5. Discussion

Changes in vaccination practice

The years 2001 to 2002 have been a period of consolidation in immunisation practice and coverage in Australia, following the implementation of the new vaccination schedule in mid-2000. There has been continuing evidence of the effectiveness of immunisation strategies undertaken in the late 1990s, such as the Measles Control Campaign in 1998 and the introduction of a fourth dose of pertussis-containing vaccine in 1995, as well as improvements in vaccination coverage. In December 2000 the Australian Childhood Immunisation Register (ACIR) documented the fact that the 90 per cent coverage target for immunisation of 12 month olds had been achieved for the first time. This has been maintained and exceeded following the introduction of the new schedule through to the end of 2003.

These vaccine policy and program changes represent a large investment in public health, which is set to further increase in coming years, with increasingly expensive new vaccines and the increasing cost of all the supporting pillars of immunisation in Australia. Like other industrialised countries, Australia faces the dual challenges of maintaining both high immunisation coverage and public confidence in immunisation, while implementing increasingly complex decisions about the introduction of new vaccines for both children and adults. Although the full evaluation of the impact of current programs, and prioritisation and planning for future programs, require more detailed and precise data, the multiple data sources (notifications, hospitalisations and mortality) contained in this report provide an ongoing picture of progress across the spectrum of Australian immunisation activity.

Current and comparative morbidity from vaccine preventable diseases

A summary of the relative morbidity and mortality due to the diseases covered in the four years prior to the current report (1996 to 2000) is shown in Table 23 and for the two years 2001 to 2002 in Table 24. 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 trends in the burden of vaccine preventable diseases in Australia over the past several years.

In children under five years of age (the main target of the current childhood program), ongoing reductions in relative disease burden have continued in 2001 and 2002. Among diseases currently targeted by immunisation, hospitalisations due to measles, rubella, mumps and Hib disease have all decreased substantially. Hospitalisations due to pertussis continue to be a significant burden in young infants. Influenza, pertussis, varicella, pneumococcal disease and meningococcal disease accounted for the largest numbers of hospitalisations in those under the age of five years. Outside this age group, the three most common causes of hospitalisation also included influenza and varicella, but zoster was the third most common recorded cause. By contrast with the hospitalisation data, the most prominent causes of death in all age groups were influenza and meningococcal disease. The implications of these data are discussed below, first with respect to vaccines included in the Australian Standard Vaccination Schedule (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 2002.

Table 23. Average annual morbidity and mortality from vaccine preventable diseases in Australia for 4 years 1996/1997–1999/2000*

Disease†	Notifications 1997–2000 (average n)		Notification rate/100,000 (average rate)		Hospitalisations 1996/97–1999/00 (average n)		Hospitalisation rate/100,000 (average rate)		Deaths‡ 1997–2000 (average n)		Death rate /100,000 (average rate)	
	0–4 yr	All ages	0–4 yr	All ages	0–4 yr	All ages	0–4 yr	All ages	0–4 yr	All ages	0–4 yr	All ages
Diphtheria	0	0	–	–	0.3	0.8	0.02	0.00	0	0	–	–
Hib§	21.8	26.5	1.69	0.68	39.5	77.5	3.06	1.97	0.5	1.3	0.04	0.03
Hepatitis A	118.5	1977.0	9.21	10.50	29.0	824.0	2.25	4.43	0.5	3.0	0.04	0.02
Hepatitis B‡‖	1.8	312.3	0.14	1.66	1.5	181.8	0.12	0.98	0	22.5‖	–	0.12‖
Influenza	NN	NN	NN	NN	880.3	4766.5	68.14	25.60	3.3	117.3	0.25	0.62
Measles	166.8	367.8	12.95	1.95	43.0	95.5	3.33	0.51	0	0	–	–
Meningococcal disease	202.0	546.8	15.69	2.90	283.8	740.5	21.97	3.98	9.5	31.3	0.74	0.17
Mumps¶	31.3	192.8	2.43	1.02	8.3	53.3	0.64	0.29	0	0.5	–	<0.01
Pertussis	694.5	6748.5	53.95	35.84	486.5	708.3	37.66	3.80	1.3	1.5	0.10	0.01
Pneumococcal (invasive)**	NN	NN	NN	NN	252.0	754.0	19.50	4.05	4.8	14.8	0.37	0.08
Poliomyelitis‡	0	0	–	–	0	1.5	–	0.01	0	0	–	–
Rubella	130.5	709.8	10.14	3.77	19.5	43.0	1.51	0.23	0	0	–	–
Tetanus	0.3	5.8	0.02	0.03	0.3	34.5	0.02	0.19	0	1.3	–	0.01
Varicella	NN	NN	NN	NN	726.5	1701.8	56.24	9.14	1.3	8.3	0.10	0.04
Zoster††	NN	NN	NN	NN	28.8	4469.0	2.23	24.01	0.3††	19.3††	0.03††	0.10††

NN = Not Notifiable.

* Notification data, National Notifiable Diseases Surveillance System, January 1997–December 2000; hospitalisation data, Australian Institute of Health and Welfare (AIHW) National Morbidity database, July 1996–June 2000; death data, AIHW National Mortality database, January 1997–December 2000.

† See Chapter 3 for case definitions.

‡ Principal diagnosis only for hospitalisations, and for deaths only cases with disease classified as underlying cause of death.

§ Data for *Haemophilus influenzae* disease include only cases aged 0–14 years of age. For hospitalisations and deaths only includes meningitis or epiglottis cases.

‖ Includes deaths from acute and chronic hepatitis B infection up to 1998, acute deaths only from 1999, due to change from ICD9 to ICD10 codes; includes only acute hepatitis B notifications and hospitalisations.

¶ In Queensland mumps not notifiable in 2000 or for complete year in 1999.

** Includes pneumococcal meningitis and septicaemia only.

†† Includes zoster deaths for 1998–2000 only.

Table 24. Average annual morbidity and mortality from vaccine preventable diseases in Australia for 2 years 2000/2001–2001/2002*

Disease†	Notifications 2001–2002 (average n)		Notification rate/100,000 (average rate)		Hospitalisations (average n)		Hospitalisation rate/100,000 (average rate)		Deaths‡ 2001–2002 (average n)		Death rate/100,000 (average rate)	
	0–4 yr	All ages	0–4 yr	All ages	0–4 yr	All ages	0–4 yr	All ages	0–4 yr	All ages	0–4 yr	All ages
Diphtheria	0	0.5	–	0.00	0	0.5	–	0.00	0	0	–	–
Hib‖	12.0	16.5	0.94	0.41	30.0	45.5	2.34	1.14	0.5	1.5	0.04	0.04
Hepatitis A	28.0	454.5	2.19	2.33	9.0	335.5	0.70	1.74	0.5	1.0	0.04	0.01
Hepatitis B‡§	1.0	418.5	0.08	2.14	0	152.5	–	0.79	0	10.0	–	0.05
Influenza††	962.5	2479.5	119.13	18.72	615.5	2905.0	48.06	15.06	1.5	43.5	0.12	0.22
Measles	18.0	85.5	1.41	0.44	13.0	52.5	1.02	0.27	0	0	–	–
Meningococcal disease	196.5	677.5	15.39	3.47	261.0	871.5	20.38	4.52	13.0	44.0	1.02	0.23
Mumps¶	10.5	91.5	0.82	0.47	8.0	42.5	0.62	0.22	0	0.5	–	<0.01
Pertussis	657.0	7358.5	51.46	37.68	443.5	638.5	34.63	3.31	2.5	3.0	0.20	0.02
Pneumococcal (invasive) **††	676.0	1975.5	59.01	11.68	344.0	1055.5	26.86	5.47	2.5	14.5	0.20	0.07
Polio‡	0	0	–	–	0	1.5	–	0.01	0	0	–	–
Rubella	15.5	255.5	1.21	1.31	6.5	27.0	0.51	0.14	0	0	–	–
Tetanus	0	2.5	–	0.01	0.5	27.0	0.04	0.14	0	0.5	–	<0.01
Varicella	NN	NN	NN	NN	691.5	1659.0	54.00	8.60	0.5	9.5	0.04	0.05
Zoster	NN	NN	NN	NN	34.5	4580.5	2.69	23.75	0	15.0	–	0.08

NN = Not Notifiable

* Notification data, National Notifiable Diseases Surveillance System, January 2001–December 2002; Hospitalisation data, Australian Institute of Health and Welfare (AIHW), July 2000–June 2002; death data, AIHW National Morbidity database, January 2001–December 2002.

† See Chapter 3 for case definitions.

‡ Principal diagnosis only for hospitalisations and for deaths only cases with disease classified as underlying cause of death.

§ Includes only acute hepatitis B notifications and hospitalisations, and deaths from acute hepatitis B.

‖ Data for *Haemophilus influenzae* disease include only cases aged 0–14 years of age. For hospitalisations and deaths only includes meningitis or epiglottis cases.

¶ Mumps not notifiable in Queensland for first half of 2001.

** Includes pneumococcal meningitis and septicaemia only.

†† Notifications only complete for 2002—notification rate for 2002 only.

Diseases on the Australian Standard Vaccination Schedule in 2001–2002

Measles

During 2001–2002 measles notifications and hospitalisations continued their decline to record lows, reflecting the success of the Measles Control Campaign and ongoing high childhood vaccine coverage with measles-mumps-rubella (MMR) vaccine. Continued high childhood vaccine coverage for two doses of MMR vaccine will be required to maintain this status. Evaluation of the young adult MMR vaccination campaign of 2001 will help decide whether further initiatives targeting this relatively susceptible group are required. In the face of declining public familiarity with measles, due to its successful control through immunisation, Australia needs to maintain good communication strategies to emphasise first the benefits of measles control and second the lack of evidence to support concerns about adverse effects. The most prominent of the latter is the purported link between MMR vaccine and neurodevelopmental disorders which, despite now well-defined evidence to counter it,[177] continues to cause suboptimal uptake of MMR vaccine in England.[178]

Rubella and mumps

Like measles, rubella and mumps notifications and hospitalisations have continued to decline to record lows in 2001–2002, reflecting improvements in coverage with MMR vaccine in Australia. Laboratory confirmation of cases is increasingly important as these diseases become rare. Vigilance for cases in young adults, and particularly in ensuring rubella immunity in women of childbearing age (especially those not born in Australia), is required. Although mass adult vaccination campaigns have been successfully implemented in some countries, any additional initiative in Australia will be difficult to implement and will require innovative approaches.[146]

Hib disease

The virtual disappearance of invasive Hib disease among children less than five years old has been the greatest success story for vaccination in the past decade. In the two years covered by this review period, there has been a further 20–25 per cent reduction in the average annual notification and hospitalisation rates of Hib disease in 0–4 year olds, with invasive Hib disease and deaths becoming a rarity. Laboratory confirmation is increasingly important, now that Hib disease is rare, as the relative incidence of non-type b invasive *Haemophilus influenzae* becomes greater. The recent resurgence of Hib disease in both children and adults in the United Kingdom exemplifies this, and most likely reflects their different childhood schedule, with no booster dose after six months of age and progressive decrease of herd immunity.[179,180]

Pertussis

Of the diseases with well-established vaccination programs, pertussis again stands out, as in the previous review period, as causing the greatest morbidity in 2001–2002, when epidemics occurred in several regions of Australia. Most infection occurs in those too young to be immunised[120] and in adolescents and adults whose vaccine or infection induced immunity has waned over time. There is good epidemiological evidence of the benefit of the addition of the preschool booster dose in late 1994, with a subsequent decline in national notifications in older children.[121] The recent availability of pertussis vaccines suitable for adolescents and adults promises to improve our ability to control pertussis. Immunisation should reduce the spread of pertussis by adolescents (who currently have the highest rates of notification) and provide protection against pertussis to adults who have contact with infants too young to be immunised. In September 2003, a booster dose of dTpa vaccine was substituted for DT vaccine in the ASVS at age 15–17 years and the 18-month booster was discontinued. Current recommendations also encourage dTpa vaccination for prospective and recent parents and for adults working with young children.[49] These recommendations will require careful implementation strategies in order to achieve reasonable uptake: in the interim, research into neonatal pertussis vaccination strategies will continue.

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 was made available in 1998. This makes influenza vaccine a large, recurrent and therefore costly part of the overall immunisation program. The data presented in this report, although minimal estimates of influenza cases, indicate that the disease burden from influenza is also large, with the highest number of hospitalisations and bed days, both for children under five years of age and

for older age groups. Influenza notifications commenced nationally in 2001 for laboratory-confirmed cases and, although a gross underestimate of disease burden, will provide useful information about relative size of influenza seasons, circulating influenza strains and changes in age distribution consequent upon vaccination. However, caution in interpretation of these data is required due to differential rates of testing among jurisdictions and age groups. Influenza was the underlying cause of death more frequently than any other disease under review, especially in the elderly, with 84 per cent of deaths attributed to influenza in people over 60 years of age. The high disease burden from influenza among young children (Tables 23 and 24) is similar to that described in the United States of America,[67] where universal childhood influenza vaccination has recently been recommended for infants aged 6–23 months.

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. The national notification rate of acute hepatitis B infection peaked in 2001. During the review period notification rates were highest in those aged 15–24 years and hospitalisation rates were highest in those aged 25–29 years. A national serosurvey of samples from 1996–1999 of 1–59 year olds found that only 29 per cent of subjects had evidence of vaccine-induced immunity to hepatitis B.[56] In addition to childhood vaccination, there is an ongoing need to promote hepatitis B immunisation for groups at high risk of acquisition of infection, including prisoners, men who have sex with men and injecting drug users.

Rare vaccine preventable diseases (tetanus, diphtheria and poliomyelitis)

Cases of tetanus continue to occur, despite tetanus toxoid being available for more than 60 years. However, tetanus has become a disease of older adults, reinforcing the need for vigilance in assessing tetanus immunity when older adults present for treatment of tetanus-prone injuries and for ensuring implementation of the ADT booster dose recommended at 50 years of age. In 2001 a cutaneous case of diphtheria was notified, the first case since 1992, but acquired overseas. There is an ongoing risk of the importation of diphtheria into Australia from regions where diphtheria is not well controlled, reinforcing the need for ensuring adequate immunisation across all age groups, especially amongst travellers. A travel-related acquisition of diphtheria was recently reported in an unimmunised child in New Zealand.[181] Australia and the Western Pacific region have been declared polio free,[141] 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 2001–2002

Varicella zoster

Currently, only South Australia has made varicella zoster a notifiable disease. Zoster hospitalisation data are presented for the first time in this report and demonstrate that, as measured by hospitalisation codes, the burden of zoster is higher than varicella in Australia. For varicella, the very young were most commonly hospitalised while the elderly had the longest length of stay. Should the 2003 recommendation for the use of varicella vaccine in Australian infants at the age of 18 months be fully funded and achieve coverage comparable to other vaccines on the ACIR, significant improvements to routinely available surveillance of these two conditions will be required.

Pneumococcal disease

Notification of invasive pneumococcal disease (IPD) was instituted nationally in 2001, and implemented in full in 2002, together with the introduction of conjugate pneumococcal vaccine for high-risk children. Two national reports on IPD have been published, for 2001[182] and 2002,[183] and these notification data illustrate the underestimation of IPD from hospitalisation data, with the exception of pneumococcal meningitis. Thus, for bacteraemic disease, these ongoing national reports, with serotype data, will be crucial in evaluating the impact of pneumococcal vaccine programs in children and in Indigenous and elderly adults, as both the conjugate and polysaccharide vaccines cover only a proportion of the serotypes associated with pneumococcal disease. The success of the conjugate pneumococcal program for children under the age of two years in

the United States of America, with significant reductions in diseases among older age groups due to herd immunity, have given an important lead for the impact to be expected in Australia when universal conjugate pneumococcal vaccination commences in January, 2005.[184]

Meningococcal disease

Meningococcal disease ranked behind zoster, invasive pneumococcal disease, influenza and varicella in terms of total hospital bed days in 2001–2002. It accounted for the highest number of childhood and adult deaths (although the deaths attributable to influenza in adults are grossly underestimated from death certificate coding.) 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 per cent to 40 per cent depending on age group and region.[106–108] A protein conjugate vaccine protective against serogroup C meningococcal disease has been available in Australia since the beginning of 2002. It was funded for all children aged 1–18 years in 2002, with a dose at 12 months of age becoming part of the National Immunisation Program from 2003. These vaccines have been used in a universal program for children two 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.[105] 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[105] and the rates of 1 per 100,000 population or less generally seen in North America.[185] 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,[186] although present in Australia, is a much lower proportion of B serotypes than in New Zealand and has not been responsible for any disease outbreaks to date.

Hepatitis A

There was a decline in hepatitis A rates in 2001–2002 following peaks in total hepatitis cases during the 1990s. The epidemiology of hepatitis A differs significantly for the Indigenous population, where it is endemic and is acquired primarily in early childhood, compared with the non-Indigenous population. An immunisation program targeting Indigenous children aged 18 months to six years living in north Queensland commenced in 1999, following cases of severe disease due to hepatitis A and day-care outbreaks. Data indicate that this program has had a significant impact on reducing hepatitis A in both Indigenous and non-Indigenous people in North Queensland.[52]

Vaccine preventable disease notification rates compared with other industrialised countries

The most recent notification rates for the five most frequently occurring vaccine preventable diseases compared with the rates in New Zealand, the USA, Canada and England, are shown in Table 25. Notifications of invasive Hib disease were low in all countries, reflecting the excellent results of Hib vaccination programs, although starting to show an increase in cases in the United Kingdom which now has a rate higher than Australia. 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 0.2 per 100,000 in 2002. Pertussis notification rates in Australia remain higher than in the other countries shown in Table 25. Comparisons with other countries are difficult because of differences in notification case definitions and particularly the ready availability of serology and compulsory laboratory notification in Australia. Nevertheless, it is likely that Australia still has a comparatively high pertussis disease burden, as reflected in hospitalisations.

Future surveillance priorities

For this biennial report, access to and the scope of the data available from the Australian Institute of Health and Welfare (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 National Notifiable Diseases Surveillance System (NNDSS) database some additional important fields, such as laboratory confirmation and immunisation status, are becoming available through enhanced surveillance initiatives. The Communicable Diseases Network Australia has recently revised case definitions, including those for vaccine preventable diseases, which will provide increasing consistency to notification data. Increasing requirements for the laboratory confirmation of diseases that have become rare due to the success of immunisation (e.g. Hib disease, measles, mumps and rubella) should provide increasing confidence in notification data. The recent additions of varicella, meningococcal C and pneumococcal conjugate vaccines to the ASVS in 2003 make close moni-

Table 25. Most recent* notification rates per 100,000 population for frequently notified vaccine preventable diseases, by country of residence

Disease	Australia	New Zealand[187]	USA[113]	Canada[188]	England/ Wales[189]
Hib disease	0.2	0.2	0.6	0.1	0.5
Measles	0.2	1.8	<0.05	0.7	6.1 (0.6)†
Mumps	0.4	1.3	0.1	0.3	3.8 (0.9)‡
Pertussis	28.3	24.3	3.5	16.1	1.7
Rubella	1.3	0.8	<0.05	0.1	3.2 (0.1)§

* Australia 2002; New Zealand 2004; USA 2002; Canada 2000; England/Wales 2002.

† Incidence corrected for proportion serologically confirmed = 10%.

‡ Incidence corrected for proportion serologically confirmed = 25%.

§ Incidence corrected for proportion serologically confirmed = 4%.

toring of the impact of these vaccination programs critical. Although enhanced laboratory surveillance is in place for meningococcal and pneumococcal disease, additional mechanisms at minimum increased sentinel surveillance sites for both varicella and zoster will be needed should varicella vaccination increase above the present low rate. The United Kingdom experience with Hib disease resurgence highlights the importance of investing in high quality surveillance in the long term.

Future vaccination priorities

Table 24 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 vaccine preventable diseases, the notification and hospitalisation rates are highest in children under five years of age. 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.[14,175,190,191] For other vaccine preventable diseases 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 years for measles and mumps and in young adults 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. Australia has so far not invested significantly in vaccination programs in older adolescents and young adults, other than the relatively passive approach adopted for the promotion of MMR vaccine to 18–30 year olds. However, school-based delivery of conjugate meningococcal C vaccine is now in place nationally, so the potential for ongoing programs has been established. Delivery of vaccines such as MMR to the 18–30 year old age group is difficult to implement and it is likely that this age group will represent an ongoing challenge for measles, mumps and rubella control over the next five years. Approaches to adolescent pertussis must have the twin focus of morbidity in adolescents themselves and projected impact on disease transmission to infants. The 2003 addition to the ASVS of dTpa for adolescents in Australia has the potential to provide an international lead in pertussis control, as long as high coverage can be achieved. 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. In the near future it is likely that vaccines against diseases such as human papillomavirus and rotavirus will become available. 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.