

1. Introduction

This is the third national report on the morbidity and mortality from vaccine preventable diseases (VPDs) and vaccine coverage in Australia. The first (1993 to 1998) was published in 2000 and the second (1999 to 2000) in 2002.^{1,2} The progressive decline in the incidence of all the childhood VPDs continues, with the exception of 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 almost threefold (Table 2), and the close association this decline has had with the introduction of specific vaccination programs.³

The past decade has seen 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 (ACIR) in 1996;⁴
- the *Seven Point Plan* in 1997 (this included the Measles Control Program in the later part of 1998);⁵
- the General Practice Immunisation Initiative in 1998; and
- several new vaccination programs for children, the elderly and Indigenous people.

Although specific evaluations are important, much can be learned from examining routinely collected data, especially for trends over time. This third report uses similar methods to the first two, bringing together data sources available at the national level relevant to VPDs and vaccination (deaths, notifications, hospitalisations and vaccination coverage) for all age groups. The diseases covered in this report include those for which vaccines were funded nationally for children during the review period (diphtheria, *Haemophilus influenzae* type b (Hib) disease, hepatitis B, 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 at least partially preventable by vaccination, such as tuberculosis, for which reports can be found elsewhere.⁶

This and the previous two reports, 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, as detailed in Appendix 4. These reports provide baselines against which further initiatives can be evaluated.

Table 2. Number of deaths from diseases commonly vaccinated against, by decade, Australia 1926 to 1995 and 1996 to 2002*

Period	Diphtheria	Pertussis	Tetanus	Poliomyelitis	Measles [†]	Population estimate (yearly average)
1926–1935	4,073	2,808	879	430	1,102	6,600,000
1936–1945	2,791	1,693	655	618	822	7,200,000
1946–1955	624	429	625	1,013	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
1996–2002	0	15	6	0	0	18,900,000

* 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 1996–2002 updated with data provided by AIHW Mortality Database.

† Excludes deaths from subacute sclerosing panencephalitis.

■ 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.⁷ However, application of these definitions and even the definitions themselves may differ between jurisdictions. In 2001 invasive pneumococcal disease and laboratory-confirmed influenza became notifiable to the NNDSS. Varicella and zoster are not notifiable to the NNDSS.

Data extracted from the NNDSS as at 18 December 2003 was examined. Note that these data are later versions than those used for the 2001 and 2002 Australia's Notifiable Disease Status reports and the AIHW publication *Australia's Health 2004*.⁸⁻¹⁰ Disease notification data for cases with an onset between 1 January 2001 and 31 December 2002 (2 years) are included in this report. Notification data are presented and reported by date of onset. Date of onset is collected from the clinical history where available, or the specimen collection date for laboratory-confirmed cases. Those with onset dates between 1 January 1993 and 31 December 2000 were reported previously.^{1,2} However, to reflect the ongoing process of improving and cleaning of the NNDSS database since the publication of the previous report, all historical notification data included within this report has been updated. 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 when calculating rates 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 (2000/2001 and 2001/2002) were examined. Note, however, that receipt of the 2000/2001 and 2001/2002 hospitalisation data was delayed due to concerns over possible coding problems with New South Wales data. Due to production deadlines, this report uses the finalised data for 2001/2002 and the provisional data (possibly with some minor errors for New South Wales data) for 2000/2001. Cases with separation dates between 1 July 1993 and 30 June 2000 (7 years) were reported previously.^{1,2} In the current report all hospitalisations with a separation date in 2000/2001 or 2001/2002 were included. Hospitalisation data are presented and reported by date of admission. Data were extracted based on the International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Australian Modification, 1st Edition (ICD-10-AM). Eligible separations were those with the code of interest listed in 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 (e.g. 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), and diagnosis (principal and other diagnoses—up to 31 diagnoses were recorded for each admission) coded using ICD-10-AM. The mode of separation (whether a patient died while in hospital) and hours of mechanical ventilation (as a measure of critical care) were not included in this report due to concerns over the accuracy of these data. The only exception to this is deaths in hospital due

to meningococcal disease, as for this disease this measure was felt to be of importance. Where State of residence was missing in hospitalisation data this variable was replaced with State of hospitalisation, affecting 0.3 per cent of records in 2000/2001 and 2001/2002.

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. Deaths analysed in this report were those registered in 2001 to 2002 (two 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 finalised 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—e.g. the 2000 mid-year population estimate was used to calculate rates for 2000/2001. 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 — the pattern of notifications and hospitalisations over time, with reference to seasonality and outbreaks;
- severe morbidity and mortality — hospital bed days, length of stay, principal diagnosis, complications and mortality by age group in standard categories;
- age and sex distribution — 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;
- 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 Australian Government Department of Health and Ageing. The ACIR records details, as supplied by vaccination providers, about the vaccination status of children aged less than seven years. Vaccination coverage estimates derived from ACIR data have been reported in *Communicable Diseases Intelligence* since early 1998. A complete description of the method for calculating coverage estimates by age cohorts is given elsewhere.¹¹ In this report we have described trends in 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 (e.g. age, ethnicity and population density) between jurisdictions. An exploratory analysis of 2002 pneumococcal and incident hepatitis B notification rates for the Northern Territory found that directly age-standardising the rates to the 2001 Australian population did not change the rates significantly (pneumococcal crude rate 20.2 per 100,000 vs 20.5 per 100,000 age-standardised; hepatitis B crude rate 6.8 per 100,000 vs 5.7 age-standardised.) Therefore, given that the Northern Territory is the jurisdiction with the most different age structure, we have elected to use crude rates. 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. For example, during this reporting period notifications of rubella and mumps in New South Wales were purely laboratory based, whereas in other jurisdictions clinical or epidemiologically linked cases were notifiable by medical practitioners. 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 theoretically 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, use of diagnostic tests 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 impacted on the sensitivity and specificity of some diagnostic codes. 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 (e.g. rare diseases such as tetanus or diphtheria) and for admissions with multiple diagnoses.¹² Assignment of codes is based on information in medical records, as recorded by clinicians, and there are few strict case definitions. As indicated in relevant disease chapters, the short lengths of stay and lack of notification to public health authorities strongly suggest that some cases with hospitalisation codes for diseases such as tetanus and diphtheria are likely to be due to coding errors. For some diseases, such as *Haemophilus influenzae* type b infection, the previously used 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. 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 six 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.^{4,9,10} Another limitation of ACIR data is that records are only held for children up to seven 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.^{11,13,14}