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IMMUNISATION: A PUBLIC HEALTH SUCCESS

GUEST EDITORIAL

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Since the introduction of childhood vaccination for diphtheria in 1932—and the widespread use of vaccines to prevent tetanus, pertussis (whooping cough), and poliomyelitis in the 1950s, and measles, mumps and rubella in the 1960s—deaths in Australia from these vaccine preventable diseases (VPDs) have declined by more than 99 per cent, despite the Australian population increasing 2.8-fold. This striking reduction in deaths, and in the incidence of these diseases, has been closely associated with the introduction of specific vaccination programs (Table 1, Figure 1).[1] In fact, over this time vaccinations for diphtheria, pertussis, and tetanus have saved a total of at least 70,000 Australian lives and prevented untold morbidity. Poliomyelitis and measles vaccinations have prevented a further 8,000 deaths.

Recently, additional infections have become preventable by vaccination; for example, *Haemophilus influenzae* type b disease (Hib), hepatitis B, varicella, invasive pneumococcal disease and meningococcal disease. Hib causes meningitis, pneumonia and other life-threatening conditions. The introduction of Hib vaccine in 1993 was followed by an immediate fall in the incidence of the disease (Figure 2), and it is estimated that between 1993 and 2000 more than 100 deaths have been prevented in children under the age of five years.[1]

In contrast to those diseases for which there are specific therapeutic agents—such as antibiotics, antivirals, or antihypertensives—many VPDs, especially those caused by viruses (for example: poliomyelitis, measles, mumps, rubella, and hepatitis A) have no specific drug management. Even where specific therapy is available, the emergence of drug-resistant strains of some organisms (for example, Hib and pneumococcal infection) is a growing problem. Therefore, prevention is especially important.

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TABLE 1

DEATHS FROM DISEASES COMMONLY VACCINATED AGAINST, AUSTRALIA 1926–2000*

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. *N S W Public Health Bull* 1997;8:61–3. Feery B. Impact of immunisation on disease patterns in Australia. *Med J Aust* 1981;2:172–6. 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 panencephalitis.

Indicates decade in which community vaccination started for the disease.

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While many VPDs such as diphtheria, tetanus, and poliomyelitis, are presently controlled by vaccination and are no longer feared by the Australian community, experience overseas has shown that these VPDs can re-emerge if vaccination rates are not maintained. This happened in the newly-independent states of the former Soviet Republic when, between 1990 and 1997, over 150,000 cases of diphtheria occurred and caused more than 5,000 deaths.[2]

So, while Australia continues to control VPDs with high vaccination rates, the threat of outbreaks due to imported cases (for example, of poliomyelitis or measles) remains low. The community must, however, continue to maintain high participation in vaccination programs (currently close to 95 per cent of one-year-old and 90 per cent of two-year-old children are fully immunised),[3] with the aim that some of these diseases will ultimately be eliminated worldwide. This is anticipated for poliomyelitis by 2005 and for measles in the subsequent decade.[4]

In Australia, vaccination coverage has improved significantly over the past five years for all diseases, and is comparable to or better than most developed countries. However, pertussis continues to claim infant lives and its ultimate control will require innovative strategies.

NEW VACCINES

Prevention of diseases such as varicella and pneumococcal infection in childhood requires the routine use of vaccines that are now available in Australia but which are 10 or more times more expensive than the vaccines used for the prevention of the traditional VPDs. The cost-benefit ratio will be less for these vaccines and the institution of community-wide programs will require careful economic analysis and priority setting based on the burden of disease (Table 2).

Over the next 10–20 years, a portfolio of new vaccines will become available to prevent infectious diseases as diverse as neonatal sepsis, peptic ulcer and carcinoma of the uterine cervix.[5] This availability will greatly expand the diseases considered to be vaccine preventable.

IMMUNISATION ADVERSE EVENTS

As the traditional VPDs become less frequent, concerns about the real or perceived side-effects of vaccination appear relatively more important. Most of these concerns are readily addressed from a scientific standpoint, but these facts do not always provide individuals with the reassurance they seek. For this reason, it is essential that Australia uses the safest vaccines available and that all serious vaccine-related adverse events are reported promptly and assessed.

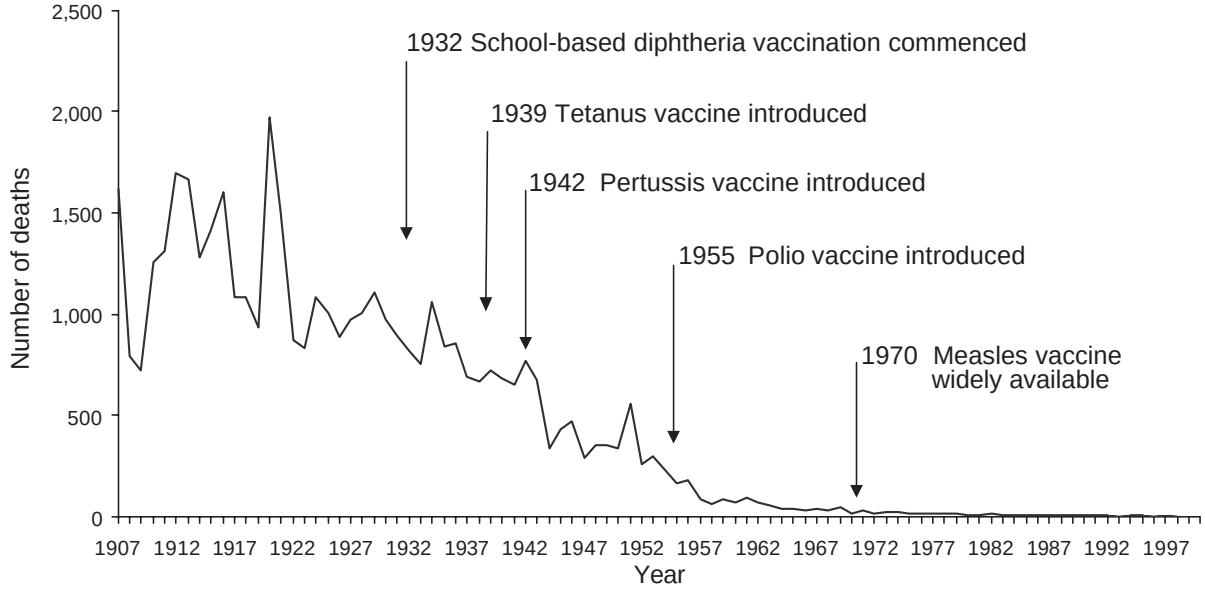
SURVEILLANCE

To evaluate the likely benefits of the introduction of the newer vaccines into routine vaccination programs, it is important to have reliable systems of regional and national surveillance to assess the burden of disease (deaths, disabilities and costs) and the effects of the proposed program. Good surveillance is also required to monitor both the ongoing effects of existing programs and any vaccine-related adverse events.

Surveillance of VPDs is difficult because Australia is a large continent, the population is scattered, and there are jurisdictional differences. Serosurveys can measure population immunity to a range of VPDs with sufficient accuracy to monitor trends in vaccination uptake, evaluate interventions and predict outbreaks. The first Australian national serosurveys have been carried out recently by the National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases (NCIRS) and have proved valuable in monitoring changes in measles and rubella immunity in response to the national Measles Control Campaign.[6] The serosurveys were also useful for assessing the need for vaccination programs for varicella, hepatitis A, and hepatitis B. The

FIGURE 1

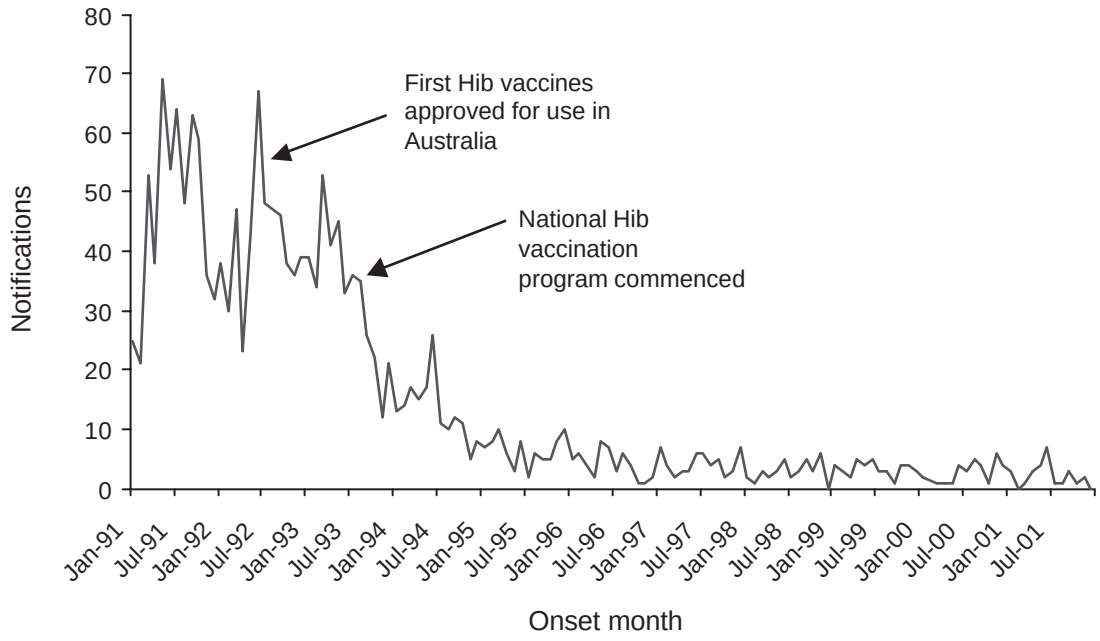
DEATHS FROM LEADING VACCINE PREVENTABLE DISEASES, AUSTRALIA, 1907–2000: INCLUDES MEASLES, PERTUSSIS, DIPHTHERIA, TETANUS AND POLIO



Source: Australian long-term trends in mortality. Canberra: Australian Institute of Health and Welfare; 2002.

FIGURE 2

NOTIFICATIONS OF INVASIVE HIB DISEASE IN AUSTRALIA, 1991–2001



Source: Communicable Diseases Network—Australia New Zealand—National Notifiable Diseases Surveillance System, personal communication.

TABLE 2

AVERAGE ANNUAL MORBIDITY AND MORTALITY FROM VACCINE PREVENTABLE DISEASES IN AUSTRALIA FOR THE TWO YEARS 1998–1999 TO 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		Age				Age	
	0–4 yrs	All ages	0–4 yrs	All ages			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	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.

‡ 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.

Australian Childhood Immunisation Register, established in 1996, is a unique initiative providing a valuable means of measuring vaccination coverage.[7]

RESEARCH

Australia has a strong record in vaccine research. At the present time, basic and clinical research on VPDs and vaccines takes place in a number of academic centres throughout the country, including the Collaborative Research Centre for Vaccine Technology. The establishment in 1997 of the National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases (NCIRS), supported by the Commonwealth Department of Health and Ageing and the NSW Department of Health, has strengthened and helped integrate VPD surveillance, research and evaluation.

THIS ISSUE OF THE *NSW PUBLIC HEALTH BULLETIN*

This and the April issue of the *NSW Public Health Bulletin* highlight some of immunisation's successes and challenges. In this issue, there is a brief account of the history of immunisation in Australia; we see how data from the Australian Childhood Immunisation Register is used to map coverage and conscientious objectors in NSW; how mathematical modelling can be used to predict epidemics; we look at hepatitis B vaccination coverage in pre-adolescents; we describe the work of an immunisation adverse events clinic and summarise the current status of adverse events reporting.

The first use of vaccines in Australia commenced with smallpox in 1804. As you read these two issues of the *Bulletin*, pause a moment to consider how the public health community might view their content 200 years from now.

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TEARS OFTEN SHED

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In seeking a theme for this Oration, I was drawn to a small volume on my bookshelf, given to me by Sir Lorimer Dods, who was the first Professor of Child Health in Australia. The book, entitled *Tears often shed*, was written by Dr Bryan Gandevia and was published in 1978.[1]

The book tells the history of child health in Australia from the first European settlement in 1788, and it emphasises the fact that the health of children very accurately reflects the living conditions of the entire community. As Gandevia writes: 'Children, their health and welfare, their morbidity and mortality, necessarily offer a most sensitive reflection of the social and physical environment in which they find themselves.' In tracing the history of child health in Australia from the time of the first penal settlement at Port Jackson, Gandevia noted the tears that 'were often shed' by parents of infants dying of communicable diseases which are now prevented by vaccination.

Today the Australian community is remarkably free of deaths from measles, diphtheria, tetanus, poliomyelitis and congenital rubella, all of which caused significant morbidity and mortality until 50 years ago. New vaccines are providing a wider spectrum of disease protection than ever before. In contrast, about two million children die each year globally from infections that could be prevented by vaccines that are currently available in the Australian vaccination schedule. However, as the diseases they prevent disappear, vaccines are more and more in the news, sometimes unfairly reported. Vaccine safety is of importance to all. Scientific rigour therefore must always inform the processes leading to the development, approval and introduction of new vaccination programs.

THE COLONIAL ERA

The long voyage from England to Botany Bay was one that, even in the late 1780s, was almost too much to contemplate. Smallpox, cholera and tetanus were common on board the transport ships and, in the colony, sexually transmissible infections were rife. By 1800 there were about 1,000 children in the settlement—almost half that number were orphans. Infant mortality was 11 per cent, 20 times higher than today's rate of 5.2 per 1,000, and 10 per cent of infant deaths were due to syphilis. Pertussis appeared for the first time about 1827, measles and diphtheria a few years later; the mortality from each was very high, especially from diphtheria (estimated to be about 150 per 100,000 population). There was a very large outbreak of measles in Sydney in 1880, by which time children's hospitals had been established in Melbourne, Brisbane, Adelaide and Sydney. However, child mortality remained high and Henry Lawson, a popular poet of the time, poignantly drew attention to this state of affairs:

Our first child took—a cruel week in dyin', …
I've pulled three through and buried two
Since then—and I'm past carin'.

INTRODUCTION OF VACCINES

The first use of vaccines in Australia commenced with smallpox in 1804. It was not until the 1890s that plague and typhoid vaccines and diphtheria antiserum became available.[2]

A major milestone in the early 20th century was the establishment, by the Commonwealth Government, of the Commonwealth Serum Laboratories (CSL) in Melbourne in 1916. CSL rapidly commenced production of vaccines for typhoid, cholera, plague, smallpox and diphtheria antitoxin. In the 1920s childhood vaccination with a combined toxin–antitoxin vaccine resulted in a marked fall in the incidence of diphtheria (Figure 1), but this vaccine was withdrawn following a serious incident due to bacterial contamination of a multidose container of the vaccine in Bundaberg, Queensland.[2] Following the introduction of school-based programs (using diphtheria toxoid vaccine in single-dose vials) which became widespread by the mid-1930s, there was a further marked decline in diphtheria. Infant vaccination for diphtheria was not routine until the early 1940s, and emergency tracheostomy for diphtheria was still commonly seen in children's hospitals through to the early 1950s.