0.8	0.9	1.5	2.1	1.1
	2000	17	92	4	NN	15	2	43	39	212	5.5	1.4	2.0	NN	1.0	0.4	0.9	2.1	1.4
	Total*	60	235	35	59	87	23	363	189	1039	3.2	0.6	3.1	0.7	1.0	0.8	1.3	1.7	1.1
Pertussis	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	10 907	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
	1999	83	1429	2	963	217	610	997	96	4397	26.8	22.3	1.0	27.4	14.5	129.7	21.2	5.2	23.2
	2000	208	3683	5	525	588	143	699	91	5942	66.9	57.0	2.6	14.7	39.3	30.4	14.7	4.8	31.0
	Total*	573	13 861	201	6904	4274	1069	6147	2261	35 290	30.9	36.6	17.9	33.6	48.0	37.7	22.1	20.8	31.6
(<5 yr only)	Total*	50	1575	58	518	381	64	822	533	4001	38.5	60.2	54.6	35.7	66.3	32.6	43.9	70.1	51.9

NN = not notifiable.

* Total cases for 6-year period and average annual rate per 100 000 population.

† Disease not notifiable for complete year, data not included in totals

Table 31. Notifications by State/Territory and year (January 1995–December 2000), (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**
Poliomyelitis	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	-	-	-	-	-	-	-	-	-
	1999	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-
	2000	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-
	Total*	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-
Rubella	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
	1999	17	45	3	157	4	7	121	21	375	5.5	0.7	1.6	4.5	0.3	1.5	2.6	1.1	2.0
	2000	4	191	0	46	7	1	67	6	322	1.3	3.0	-	1.3	0.5	0.2	1.4	0.3	1.7
	Total*	327	1932	32	3166	679	241	2878	734	9989	17.7	5.1	2.8	15.4	7.6	8.5	10.3	6.8	8.9
Tetanus	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
	1999	0	1	0	1	0	0	0	0	2	-	0.0	-	0.0	-	-	-	-	0.0
	2000	0	2	0	0	3	0	1	0	6	-	0.0	-	-	0.2	-	0.0	-	0.0
	Total*	0	10	0	4	3	2	8	5	32	-	0.0	-	0.0	0.0	0.1	0.0	0.0	0.0

* Total cases for 6-year period and average annual rate per 100 000 population.

Appendix 3 Hospitalisations by State/Territory and year (July 1995–June 2000)

Table 32. Hospitalisations by State/Territory and financial year (July 1995–June 2000)

		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	95/96	0	1	1	1	1	0	0	2	6	-	0.0	0.6	0.0	0.1	-	-	0.1	0.0
	96/97	0	0	0	1	0	0	0	0	1	-	-	-	0.0	-	-	-	-	0.0
	97/98	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	0.0
	98/99	0	1	0	0	0	0	0	0	1	-	0.0	-	-	-	-	-	-	0.0
	99/00	0	0	0	0	0	0	1	0	1	-	-	-	-	-	-	0.0	-	0.0
	Total†	0	2	1	2	1	0	1	2	9	-	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0
Haemophilus influenzae type b disease (<15 yr only)	95/96	2	41	0	16	13	2	23	9	106	2.9	3.1	-	2.2	4.3	1.9	2.4	2.3	2.7
	96/97	0	34	1	20	5	3	11	9	83	-	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
	98/99	1	17	1	15	6	2	8	10	60	1.5	1.3	2.0	2.0	2.0	2.0	0.8	2.5	1.5
	99/00	1	9	1	18	3	1	11	5	49	1.5	0.7	2.0	2.4	1.0	1.0	1.2	1.3	1.3
	Total†	5	135	6	87	31	10	66	76	416	1.5	2.1	2.4	2.3	2.1	1.9	1.4	3.8	2.1
Hepatitis A	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	-	2.1	4.1	5.1
	98/99	5	256	11	252	64	4	110	74	781	1.6	4.0	5.8	7.3	4.3	0.8	2.4	4.0	4.2
	99/00	1	181	20	122	57	6	157	100	649	0.3	2.8	10.4	3.5	3.8	1.3	3.3	5.4	3.4
	Total†	31	1474	109	1086	254	18	678	334	3994	2.0	4.7	11.7	6.4	3.4	0.8	2.9	3.7	4.3
Hepatitis B (acute)	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	-	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	-	1.4	0.8	0.9
	98/99	2	45	3	31	12	0	70	20	187	0.6	0.7	1.6	0.9	0.8	-	1.5	1.1	1.0
	99/00	1	46	3	19	11	1	53	21	158	0.3	0.7	1.6	0.5	0.7	0.2	1.1	1.1	0.8
	Total†	8	273	14	130	76	5	352	92	957	0.5	0.9	1.5	0.8	1.0	0.2	1.5	1.0	1.0

* See Chapter 3 for case definitions.

† Total cases for 5-year period and average annual rate per 100 000 population.

Table 32. Hospitalisations by State/Territory and financial year (July 1995–June 2000), (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
Influenza	95/96	11	951	27	818	225	58	607	308	3005	3.6	15.5	15.2	25.1	15.3	12.2	13.4	17.8	16.6
	96/97	18	1128	82	1219	399	36	759	702	4343	5.8	18.2	45.1	36.5	27.1	7.6	16.6	39.8	23.7
	97/98	37	1698	32	1058	559	68	1591	1090	6133	11.9	27.1	17.1	31.1	37.8	14.4	34.5	60.6	33.1
	98/99	20	1494	46	1145	442	36	836	573	4592	6.5	23.6	24.2	33.2	29.7	7.6	18.0	31.3	24.5
	99/00	10	1154	25	858	282	41	781	847	3998	3.2	18.0	13.0	24.4	18.9	8.7	16.6	45.5	21.1
	Total†	96	6425	212	5098	1907	239	4574	3520	22 071	6.2	20.5	22.8	30.0	25.8	10.1	19.8	39.2	23.8
Measles	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
	98/99	0	17	0	13	6	3	30	8	78	-	0.3	-	0.4	0.4	0.6	0.6	0.4	0.4
	99/00	1	9	14	10	3	1	15	7	67	0.3	0.1	7.3	0.3	0.2	0.2	0.3	0.4	0.4
	Total†	13	153	24	120	20	11	77	26	452	0.8	0.5	2.6	0.7	0.3	0.5	0.3	0.3	0.5
Meningococcal disease	98/99	2	284	15	155	39	23	105	124	749	0.6	4.5	7.9	4.5	2.6	4.9	2.3	6.8	4.0
	99/00	5	297	13	108	51	18	210	107	817	1.6	4.6	6.7	3.1	3.4	3.8	4.5	5.7	4.3
	Total‡	7	581	28	263	90	41	315	231	1566	1.1	4.6	7.3	3.8	3.0	4.4	3.4	6.3	4.2
Mumps	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
	98/99	1	35	0	9	6	1	4	2	58	0.3	0.6	-	0.3	0.4	0.2	0.1	0.1	0.3
	99/00	2	22	0	14	2	0	7	7	54	0.6	0.3	-	0.4	0.1	-	0.1	0.4	0.3
	Total†	6	110	4	51	25	2	44	26	268	0.4	0.4	0.4	0.3	0.3	0.1	0.2	0.3	0.3

* See Chapter 3 for case definitions.

†Total cases for 5-year period and average annual rate per 100 000 population.

‡ Total cases for 2-year period and average annual rate per 100 000 population.

Table 32. Hospitalisations by State/Territory and financial year (July 1995–June 2000), (continued)

		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**
Pertussis	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
	98/99	2	171	2	87	25	1	79	27	396	0.7	2.7	1.1	2.5	1.7	0.2	1.7	1.5	2.1
	99/00	8	115	2	53	13	21	118	17	349	2.6	1.8	1.0	1.5	0.9	4.5	2.5	0.9	1.8
	Total†	31	1185	26	612	404	56	761	462	3541	2.0	3.8	2.8	3.6	5.5	2.4	3.3	5.1	3.8
(<5 yr only)	Total	23	855	23	401	226	28	550	371	2478	21.1	39.1	25.9	33.1	46.9	16.9	35.1	58.5	38.5
Pneumococcal	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
disease	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
(invasive) ‡	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
	98/99	9	292	54	88	74	16	173	44	753	2.9	4.6	28.4	2.6	5.0	3.4	3.7	2.4	4.0
	99/00	27	333	43	116	82	23	200	118	949	8.7	5.2	22.3	3.3	5.5	4.9	4.2	6.3	5.0
	Total†	65	1283	195	453	307	65	762	270	3410	4.2	4.1	21.0	2.7	4.1	2.7	3.3	3.0	3.7
Poliomyelitis	95/96	0	22	0	13	8	5	20	3	71	-	0.4	-	0.4	0.5	1.1	0.4	0.2	0.4
	96/97	0	28	0	16	0	3	20	0	67	-	0.5	-	0.5	-	0.6	0.4	-	0.4
	97/98	0	31	0	19	6	1	14	0	71	-	0.5	-	0.6	0.4	0.2	0.3	-	0.4
	98/99	0	34	0	11	1	2	20	1	69	-	0.5	-	0.3	0.1	0.4	0.4	0.1	0.4
	99/00	0	1	0	0	4	0	16	0	21	-	0.1	-	-	0.3	-	0.3	-	0.1
	Total†	0	116	0	59	19	11	90	4	299	-	0.4	-	0.3	0.3	0.5	0.4	0.0	0.3
(Principal diagnosis only)	Total†	0	2	0	3	0	0	3	0	8	-	0.0	-	0.0	-	-	0.0	-	0.0

* See Chapter 3 for case definitions.

† Total cases for 5-year period and average annual rate per 100 000 population.

‡ Pneumococcal meningitis and septicaemia

Table 32. Hospitalisations by State/Territory and financial year (July 1995–June 2000), (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
Rubella	95/96	1	61	0	22	5	5	19	13	126	0.3	1.0	-	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	-	0.4	0.3	-	0.1	0.3	0.3
	98/99	0	16	0	9	3	1	11	3	43	-	0.3	-	0.3	0.2	0.2	0.2	0.2	0.2
	99/00	0	8	0	8	3	0	10	0	29	-	0.1	-	0.2	0.2	-	0.2	-	0.2
	Total†	3	125	1	69	19	9	49	23	298	0.2	0.4	0.1	0.4	0.3	0.4	0.2	0.3	0.3
Tetanus	95/96	0	3	0	3	3	1	4	5	19	-	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	-	0.1	-	0.3	0.1	0.2	0.3	0.1	0.2
	97/98	0	20	0	2	3	1	4	4	34	-	0.3	-	0.1	0.2	0.2	0.1	0.2	0.2
	98/99	0	15	0	6	0	1	4	7	33	-	0.2	-	0.2	-	0.2	0.1	0.4	0.2
	99/00	0	8	0	8	6	2	5	2	32	-	0.1	-	0.2	0.4	0.4	0.1	0.1	0.2
	Total†	0	55	0	30	14	6	32	19	157	-	0.2	-	0.2	0.2	0.3	0.1	0.2	0.2
Varicella	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
	98/99	22	677	33	427	188	36	399	199	1991	7.1	10.7	17.4	12.4	12.7	7.6	8.6	10.9	10.6
	99/00	30	580	32	332	93	48	418	190	1734	9.7	9.0	16.6	9.5	6.2	10.2	8.9	10.2	9.1
	Total†	130	2674	110	1678	681	166	1823	896	8179	8.4	8.5	11.8	9.9	9.2	7.0	7.9	10.0	8.8

* See Chapter 3 for case definitions.

† Total cases for 5-year period and average annual rate per 100 000 population.

Appendix 4 Changes to the Australian Standard Vaccination Schedule (1992–2000)

Table 33. Diphtheria, tetanus and pertussis (DTP) vaccination practice in Australia, 1992 to 2000

Date	Intervention
1994	5th dose of DTP at 4–5 years added to the recommended vaccination schedule (replacing CDT vaccine) 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)
1998	5th dose of DTPa changed from 4–5 years to 4 years of age
1999	DTPa recommended for all 5 childhood DTP doses Combined DTPa-hepatitis B vaccine approved

Table 34. *Haemophilus influenzae* type b vaccination practice in Australia, 1992 to 2000

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 Hib vaccines: HBOC (HibTITER), PRP-T (Act-HIB), and PRP-OMP (PedvaxHIB) licensed for infants aged <18 months PRP-OMP recommended at 2, 4 and 12 months, HBOC and PRP-T at 2, 4, 6 and 18 months
2000	Combined Hib(PRP-OMP)-hepatitis B vaccine approved PRP-OMP recommended for all infants (administered separately or in combination with hepatitis B vaccine)

Table 35. Hepatitis B vaccination practice in Australia, 1992 to 2000

Date	Intervention
1997	Vaccination recommended for adolescents aged 10–16 yrs 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
2000	Combined DTPa-hepatitis B vaccine approved Thiomersal-free paediatric hepatitis B vaccine approved May: Universal infant vaccination included in childhood schedule with a birth dose of monovalent paediatric hepatitis B vaccine, followed by 3 doses as part of a combination vaccine schedule Preadolescent vaccination recommended at 10–13 years rather than 10–16 years of age Booster doses no longer recommended by NHMRC

Table 36. Measles, mumps and rubella vaccination practice in Australia, 1992 to 2000

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)
	July: Recommended age for 2nd MMR vaccine dose lowered to 4–5 years
	July–December: Implementation of Measles Control Campaign (involving mass vaccination of primary school aged children with MMR vaccine)
	December: 2nd MMR vaccine dose recommended at 4 years
2000	MMR rather than rubella vaccine recommended for non-immune women of child-bearing age

Table 37. Polio vaccination practice in Australia, 1992 to 2000

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

Appendix 5 Vaccination funding in Australia

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 fourth and fifth 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 to 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 to 2000, PHOFA funding to purchase enough vaccine for 105 per cent 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 38.

Acknowledgements

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

Table 38. 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) NSW 1966 Tas 1966
DTPw	1953		1994	WA 1988
Rubella (adolescent girls)	1971			
MMR (infant dose)	1989		1994	NSW 1989 Qld 1989
MMR (adolescent dose)	1994	SA 1996	1994	WA 1993 SA 1996
ADT	1982		1994	WA 1988
CDT	1975		1994	WA 1988
Hib vaccines (infants born from Feb 1993)	1993 April		1993 April	
Hib vaccines (all infants aged <5 years)	1993 July	WA 1993 Jan NT 1993 April	1993 July	WA 1993 Jan NT 1994
DTPa boosters (infants aged 18 months) and 4-5 years	1997 Sept	Tas 1997 Oct Qld 1997 Dec	1997 Sept	Tas 1997 Oct Qld 1997 Dec
DTPa (infants aged 2, 4 and 6 months)	1999 Feb	NT 1997 Aug SA 1997 Aug Tas 1999 Feb Qld 1999 April	1999 Feb	NT 1997 Aug SA 1997 Aug Tas 1999 Feb Qld 1999 April
Hep B (at-risk infants)	1987	NT 1988 Jan SA 1996	Not funded by the C'wealth	NSW 1987
Hep B (adolescent dose)	1998 Jan	Qld 1998 March Tas 1998 March NT 1998 April NSW 1999 SA 1999	?1998	Qld 1998 March Tas 1998 March NT 1998 April 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 Australian Capital Territory in 1993 (except for MMR vaccine which became free in the private sector in 1994) and in the Northern Territory in 1994.