NSW Public Health Bulletin

Volume 14, Numbers 4–5
April–May 2003

NSW HEALTH Working as a Team

ISSN 1034 7674
State Health Publication PH 030019

LESSONS FROM SURVEILLANCE: SOLVING THE PERTUSSIS PUZZLE

GUEST EDITORIAL

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This issue of the *NSW Public Health Bulletin* is the second in a series of two to focus on vaccine-preventable diseases (VPDs). In particular, the theme of this issue is the surveillance of VPDs, including the application of routine surveillance data to VPDs targeted by well established programs (for example, pertussis), enhanced surveillance of diseases more recently targeted by vaccines (for example, pneumococcal disease), and the use of new methods of surveillance in the Australian context (for example, serosurveillance). As pertussis is the most problematic disease for surveillance in NSW and Australia, I will focus this editorial on the problems associated with the interpretation of surveillance data for pertussis, and the insights offered by the articles in this issue for the control of pertussis by vaccines.

SURVEILLANCE DATA FOR PERTUSSIS

There are several factors that must be taken into consideration when interpreting surveillance data for pertussis, which have made the analysis of trends of this disease over the past decade difficult. First, in NSW, in common with all jurisdictions except South Australia, routine notification of pertussis lapsed between the late 1950s and the late 1970s.[1] This lapse followed a dramatic fall in notifications that occurred after a pertussis vaccine first became available in 1942, and with the later introduction of the combined diphtheria–tetanus–whole cell pertussis (DTPw) vaccine in the routine infant vaccine schedule in 1953.[2] Second, although pertussis in adults was recognised in the pre-vaccine era,[3] it was thought to be rare and was poorly diagnosed by physicians. A Sydney study of patients with prolonged cough referred to a respiratory physician in the 1980s played an important role in changing this perception. The study was one of the first to document adult pertussis using serology, which is based on IgA antibody response to a whole-cell pertussis antigen.[4]

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The use of serological testing to confirm the diagnosis of pertussis rapidly increased in NSW in the 1990s following the release of a commercially-produced kit. By 1993, notification by laboratories accounted for more than 70 per cent of all notifications. Third, medical practitioners are notoriously poor notifiers of communicable diseases,[5,6] so the introduction of mandatory notification by laboratories in the *Public Health Act* of 1991, together with the increased use of serology, had a significant impact on the number of pertussis notifications in the 1990s.

There has been concern that these laboratory-notified cases may overestimate the true incidence of pertussis. Reassurance on this point comes from two sources. First, whole-cell pertussis serology has the desirable characteristic, from a surveillance point of view, of high specificity and low sensitivity (although at the clinical level this characteristic adds to uncertainty as a negative test does not rule out a diagnosis of pertussis).[7] Second, a high proportion of notified cases in adults are associated with typical symptoms.[8] So, if we can be confident that the increase in notified cases, especially in older people, represents real or indeed underestimated case numbers, does it constitute a true increase in the incidence of pertussis over time or simply increased testing and reporting?

The pattern of age-specific hospitalisation data analysed by Menzies, Wang, and McIntyre presented in this issue provide probably the best evidence available to date that there has indeed been a real increase in pertussis in NSW that is not accounted for by diagnostic or notification practices. As opposed to notification rates, which showed a general increase, hospitalisation rates increased significantly in only one age group—adults. It is interesting that this increase was demonstrable despite the relatively small proportion of adults with pertussis who are hospitalised. At the other end of the age spectrum, the data presented by Torvaldsen show that the gap between hospitalisation and notification rates in infants is narrowing, consistent with improved reporting; however, there are real differences in both hospitalisation rates and reporting by notifiers between regions of NSW. The highest infant hospitalisation rates were seen in rural health areas, but of note is that all but one rural area recorded static or declining hospitalisations in the most recent epidemic, whereas four metropolitan health areas saw substantial increases. Are there any lessons for the control of pertussis from these data, particularly control by vaccines?

EFFECT OF VACCINES ON PERTUSSIS

The articles by Brotherton and McAnulty, and Menzies, Wang and McIntyre, give useful insights into the effect of vaccines on the presentation of pertussis in two age groups —school-aged children and infants. Important background information to both articles is the fact that Australia has a relatively poorly immunised cohort: those born in the late 1970s to the early 1990s (currently aged between 13 and 25 years).[9] This period was associated with an excessive concern about the side-effects of and contraindications to whole-cell pertussis vaccine, which led to many infants having only one or two doses of DTPw, with subsequent doses given as diphtheria–tetanus vaccine (CDT) only.[10] The tail-end of this cohort, those born after 1990, were eligible for a fifth dose of pertussis-containing vaccine at 4–5 years of age, though uptake is likely to have been sub-optimal until this dose became exclusively acellular vaccine after 1998. Brotherton and McAnulty demonstrate that the fifth dose has had a significant impact on pertussis notifications in the eligible cohort in successive epidemics. However, the largest group of under-immunised persons—those born in the 1980s—continue to have high rates of pertussis notification. A similar cohort effect has also been reported in Canada, but there the affected cohort had high coverage with a sub-optimal vaccine, rather than sub-optimal coverage.[11] In infants, Menzies, Wang, and McIntyre show that a significant fall in pertussis hospitalisations coincided with improved coverage in the first half of the 1990s, but benefit was only evident among age groups eligible for two or more doses of vaccine. This fall commenced while DTPw was still in general use, consistent with estimates of the Australian whole-cell vaccine's effectiveness in NSW in the 1990s using the screening method.[12]

In 2003, the challenge remains of death and hospitalisations among infants too young to receive two doses of diphtheria–tetanus–acellular pertussis (DTPa) vaccine. These cases are largely related to the continued high incidence of pertussis in their adult contacts—in particular, their parents.[13] Current recommendations to reduce this are summarised in the paper by Brotherton and McAnulty. First, implementation of the recommendation to replace the current scheduled dose of adult diphtheria–tetanus (ADT) vaccine at 15–17 years with an adult-formulated acellular pertussis (dTpa) vaccine, would reduce pertussis cases in one part of the under-immunised cohort. Second, wider use of dTpa instead of ADT in adults, especially those in contact with infants, such as new or prospective parents and health care workers, should reduce the exposure of infants to pertussis. In the recently-released NSW guidelines for immunisation of health care workers, dTpa vaccine is recommended unless ADT has been received in the previous five years.[14] Active promotion of dTpa vaccine to new and prospective parents by healthcare workers, including general practitioners, obstetricians, midwives, and infant welfare nurses, could significantly enhance the benefits from awareness of cough exposure for newborns, already provided by the sticker in their personal health record (or 'blue book'), by adding protection from pertussis to awareness of its dangers.

The final articles in this issue of the Bulletin concentrate on other aspects of the surveillance of VPD. McIntyre, Gilmour, and Watson describe the work of the Metropolitan NSW Pneumococcal Study Group in using enhanced surveillance to describe the age-specific incidence, serotype distribution, and antimicrobial resistance

patterns of invasive pneumococcal disease. Gidding describes population serosurveillance and Australia's national serosurveillance program, in particular, how it is used to estimate levels of immunity to vaccine-preventable diseases. The issue concludes with two short reports of recent publications by the National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases (NCIRS), *Vaccine-Preventable Diseases and Vaccination Coverage in Australia, 1999–2000* and *Immunisation Coverage: Australia 2001*.

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HAS PERTUSSIS INCREASED IN NSW OVER THE PAST DECADE? AN EVALUATION USING HOSPITALISATION AND MORTALITY DATA VERSUS NOTIFICATIONS 1988–2002

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Pertussis, or whooping cough, notifications, and deaths declined dramatically after the introduction of mass vaccination in the 1950s, to the extent that many states stopped collecting notifications.[1] However, since 1990, notification rates have increased noticeably from the record low levels seen in the 1970s and 1980s in all Australian states and territories, including NSW.[1] A number of factors, other than a true increase in the underlying incidence of pertussis, may account for this.[2,3] These factors include: improved surveillance, the introduction of direct notification of cases by laboratories, and the introduction of additional means of laboratory diagnosis such as serology and nucleic acid testing.[2] In contrast to notifications, criteria for coding hospital separations or deaths due to pertussis are less likely to have been influenced by these changes,[3–7] thus providing a data source that is more consistent over time to evaluate for evidence of a resurgence in pertussis. This article compares age-specific hospital separations, notifications, and deaths due to pertussis in NSW, prior to and including the period of changes to the notification procedure that followed introduction of the *NSW Public Health Act 1991*.

METHODS

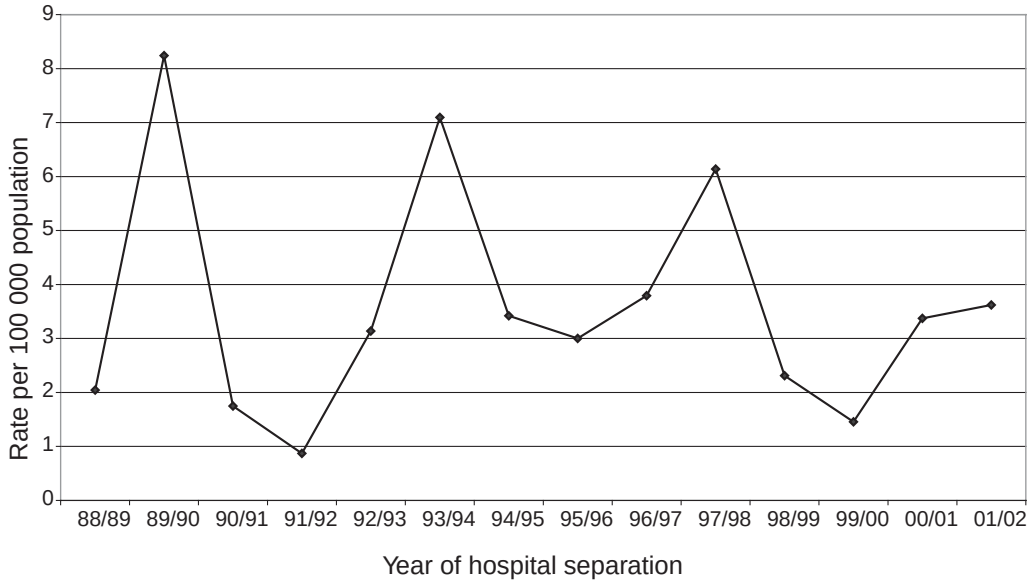
Data sources

NSW hospital separations with a primary diagnosis code of pertussis (ICD-9, 033; ICD–10, A37) were available from 1988–1989 to 2000–2001 from the NSW Inpatients Statistics Collection (ISC) through the Health Outcomes Information Statistical Toolkit (HOIST), and the yearly total for 2001–2002 from the NSW Health Information Exchange. Notifications were available from 1992– 2002 from the Notifiable Disease Database, via HOIST.

Deaths reported with a principal or underlying cause of pertussis (ICD-7, 056; ICD-8, 033; ICD-9, 033; ICD-10, A37) were obtained from the Australian Bureau of Statistics via HOIST. Death data were available from 1964–2000. Deaths that occurred in 2001 were ascertained by a

FIGURE 1

HOSPITAL SEPARATION RATES FOR PERTUSSIS, NSW, FOR FINANCIAL YEARS 1988–89 TO 2001–02



Sources: NSW Inpatients Statistics Collection and ABS population estimates (HOIST), Centre for Epidemiology and Research, and the NSW Health Information Exchange, NSW Department of Health.

request to public health units via the Communicable Diseases Network, Australia. Pertussis notifications were available from 1992 to 2002 from the Notifiable Disease Database via HOIST.

Immunisation coverage estimates for NSW from 1989 to 1995 were available from several published sources.[8–10] From 1997 to 2002, coverage for NSW was calculated from Australian Childhood Immunisation Register (ACIR) data, maintained by the Health Insurance Commission and published annually in *Communicable Disease Intelligence*. Coverage was calculated for three-month cohorts of children aged 12 months. Coverage was adjusted upwards by 2.7 per cent to correct for under-reporting, using estimates from a recent study.[11]

Statistical methods

For analysis by age, records were grouped according to critical ages for expected acquisition of vaccine-induced immunity. These ages corresponded to the time of scheduled vaccine doses for diphtheria-tetanus-pertussis (DTP) vaccine: 0–2 months (0–1 dose); 3–4 months (1–2 doses); 5–6 months (2–3 doses); 7–11 months (3 doses); 1–4 years (3–5 doses); 5–9 years (1–5 years after last dose); 10–14 years (5–9 years after last dose) and 15 years and over (10 or more years after last dose). Notification and hospitalisation rates were calculated using ABS mid-year estimated residential populations as rates per 100,000.

Linear regression was used to test for the significance of trends over time and to estimate their magnitude. Models included the monthly notification or separation rate per 100,000 population as the dependent variable, and the month of onset or separation as the independent variable. Given that epidemics occur in cycles every three to four years, the likelihood of detecting trends over time is influenced by the stages of the cycle in the first and last years included in the analysis. Notifications from 1992–1993 were excluded from this analysis, so that the period included in the model would begin and end at the same stage of the epidemic cycle, including three epidemic periods (1993–1994, 1997–1998, and 2000–2001). Analysis was carried out in SAS 8.2.[12]

RESULTS

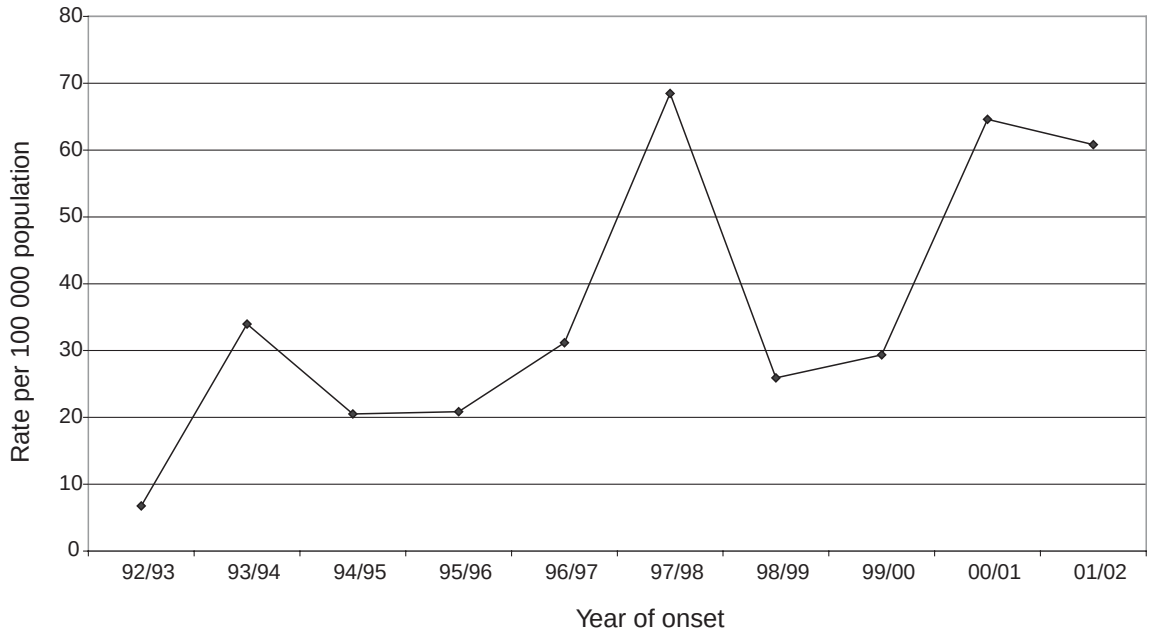
Descriptive analysis

Overall hospital separation and notification rates

Figure 1 shows the separation rate per 100,000 total population and Figure 2 shows the annual notification rates per 100,000 population (using different scales). Separation data are shown for all available consecutive years (from 1988–1989 to 2000–2001). Notification data are shown only from 1992, as this was the first complete year of mandatory laboratory notification. Separation data cover four epidemic periods (1989–1990, 1993–1994, 1997–1998, and 2000–2001), while notification data include only the last three periods. Notification and hospitalisation rates reach epidemic peaks at similar times. However, the height of successive epidemic peaks for separations became progressively lower with each epidemic, while the peak notification rate progressively increased.

FIGURE 2

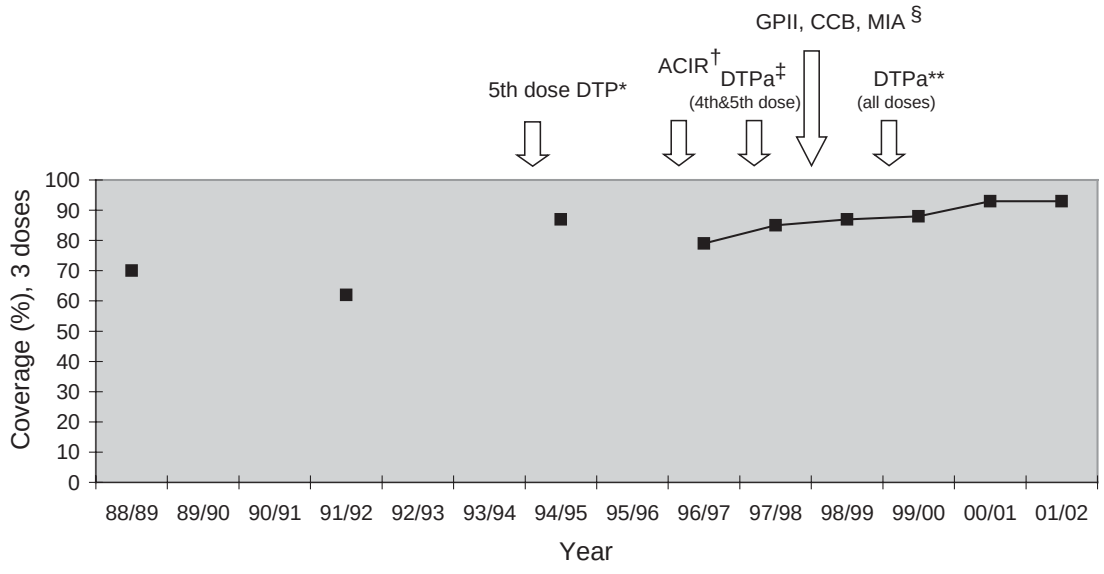
NOTIFICATION RATES FOR PERTUSSIS, NSW, FOR THE FINANCIAL YEARS 1992–93 TO 2001–02



Sources: Communicable Diseases Branch, NSW Notifiable Disease Database and ABS population estimates (HOIST), Centre for Epidemiology and Research, NSW Department of Health.

FIGURE 3

INITIATIVES IN VACCINATION, AND DIPHTHERIA-TETANUS-PERTUSSIS (DTP) VACCINATION COVERAGE, NSW, 1988–2001



* 5th dose of DTP introduced into standard vaccination schedule

† Introduction of Australian Childhood Immunisation Register (ACIR)

‡ DTP with acellular pertussis component approved for use in 4th and 5th doses

§ Introduction of General Practice Immunisation Incentive, Child Care Benefit and Maternity Immunisation Allowance

**DTP with acellular pertussis component approved for use in all doses

Sources: References 8–10, ACIR.

Vaccine coverage

Coverage estimates for diphtheria–tetanus–pertussis (DTP) vaccine are displayed in Figure 3. The first data point shown, for 1988–1989, is derived from the 1989–1990 ABS survey, which estimated that 70 per cent of NSW children aged 0–6 years were fully immunised for pertussis.[8] The second data point shown, for 1991–1992, is derived from a 1992 cross-sectional survey of NSW residents. This household survey, primarily designed to validate child health records, found an even lower estimated coverage of 62 per cent for the primary course of three doses in children aged 7–24 months.[9] By the time of the 1995 ABS survey, shown as the third data point, 87 per cent of NSW children aged one year were estimated to be fully immunised for DTP.[10] Coverage data from the ACIR for DTP for children aged 12–24 months were significantly under-reported in the early period of operation of the ACIR,[11] such that initial reported coverage of 77 per cent was lower (almost certainly falsely lower) than the 1995 ABS estimates. Overall, coverage for three doses of pertussis vaccine, according to the ACIR, and adjusted for under-reporting, increased from 79 per cent in 1997 to 94 per cent in 2001.

Figure 3 also shows the timing of various key initiatives to improve immunisation coverage and vaccine-acquired immunity to pertussis in particular. These key initiatives include the introduction of a fifth dose at 4–5 years in 1994, the change to acellular vaccines for booster doses in early 1998, and for all doses by mid 1999.

Age-specific hospital separation and notification rates

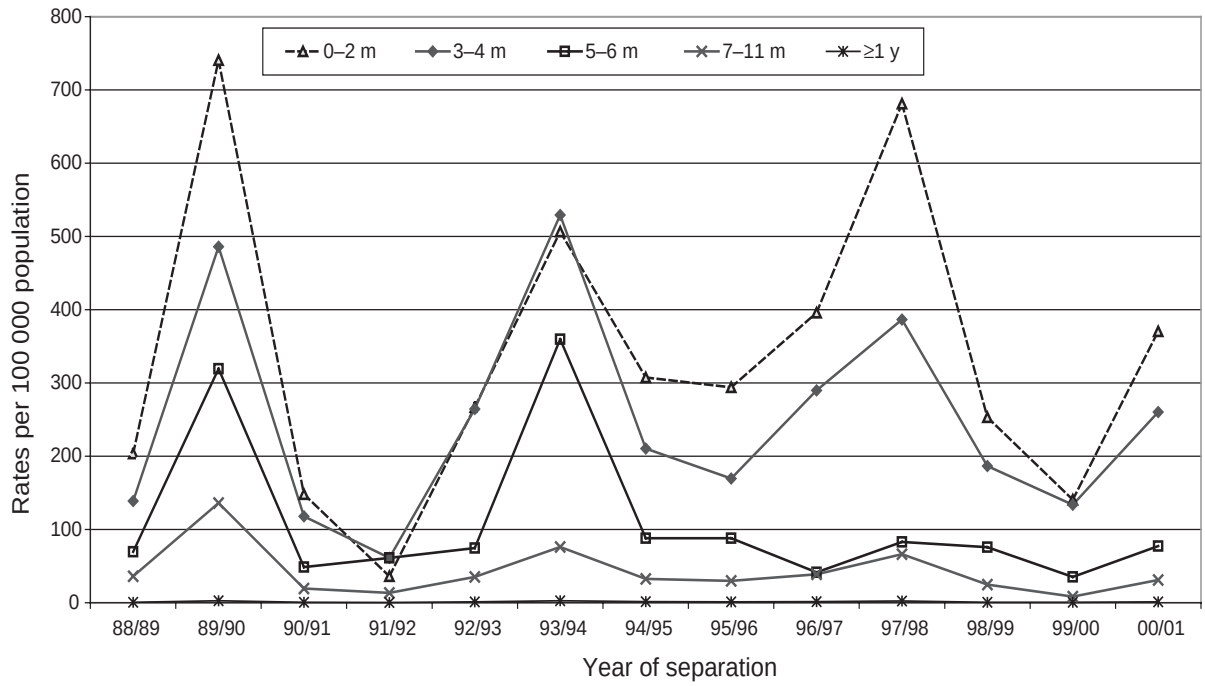
In Figure 4, separation rates are shown divided into four age groups to show the trends over time in those under one year of age. The most striking change in Figure 4 is the downward trend in separation rates among infants aged 5–6 months. This trend is progressively evident from 1994–1995 when it coincides with improved vaccine coverage in infancy,[10] subsequently remaining constant with the introduction of acellular vaccines, shown in Figure 3. There is a less marked but perceptible fall in separation rates among 7–11-month-old infants. In contrast, no change is seen in separation rates for infants 0–2 months of age, while a minor decrease is seen in those aged 3–4 months.

Deaths

Recorded deaths from pertussis are shown in Table 1. In the first time period (1964–1973), 47 per cent of pertussis deaths were recorded in those aged five months or older. In contrast, between 1974 and 2001, a much lower proportion (nine per cent) was aged five months or more (Table 1). There have been no deaths reported in the age group five months or older since 1984.

FIGURE 4

PERTUSSIS HOSPITAL SEPARATIONS BY AGE GROUP, NSW, FOR FINANCIAL YEARS 1988–89 TO 2000–01



Source: NSW Inpatients Statistics Collection and ABS population estimates (HOIST), Centre for Epidemiology and Research, NSW Department of Health.

Linear regression modelling

The analysis of trends in monthly pertussis separation and notification rates by age-group, using linear regression modelling, is summarised in Table 2. For all ages combined, modelling detected no statistically significant increasing or decreasing trend in monthly separation rates over the three years from July 1988 to June 2001. In contrast, notification rates increased significantly. The rate of increase in monthly notification rates in Table 2 corresponds to a total increase of 170 per cent between July 1994 and June 2002, which is in keeping with the trends shown in Figure 2.

When analysed by smaller age groups, there was no significant increase or decrease in separation rates for those infants aged between 0–4 months, although there was an increase in notification rates for 0–2-month-old infants, which was almost significant at the $P<0.05$ level. In contrast, there was a significant decrease in separation rates in the four age groups (5–6 months, 7–11 months, 1–4 years, and 5–9 years) between five months and nine years, but no significant decrease in notifications in those age groups. In the 10–14 year age group, despite a large and highly significant increase in notifications, there was no increase in separation rates. In contrast to the 10–14 year age group, a significant increase was detected among those aged over 15 years for both separations and notifications.

TABLE 1

DEATHS DUE TO PERTUSSIS, NSW, 1964–2001

Period (years)	Age of patient (months)		Total no. of deaths
	0–4	≥5	
1964–73	10	9	19
1974–83	2	1	3
1984–93	3	0	3
1994–01	5	0	5
Total	**20**	**10**	**30**

Sources: ABS mortality data (HOIST), Centre for Epidemiology and Research; and the public health units (via the Communicable Diseases Network, Australia).

DISCUSSION

Hospitalisation and notification data give very different pictures of pertussis epidemiology,[3] as the former is heavily weighted towards infants under the age of 12 months and cases of severe disease.[4,7] Overall, the hospitalisation rate in NSW did not increase over the past 13 years, while the notification rate increased substantially after 1992. When examined by age, those age groups with the highest levels of coverage (five months to nine years) showed a decreased rate of hospitalisation during that

TABLE 2

CHANGES IN MONTHLY SEPARATION RATES PER 100,000 POPULATION BETWEEN JULY 1988 AND JUNE 2001, AND IN NOTIFICATION RATES BETWEEN JULY 1993 AND JUNE 2002; RESULTS OF LINEAR REGRESSION MODELLING, NSW

Age	Separations			Notifications		
months or years	Adjusted initial monthly frequency*		Change in monthly rate, July 1988–June 2001†	Adjusted initial monthly frequency*		Change in monthly rate, July 1993–June 2002†
	N	Rate		*N*	Rate	
0–2 m	5.9	27.4	0.007	3.5	15.7	0.106‡
3–4 m	3.1	21.5	-0.010	1.7	11.5	0.039
5–6 m	2.0	13.9	-0.062§	1.4	9.5	-0.030
7–11 m	1.9	5.2	-0.021§	2.7	7.3	-0.015
1–4 yr	3.4	1.0	-0.003II	15.7	4.5	-0.011
5–9 yr	3.5	0.85	-0.005¶	37.9	8.9	-0.033**
10–14 yr	0.88	0.21	< 0.0001	8.8	2.1	0.143¶
15+ yr	0.11	0.003	0.0003¶	24.7	0.5	0.025¶
Total	**19.5**	**0.34**	**-0.0005**	**91.1**	**1.5**	**0.027¶**

* Linear regression model intercept. Rates equal number per month per 100, 000 population

† Linear regression model slope. P>0.1 unless otherwise stated.

‡ $P = 0.06$ § $P = 0.01$ II $P = 0.03$ ¶ $P < 0.0001$ ** $P = 0.09$

Sources: NSW Inpatients Statistics Collection and ABS population estimates (HOIST), Centre for Epidemiology and Research; the NSW Health Information Exchange; and the Notifiable Disease Database, NSW Department of Health.

period, in contrast to notifications, where there was no significant decrease in any age group. However, in adults (over the age of 15 years) both hospitalisation and notification data showed significant increases, suggesting that the observed increase in notifications in this age group reflected a real increase in underlying incidence and not simply increased detection from diagnostic testing.[2]

During the mid-to-late 1990s, a series of immunisation initiatives were introduced in Australia, which were intended to decrease the incidence of, and morbidity from, pertussis and other vaccine-preventable diseases (Figure 3).[1,11] In 1994, a fifth dose of DTP at 4–5 years of age was introduced into the recommended schedule. This extra dose was intended to reduce pertussis transmission in school-aged children. In 1997, DTP with an acellular pertussis component (DTPa) was recommended for the fourth and fifth doses. The aim was to increase the acceptability of the vaccine to parents by reducing its reactogenicity, thus leading to improved coverage. In 1999, DTPa was made available for all scheduled doses.[1] In addition, from 1998, three new initiatives, the General Practice Immunisation Incentive, and linkage of full immunisation to the Maternity Immunisation Allowance and the Child Care Benefit, were introduced with the aim of improving coverage for all vaccines. Linkage to the receipt of the Maternity Immunisation Allowance and the Child Care Benefit has been shown to have a positive impact on parents' decisions to immunise their children.[11]

Although the available data on vaccination coverage used in this article came from various sources using different methodology and measures, they still provide evidence of a considerable increase in coverage as a consequence of those initiatives.

There has been relatively little change in methods of treatment or management of pertussis over the past 15 years that is likely to affect the number of recorded separations.[3,7] It is likely that the reduction in hospitalisation rates seen in those aged five months to nine years is related to improvements in vaccination coverage. In contrast, the substantial and increasing proportion of pertussis notifications in children over nine years of age is likely to relate to the increasing availability of serological diagnosis. This increase, together with mandatory laboratory reporting of notifiable diseases, may explain changes in notifications among this age group. However, the proportion of pertussis separations that were aged 15 or more years also increased, from two per cent in 1988–1989 to 12 per cent in 2000–2001. Separations coded as pertussis represent more serious cases, where there is likely to be greater clinical evidence of pertussis. This increase is thus likely to be less biased by improvements in diagnosis, suggesting a real increase in incidence in adults. In contrast, among those too young to have received more than two doses of pertussis vaccine (less than five months of age) there was no evidence of change in either notifications, hospitalisations, or deaths over the period 1988–1989 to 2001–2002.

CONCLUSION

This analysis of hospitalisation and death data provides a more complete view of the evolving epidemiology of pertussis in NSW. There is evidence that improvements in immunisation coverage and changes to the immunisation schedule over the past five to seven years have had an effect on serious pertussis morbidity in the age groups with the highest immunisation coverage. In contrast, no significant reduction in the incidence of hospitalisation was found among babies too young to have received three doses of pertussis vaccine. This finding and the evidence of increased hospitalisation among adults suggest that adults are acting as a reservoir for disease transmission to infants. Further measures to control pertussis will need to focus both on reducing the burden of disease in adolescents and adults and on protecting infants too young to be immunised by current regimens.

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A PERTUSSIS EPIDEMIC IN NSW: HOW EPIDEMIOLOGY REFLECTS VACCINATION POLICY

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Pertussis has traditionally been considered a disease of young children. In Australia, combined diphtheria–tetanus–acellular pertussis (DTPa) vaccine is currently included in the childhood immunisation schedule at ages 2, 4, 6, and 18 months and, since 1994, before school entry at 4–5 years of age.[1] Prior to 1999, a formulation that included whole cell pertussis vaccine was used. In NSW, periodic epidemics of pertussis have occurred every 3–4 years, most recently in 1993–1994, 1997–1998 and now in 2000–2002. A seasonal pattern is clearly evident with peak notification rates occurring in spring every year. Even during the inter-epidemic period of 1999 however, pertussis was still common, with around 115 reported cases per month. The most recent epidemic began in May 2000 when over 200 cases were reported. In this article, we examine the distribution of, and shifts in, ages of pertussis cases notified in the three most recent NSW epidemics, in order to understand the observed age distribution of the 2000–2002 epidemic (when there were relatively few cases in children under five years of age and many cases in young adolescents). The implications for vaccination policy are also reviewed.

METHODS

By law in NSW, cases of pertussis are notified by doctors, hospitals and laboratories, and by schools and childcare facilities. Public health unit staff routinely follow up notifications of pertussis in order to limit the spread of disease by facilitating timely management of cases and contacts, including education, contact tracing and provision of antibiotic prophylaxis to contacts.

For surveillance, pertussis cases are defined as a person with a coughing illness lasting more than 14 days with:

- either paroxysms of cough, inspiratory 'whoop', or post-tussive vomiting without other apparent cause; or
- a positive *Bordetella pertussis*-specific IgA; or
- an epidemiological link to a laboratory-confirmed case; or
- a clinical specimen that isolates *Bordetella pertussis* or is identified by polymerase chain reaction (PCR) in a laboratory experienced in the technique.

We reviewed surveillance data from the NSW Notifiable Diseases Database for the period 1991 to 2002 and identified three epidemic periods when case notification rates appeared to rise above expected levels: May 2000 to April 2002 (24 months), May 1997 to April 1998 (12 months), and May 1993 to April 1994 (12 months). We analysed pertussis notifications by date of onset for these periods at 15 January 2003. Annual rates were calculated using mid-year population estimates from the Australian Bureau of Statistics.

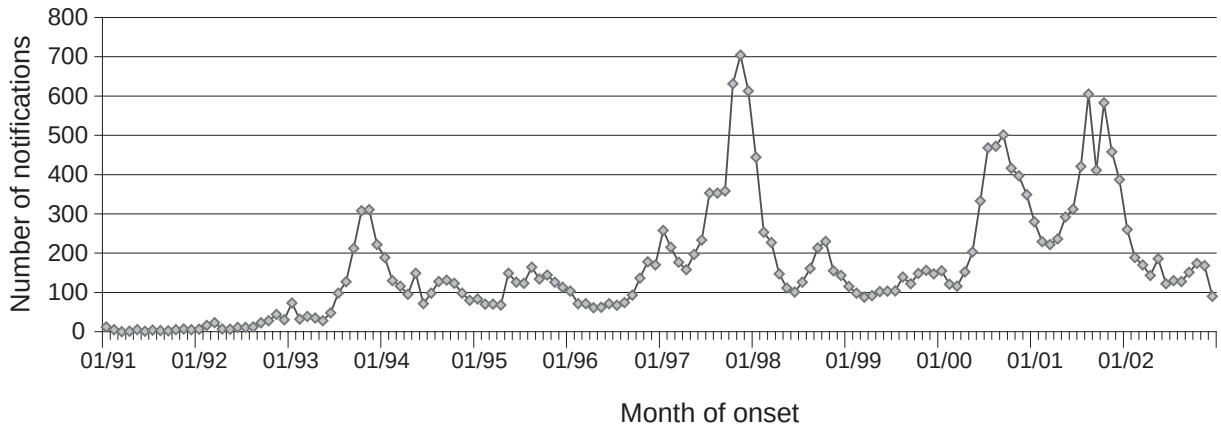
RESULTS

2000–2002 epidemic

Between 1 May 2000 and 30 April 2002, there were 8,337 notified cases (by onset date) of pertussis (63.8 per 100,000 persons per year) (Figure 1). This number compares with 1,565 notifications (24.4 per 100,000) for the preceding

FIGURE 1

NUMBER OF PERTUSSIS NOTIFICATIONS BY MONTH OF ONSET, NSW, 1991–2003



Source: Communicable Diseases Branch, NSW Notifiable Disease Database and ABS population estimates (HOIST), Centre for Epidemiology and Research, NSW Department of Health.

12 months. There was a slight predominance of female notifications (55.5 per cent). Most notifications were laboratory confirmed (74 per cent) with serology the predominant method (84 per cent).

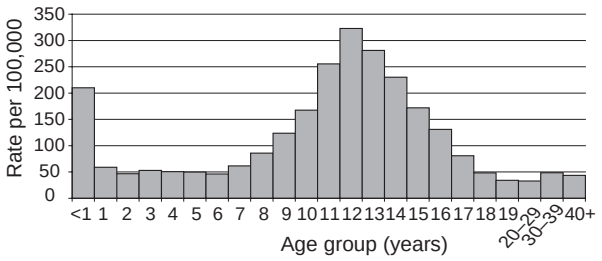
Over one quarter (27 per cent) of notifications (*N* = 2223) were in the 10 to 14-year-old age group, with a notification rate of 248.6 per 100,000 per year (Figures 2 and 3). Only eight per cent of notifications were in children 0–4 years of age, eight per cent were in children 5–9 years of age, 10 per cent were in adolescents 15–19 years of age, and the remaining 47 per cent occurred in adults 20 years and over [the overall adult rate was 41.3 per 100,000 per year, peaking by five-year age group in those adults aged 40–44 years (rate 65.3 per 100,000)]. The pertussis notification rate in older adults for those aged 50 years and over was 32.3 per 100,000 per year.

Crude incidence rates fluctuated widely between geographical areas and year of the epidemic (between 8.2 per 100,000 in the remote far west of the state in 2000–2001 and 190.8 per 100,000 in the mixed urban and rural Hunter region in 2000–2001 where the rate subsequently halved in 2001–2002). Over the two-year epidemic period, the highest average incidence rate was reported in the Macquarie Area with 157.5 notifications per 100,000 per year. All areas reported highest rates in 10–14 year olds, ranging from 85.4 per 100,000 per year in the Far West to 608.2 per 100,000 per year in the Macquarie Area. Within this age group, most notifications were in the 11 and 12-year-old age group in year one of the epidemic and in 12 and 13-year-old age group in year two.

There were 345 notified cases in children aged 12 months or younger (210.0 per 100,000), with just over half of

FIGURE 2

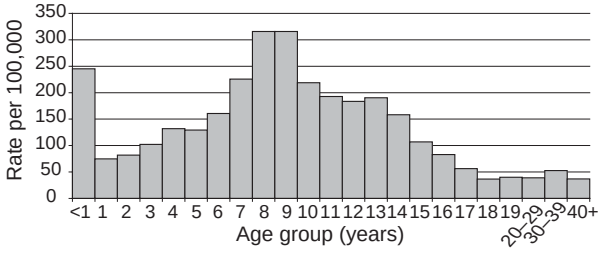
PERTUSSIS NOTIFICATION RATES BY AGE GROUP, NSW. 2000–2002 EPIDEMIC (DATE OF ONSET 1 MAY 2000 TO 30 APRIL 2002)



Source: Notifiable Diseases Database (HOIST).

FIGURE 4

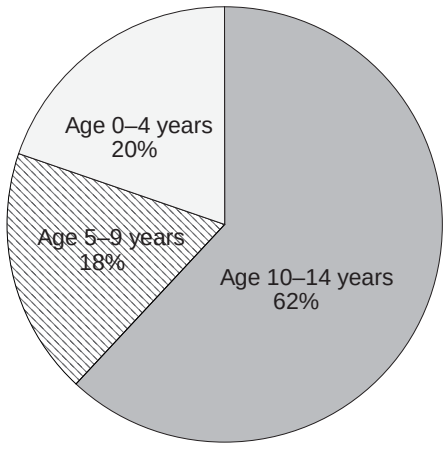
PERTUSSIS NOTIFICATION RATES BY AGE GROUP, NSW. 1997–1998 EPIDEMIC (DATE OF ONSET 1 MAY 1997 TO 30 APRIL 1998)



Source: Notifiable Diseases Database (HOIST).

FIGURE 3

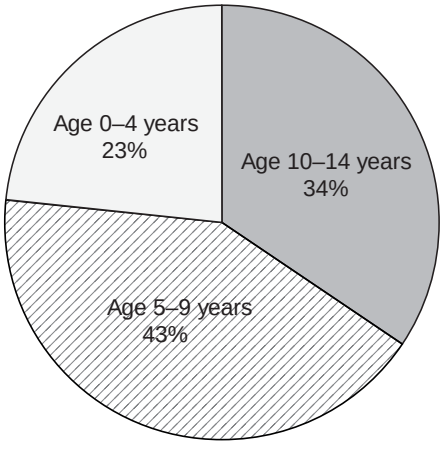
PERCENTAGE OF PERTUSSIS NOTIFICATIONS IN THOSE UNDER 15 YEARS OF AGE (*N* = 3548) BY FIVE-YEAR AGE GROUP, NSW. 2000–2002 EPIDEMIC (DATE OF ONSET 1 MAY 2000 TO 30 APRIL 2002)



Source: Notifiable Diseases Database (HOIST).

FIGURE 5

PERCENTAGE OF PERTUSSIS NOTIFICATIONS IN THOSE UNDER 15 YEARS OF AGE (*N* = 2389) BY FIVE-YEAR AGE GROUP, NSW. 1997–1998 EPIDEMIC (DATE OF ONSET 1 MAY 1997 TO 30 APRIL 1998)



Source: Notifiable Diseases Database (HOIST).

these (51.3 per cent) in those aged three months or younger. At least 107 infants were hospitalised. There was one reported death in a 10-week old infant.[2] Box 1 outlines the additional measures taken in response to the epidemic.

BOX 1

ADDITIONAL PUBLIC HEALTH ACTIONS IMPLEMENTED IN 2000–2002 EPIDEMIC

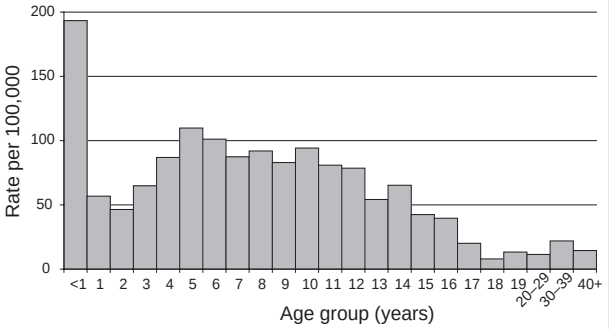
With increasing notifications of pertussis, the NSW Department of Health convened an expert committee to develop guidelines for doctors and to coordinate a response strategy. After reviewing current evidence,[3] the committee revised recommendations to reduce the duration of erythromycin treatment and prophylaxis for contacts from 10 to seven days. The shorter duration of treatment was a result of the concern that cost and side-effects of a prolonged course was undermining adherence to its use.

In September 2000, the NSW Department of Health sent all doctors, emergency departments, and school principals in NSW a letter advising of the epidemic and provided a fact sheet for distribution to patients and parents. Doctors were also sent guidelines regarding the diagnosis and management of pertussis. Public health units were emailed monthly pertussis updates that reviewed the latest notification data. Public health units developed local communication and information strategies in addition to the statewide activities.

To prevent cases in young infants, fact sheets were distributed to maternity hospitals, and a sticker was designed to be placed upon the cover of the personal health record (or 'blue book') that every newborn baby in NSW receives. This bright yellow sticker (Watch out, whooping cough is about!) warned parents to keep their babies away from anyone with a cough and to have their babies immunised on time.

FIGURE 6

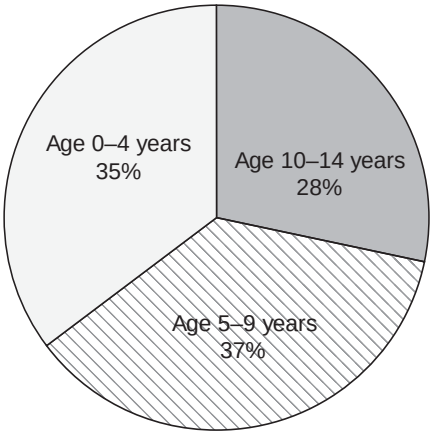
PERTUSSIS NOTIFICATION RATES BY AGE GROUP, NSW. 1993–1994 EPIDEMIC (DATE OF ONSET 1 MAY 1993 TO 30 APRIL 1994)



Source: Notifiable Diseases Database and ABS population estimates (HOIST).

FIGURE 7

PERCENTAGE OF PERTUSSIS NOTIFICATIONS IN THOSE UNDER 15 YEARS OF AGE (*N* = 1115) BY FIVE-YEAR AGE GROUP, NSW. 1993–1994 EPIDEMIC (DATE OF ONSET 1 MAY 1993 TO 30 APRIL 1994)



Source: Notifiable Diseases Database (HOIST).

1997–1998 epidemic

Between 1 May 1997 and 30 April 1998, 4,513 cases were notified (71.9 per 100,000). Of these notifications, 77 per cent were laboratory confirmed with serology the most commonly documented laboratory test (94 per cent). Highest notification rates were in five to nine-year-old children (228.8 per 100,000; 22 per cent of notifications) and most notifications in this group were in eight and nine-year-old children. Adolescents aged 10–14 years were the next most commonly affected (188.6 per 100,000; 18 per cent). Those children under five years of age comprised 12 per cent of notifications and young infants under 12-months of age were notified at a rate of 245.1 per 100,000 (Figures 4 and 5). Two infants died during the epidemic, and four infants had died in the lead up to the epidemic between October 1996 and May 1997.

1993–1994 epidemic

A smaller epidemic occurred between 1 May 1993 and 30 April 1994 when there were 1,884 notifications of pertussis (31.4 per 100,000). Seventy-seven per cent of notifications were confirmed by laboratory testing, with serology the most commonly documented laboratory test (90 per cent). Almost half of the notifications were in children under 10 years (42 per cent) (Figures 6 and 7). By five-year age group, the highest rates were in 5–9-year-old children (94.7 per 100,000) followed by the group under five years (89.8 per 100,000). Adolescents 10–14 were notified at a rate of 74.9 per 100,000 (17 per cent of

notifications). Infants under 12 months of age were notified at a rate of 193.4 per 100,000. No infant deaths were notified.

DISCUSSION

We found that the age of notified pertussis cases increased over time in NSW. When comparing pertussis rates with other countries, it must be noted that in NSW, serology (combined with an appropriate clinical history) is the main method resulting in notification of a case. Pertussis IgA serology is quite specific for disease (93–98 per cent).[4] Rates may appear high compared with countries that do not accept serology-based notifications. However, we believe there remains a substantial under-reporting of pertussis in the community. It is worth noting that the proportion of notifications that were laboratory confirmed, in particular by serology, did not increase between epidemics.

Periodic epidemics of pertussis, on a background of endemic disease, continue to occur despite high rates of vaccination for pertussis in children. In June 2001, reported uptake in NSW of the first three doses of pertussis vaccine was approximately 91 per cent, and for the 18-month-dose was 88 per cent.[5] As of 31 December 2002, reported uptake has increased slightly to 93 per cent for the primary series and 91 per cent for the 18 month dose.[6] The effectiveness of three or more doses of pertussis whole-cell vaccine in NSW children has been estimated as 91 per cent in children under two years of age, 85 per cent in children aged 2–4 years and 87 per cent in those aged 5–8 years.[7] While infants are comprising a smaller percentage of total notifications in each epidemic (those under five years of age made up 21 per cent in 1993–1994, 12 per cent in 1997–1998 , and eight per cent in 2000–2001), notification rates in young infants (one year of age and under) have not fallen substantially.

Our data suggest that waning immunity has resulted in a cohort of individuals susceptible to pertussis. It is the same cohort of children in 1997 and 2000–2002 that was maximally affected (that is, children who were born before 1990 and aged 8– 9 years in 1997). This cohort of children was the last cohort not to have received a booster dose of pertussis vaccine at age four years. This booster dose was added to the routine childhood immunisation schedule in 1994. It is now over 10 years since this cohort received their last immunisation, routinely scheduled for 18 months of age. It is likely that immunisation uptake of the primary course and the 18-month dose was also suboptimal: the 1989–1990 National Health Survey found that in NSW only 70.2 per cent of children aged 0–6 years were fully immunised against pertussis.[8]

Unlike the existing pertussis vaccine, which is recommended for use only in children aged eight years and under, the newly available adult pertussis vaccine is suitable for use in young adolescents, such as the cohort maximally affected in the NSW epidemic.

BOX 2

DRAFT NATIONAL RECOMMENDATIONS FOR IMMUNISATION AGAINST PERTUSSIS

(proposed in the draft eighth edition of the *Australian Immunisation Handbook*)[9]

- cease the 18-month dose, given the prolonged immunity resulting from a primary course of DTPa, with the fourth dose now due at four years of age; replace the existing recommendation for ADT at age 15–17 years with adult acellular pertussis (combined with tetanus and diphtheria antigens) vaccine (dTPa);
- recommend a booster dose before planning pregnancy, or for both parents as soon as possible after delivery of an infant;
- recommend a booster dose for adults working with young children, especially health care workers and child-care workers in contact with young infants;
- encourage receipt of a booster dose in any adult expressing an interest;
- subsequent boosters are not recommended.

The proposed strategy for reducing infant exposure to pertussis recognises that targeting new parents, health care workers, and child-care workers for immunisation may be more effective than a more general approach (see Box 2). In the absence of sustained immunity following either vaccination or infection, pertussis is not a candidate for elimination. Modelling of the likely impact of the adult vaccine, if it was provided to the whole adult population every 10 years, predicts only very small benefits in terms of reduced exposure of young infants.[10]

While increasing awareness of pertussis in adults and the widespread use of serology for testing in NSW may explain the apparent increase in notifications in adults, the occurrence of adult pertussis is certainly not new. In 1884, British physicians commented about pertussis:

'The disease is most common in childhood but is not confined to that period of life. The phenomenon of an old person suffering from whooping cough is far from uncommon.'[11]

Our new evidence of the extent to which adults are affected, however, serves to underscore the ongoing challenges that we face in 2003 in trying to reduce mortality and morbidity from pertussis.

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DO VARIATIONS IN PERTUSSIS NOTIFICATIONS REFLECT INCIDENCE OR SURVEILLANCE PRACTICES? A COMPARISON OF INFANT NOTIFICATION RATES AND HOSPITALISATION DATA IN NSW

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The incidence of pertussis cannot be directly measured; estimates are generally based on data sources such as notifications, hospitalisations and deaths. However, these data represent only a proportion of the total cases occurring in the community. The accuracy of notification data may vary between states and territories or over time due to different surveillance practices and as new diagnostic tests are introduced. These surveillance issues, and the typical three-to-five-year cycles of pertussis epidemics, make comparisons over time and between states and territories difficult. However, the comparisons should be more valid for hospitalisation data than for notification data, because methods of collecting hospitalisation data are likely to be more uniform. Some variation in incidence by geographical area is to be expected, depending on the timing of the last epidemic and also on geographical differences in past or present pertussis vaccination coverage. If geographical variations in pertussis notifications reflect real variations in pertussis incidence rather than reporting differences, areas with high infant (aged less than 12 months of age) notification rates would be expected to have high infant hospitalisation rates. This article describes and compares the notification and hospitalisation rates in infants for pertussis, by health area, over a period incorporating two pertussis epidemics in NSW.

METHODS

Medical practitioners and laboratories in NSW are required by legislation to notify the NSW Department of Health, through one of the 17 public health units, of any person who meets the case definition for pertussis. This information is then entered into the Notifiable Diseases Database (NDD). The case definition for pertussis is:[1]

- isolation of *Bordetella pertussis* from a clinical specimen; or
- elevated *Bordetella pertussis* specific IgA in serum or *Bordetella pertussis* antigen in a nasopharyngeal specimen using immunofluorescence, with a history of clinically compatible illness; or
- an illness lasting two weeks or more with one of the following: paroxysms of coughing, inspiratory 'whoop' without other apparent causes, or post-tussive vomiting; or

- an illness characterised by a cough illness lasting at least two weeks in a patient who is epidemiologically related to a laboratory-confirmed case.

All notified cases of pertussis with dates of onset of disease between 1 July 1993 and 30 June 1999 were extracted from NDD in the Health Outcomes Information Statistical Toolkit (HOIST), NSW Department of Health, in March 2000. SAS for Windows and Excel were used for the analyses.[2,3]

Data on pertussis cases discharged from hospital between July 1993 and June 1999 were extracted from the NSW Department of Health's Inpatient Statistics Collection Online System (ISCOS) by financial year of discharge and age in months on admission, in February 2001. For the period 1993 to June 1998, the International Classification of Diseases code 033 (whooping cough) was used to identify deaths (ICD-9) and hospitalisations (ICD-9-CM). From July 1998 to June 1999 the ICD-10-AM code A37 was used. This code includes codes for *Bordetella pertussis* (A37.0), *Bordetella parapertussis* (A37.1) and whooping cough with no organism mentioned (A37.9).

Rates were calculated using Australian Bureau of Statistics (ABS) mid-year estimated resident populations for NSW. For hospitalisation data, the mid-year population estimate for the first half of the financial year was used as the denominator.

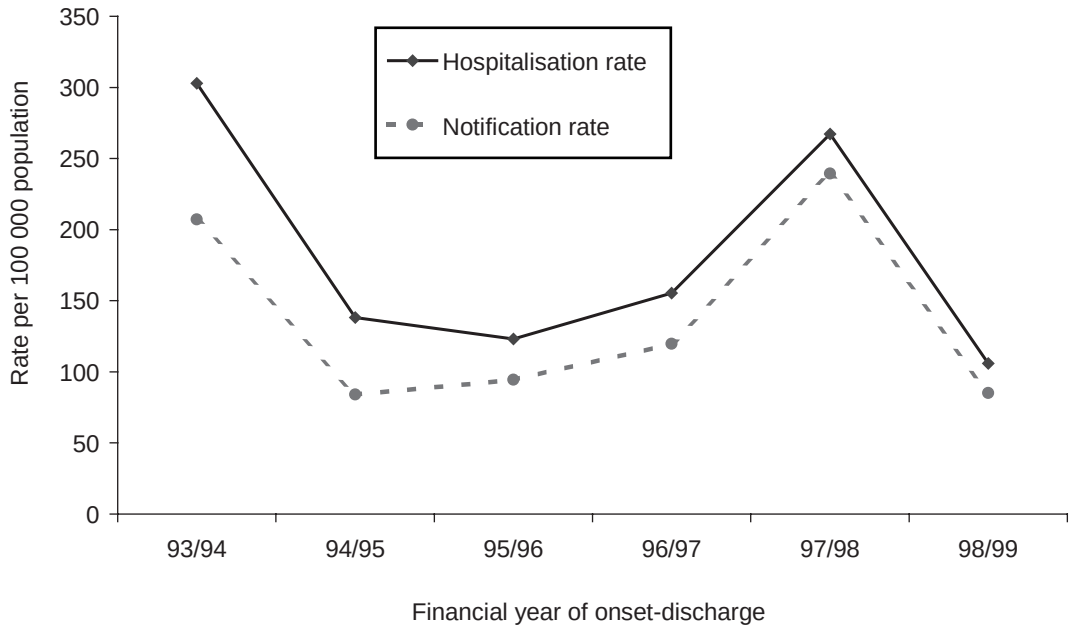
RESULTS

Between July 1993 and June 1999, 721 cases of pertussis in infants were notified, 291 (40 per cent) of whom were recorded on the NDD as being hospitalised. Infants accounted for six per cent of total pertussis notifications. During the same period, there were 949 infants hospitalised with pertussis in the ISCOS, accounting for 61 per cent of total pertussis hospitalisations. Notification and hospitalisation rates peaked in 1993–94 and again in 1997–98 (Figure 1). The notification rate became closer to, but remained less than, the hospitalisation rate over time (Figure 1).

There was considerable variation in hospitalisation and notification rates between the 17 area health services (Table 1). The overall ratio of notifications to hospitalisations for the six-year period was 1:1.3, but this ratio varied by health area from 1:0.9 in the Hunter, Northern Rivers, Mid North Coast and Mid Western areas to 1:2.2 in South Western Sydney. For each of the metropolitan areas, except the Hunter, the total number of hospitalisations in the 0–11 months age group was greater than the number of notifications for the same age group. This was also the case in half the rural areas. The Hunter

FIGURE 1

NOTIFICATION AND HOSPITALISATION RATES FOR PERTUSSIS IN INFANTS, BY FINANCIAL YEAR OF ONSET–DISCHARGE, NSW, JULY 1993–JUNE 1999



Source: Notifiable Diseases Database (HOIST); Inpatient Statistics Collection Online System (ISCOS), Information Management Directorate. NSW Department of Health; and the Australian Bureau of Statistics (ABS).

TABLE 1

NUMBER OF NOTIFICATIONS AND HOSPITALISATIONS FOR PERTUSSIS IN INFANTS, RATIOS OF NOTIFICATIONS TO HOSPITALISATIONS AND AVERAGE ANNUAL RATES PER 100,000 POPULATION AGED 0–11 MONTHS BY HEALTH AREA AND FINANCIAL YEARS OF ONSET–DISCHARGE, NSW, JULY 1993–JUNE 1999

	1993–94 to 1995–96			1996–97 to 1998–99			Total			Average Annual rate	
	Not	Hos	N:H	Not	Hos	N:H	Not	Hos	N:H	Not	Hos
	N			*N*			*N*				
Metropolitan											
S. Western Sydney	37	88	1:2.4	48	99	1:2.1	85	187	1:2.2	117	258
Western Sydney	38	55	1:1.4	48	80	1:1.7	86	135	1:1.6	144	227
Illawarra	11	28	1:2.5	17	24	1:1.4	28	52	1:1.9	97	179
Central Sydney	11	27	1:2.5	34	29	1:0.9	45	56	1:1.2	131	163
Hunter	37	42	1:1.1	44	27	1:0.6	81	69	1:0.9	181	154
Central Coast	12	25	1:2.1	7	10	1:1.4	19	35	1:1.8	78	144
Wentworth	8	12	1:1.5	30	31	1:1.0	38	43	1:1.1	124	140
S. Eastern Sydney	25	27	1:1.1	42	40	1:1.0	67	67	1:1.0	133	133
Northern Sydney	16	22	1:1.4	25	32	1:1.3	41	54	1:1.3	79	104
Total metropolitan	**195**	**326**	**1:1.7**	**295**	**372**	**1:1.3**	**490**	**698**	**1:1.4**	**123**	**176**
Rural											
Far West	3	18	1:6.0	10	2	1:0.2	13	20	1:1.5	270	416
Northern Rivers	59	54	1:0.9	15	16	1:1.1	74	70	1:0.9	364	344
Macquarie	13	22	1:1.7	6	9	1:1.5	19	31	1:1.6	179	292
Mid North Coast	22	21	1:1.0	25	23	1:0.9	47	44	1:0.9	233	218
Mid Western	18	19	1:1.1	8	5	1:0.6	26	24	1:0.9	172	159
Greater Murray	10	20	1:2.0	10	10	1:1.0	20	30	1:1.5	82	124
Southern	8	7	1:0.9	8	9	1:1.1	16	16	1:1.0	102	102
New England	5	3	1:0.6	7	13	1:1.9	12	16	1:1.3	74	98
Total rural	**138**	**164**	**1:1.2**	**89**	**87**	**1:1.0**	**227**	**251**	**1:1.1**	**178**	**197**
NSW total	**333**	**490**	**1:1.5**	**384**	**459**	**1:1.2**	**717**	**949**	**1:1.3**	**137**	**181**

Not: notifications
Hos: hospitalisations
N:H: Ratio of the number of notifications to the number of hospitalisations.

Source: Notifiable Diseases Database (HOIST); Inpatient Statistics Collection Online System (ISCOS), Information Management Directorate. NSW Department of Health; and the Australian Bureau of Statistics (ABS).

and Central Coast Areas, which are adjacent, had similar hospitalisation rates but their notification rates differed.

DISCUSSION

This comparison of infant notification and hospitalisation data highlights the extent of under-notification and the degree of variation between the health areas in notification and hospitalisation rates. Although only a proportion of infant pertussis cases (those with severe disease) are hospitalised, the number of hospitalisations exceeds the number of notifications by 32 per cent. This is similar to the pattern seen nationally,[4] and in New Zealand.[5] As the infant notification rate is lower than the hospitalisation rate, it must underestimate incidence considerably. Pertussis is more severe in infants compared with other age groups, hence the need for accurate data to target infants in pertussis control programs. In order to better control infant pertussis it would be useful to have a measure of incidence. Hospitalisation data are less subject to variations in reporting practices than notification data and therefore may be more useful for monitoring trends in incidence among infants than notification data. Notifications of pertussis by medical practitioners, as opposed to laboratories, have been shown to be low in South Eastern Sydney and the Northern Rivers Health Areas.[6,7,8] In addition, a recent survey of symptoms consistent with pertussis in Western Sydney children found the parent-reported rate of doctor-diagnosed pertussis in the previous 12 months to be 12 times greater than notifications.[9]

The extent to which the differences in notification rates between areas reflect differences in incidence versus differences in diagnostic and notification practices is difficult to determine using notification data alone. However, the comparison of infant notifications and hospitalisations in each area over the same time period provides some insights. The health area with the highest average annual notification rate was Northern Rivers. Northern Rivers also had the second highest

hospitalisation rate (the highest was the Far West, but this was calculated on very few cases) suggesting that pertussis incidence in this area is higher than in other areas. This is likely to be related to vaccination coverage. Northern Rivers has the lowest pertussis vaccination coverage of any area health service in NSW, with only 81 per cent of children aged 12 months being recorded on the Australian Childhood Immunisation Register as having received three doses of a pertussis-containing vaccine in 1999.[10] A wide range in notification rates by geographical area has also been observed in Victoria.[11]

The Hunter had a much higher notification rate than the geographically adjacent Central Coast, with the average annual infant notification rate in the Hunter being 230 per cent higher than that in the Central Coast. In contrast, the average annual infant hospitalisation rate was only seven per cent higher in the Hunter, suggesting that the degree of under-reporting is greater in the Central Coast than in the Hunter. The ratios of notifications to hospitalisations for the health areas give an indication of the relative extent of under-reporting in each health area. Some health areas may more actively seek cases, particularly if they are experiencing an outbreak. Some of the differences in ratios may be due to doctors and/or laboratories in the area being more or less willing to notify. This may have more of an influence on notification rates in less densely populated areas where there are fewer doctors or laboratories.

CONCLUSION

The epidemic pattern shown by notification and hospitalisation rates over time was very similar, suggesting that this reflects real variations in incidence. During the 1997–1998 pertussis epidemic, increased numbers of both notifications and hospitalisations occurred in almost all metropolitan health areas and some of the rural areas. However, only some of the geographical variations in notification rates correlate with hospitalisation patterns, suggesting that some of these are due to variations in surveillance practices. Although less timely, hospitalisation data are likely to be more reliable as a means of tracking infant pertussis and the effects of vaccination coverage over time.

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DIFFERENCES IN THE EPIDEMIOLOGY OF INVASIVE PNEUMOCOCCAL DISEASE, METROPOLITAN NSW, 1997–2001

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Although invasive pneumococcal disease (IPD) accounts for only a minority of the infections caused by *Streptococcus pneumoniae* (such as pneumonia and otitis media), it is associated with the most severe disease and is readily measured, as it is by definition associated with a sterile site isolate.[1] The Metropolitan NSW Pneumococcal Study Group was formed in 1997 to generate data describing the age-specific incidence, serotype distribution and antimicrobial resistance patterns of invasive pneumococcal disease in a large population that is believed to be representative of urban Australia. Results from the first two years of active surveillance for invasive pneumococcal disease in metropolitan NSW have been previously reported.[2] This article presents data from a 4.5-year period, with a greater focus on differences between the regions covered by the area health services within metropolitan NSW. These data provide an expanded picture of the profile of IPD in a representative Australian urban region—the metropolitan area health services within Sydney, the Hunter and the Illawarra.

METHODS

Case definition

Invasive pneumococcal disease was defined as isolation of *S. pneumoniae* from a normally sterile site, including blood, cerebrospinal fluid (CSF), pleural fluid or synovial fluid. Meningitis was defined as isolation of *S. pneumoniae* from CSF; or pneumococcal bacteraemia with abnormal CSF; or, if a lumbar puncture was not performed, evidence of meningitis from imaging or at post-mortem examination. Diagnosis of pneumonia or other focal infection was based on discharge diagnosis and appropriate clinical and radiographical findings. Cases where no focus of infection had been determined at the time of discharge were designated as bacteraemia without focus. Multiple isolates from a single episode of infection were counted only once.

Eligible cases had a postcode of residence within the Sydney, Hunter and Illawarra statistical divisions in the 1996 Census, and a date of collection of the positive specimen between 1 June 1997 and 31 December 2001. The data were then translated into the geographical profile of the metropolitan area health services, to give a profile for metropolitan NSW.

Case ascertainment

Cases were identified from all laboratories within the Sydney, Hunter and Illawarra area health services that process sterile site specimens. Case ascertainment was enhanced through the regular auditing of laboratories and medical record departments for discharge diagnoses coded as pneumococcal meningitis or unspecified bacterial meningitis, pneumococcal septicaemia or pneumococcal pneumonia, according to the International Classification of Diseases. Data on final diagnosis, outcome and underlying conditions, were obtained from review of patient hospital records by a single observer (RG) using a standard protocol. The vaccination status of cases was only available from hospital notes and this source was not thought sufficiently reliable to report.

Antimicrobial susceptibility testing and serotyping

Antimicrobial susceptibility was reported according to the usual practice of the reporting laboratories, all of which participate in the quality assurance program of the Royal College of Pathologists of Australasia. During the study period, the methods used were *E* test (most laboratories),[3] or disc susceptibility testing using the calibrated dichotomous standard (CDS) method.[4] For the first two years of the study, isolates were sent in batches to the Queensland Health Scientific Services for serogrouping and serotyping using reagents from Statens Serum Institute, Denmark. In the remaining years of the study, serogrouping and serotyping for the most common types were established at the microbiology laboratory of The Children's Hospital at Westmead.

Statistical analysis and ethical approval

Statistical analyses were performed using the statistical software SPSS. Incidence was calculated as an annual rate per 100,000 population for the relevant age group, using the annual resident population of the Sydney, Hunter and Illawarra statistical divisions in the 1996 Census.[5] The study was approved by the ethics committees of all the participating hospitals and laboratories. Identifying data were kept secure, with access limited to the principal investigators. Analyses were conducted on de-identified data.

RESULTS

Disease incidence

During the surveillance period 3,033 cases of IPD were identified, of whom 1986 (66 per cent) were adults aged 15 years and over and 1,041 (34 per cent) were children. The age of six cases was unknown; in total, medical records were unavailable for 28 cases (0.9 per cent). Annual incidence was highest at the extremes of age: 102.4 per 100,000 children under the age of two years and 93.5 per 100,000 in people aged 85 years or older.

Among children under the age of two years, IPD was rare under three months (19 cases), and peaked between nine and 20 months, with this age range accounting for 78 per cent of all these cases. The lowest annual incidence (4.1 per 100 000) was between the ages of five and 40 years. The male-to-female ratio was 1.3:1 overall, varying from 1.6:1 in those aged less than 15 years to 0.7:1 among those aged 80 years and over. However, it should be noted that the overall male to female ratio in the latter age group is 0.6 to 1.0.[5]

Seasonality and categories of infection

Invasive pneumococcal disease was clearly seasonal, with 1,017 cases (41 per cent) occurring during the coldest months (June–August), compared with 430 cases (13 per cent) during the warmest months (December–February). Disease manifestations differed between children and adults. Bacteraemia without focus predominated in those less than 15 years of age (680 cases or 66 per cent), while in those aged over 15 years pneumonia was the most common focus of infection (1,516 cases or 77 per cent) (Table 1). Meningitis was most common among children under the age of two years (incidence, 13.1 per 100,000; 95 per cent CI, 10.2–16.0), where it accounted for 13 per cent of cases. Overall, meningitis accounted for seven per cent of cases (incidence, 0.9 per 100,000; 95 per cent CI, 0.8–1.0).

Differences among metropolitan area health services

Figure 1 shows the total incidence of IPD (shown on the left axis) and proportion of cases with a penicillin resistant isolate (shown on the right axis) from lowest to highest, by metropolitan area health service, across all age groups. Figure 2 shows the total incidence of IPD and proportion of cases with a penicillin-resistant isolate from lowest to highest, by health service area, among children less than five years. There was a two-fold difference between the all-age incidence of IPD in the area with the lowest rate (Illawarra, 10.7 per 100,000) and the area with the highest rate (Central Coast, 22.0 per 100,000). Depending on age, however, the rank among the remaining regions differed, with the Central Sydney area in particular having a relatively higher incidence among adults.

Penicillin resistance also varied by age group, health service area and time period. In the two extremes of age (less than five years and 65 years and over) there was a change in resistance patterns between the initial and later parts of the surveillance period. Overall levels of resistance among children under five years have declined from 19 per cent in 1997–99 to 12.5 per cent for 2001, while there has been a slight increase in resistance among adults from 12.5 per cent to 15 per cent. Over the whole period of surveillance, antibiotic resistance remained highest in the South West Sydney area for all age groups. Among children under the age of five years, levels of penicillin resistance were lowest in Northern Sydney while Central Sydney had the lowest levels of resistance among adults (Figures 1 and 2).

Predisposing conditions and mortality

Under current National Health and Medical Research Council recommendations,[6] overall, 54 per cent of cases presented with predisposing illnesses qualifying them for polysaccharide pneumococcal vaccine. This proportion of cases presenting with predisposing illnesses varied significantly with age, from only 12 per cent of children under the age of five years to 86 per cent among those 65 years and over. Of the remaining cases, a further 10 per cent required regular medical review. Among children less than five years of age, the inclusion of those born at less than 28 weeks' gestation (0.9 per cent) or at any gestation with subsequent chronic lung disease (0.7 per cent) or Down's syndrome (0.4 per cent) would increase the proportion of cases with one or more predisposing conditions from 12 to 14 per cent.

Overall, there were 412 deaths (case-fatality rate, 13.6 per cent). The case-fatality rate varied with age and the focus of infection (Figure 3) as well as with underlying illness. Among people with no underlying illness, the case-fatality rate rose from 9/826 (one per cent) in those less than 15 years to 12/304 (four per cent) in those aged

TABLE 1

MANIFESTATIONS OF INVASIVE PNEUMOCOCCAL DISEASE BY AGE, METROPOLITAN NSW, 1997–2001

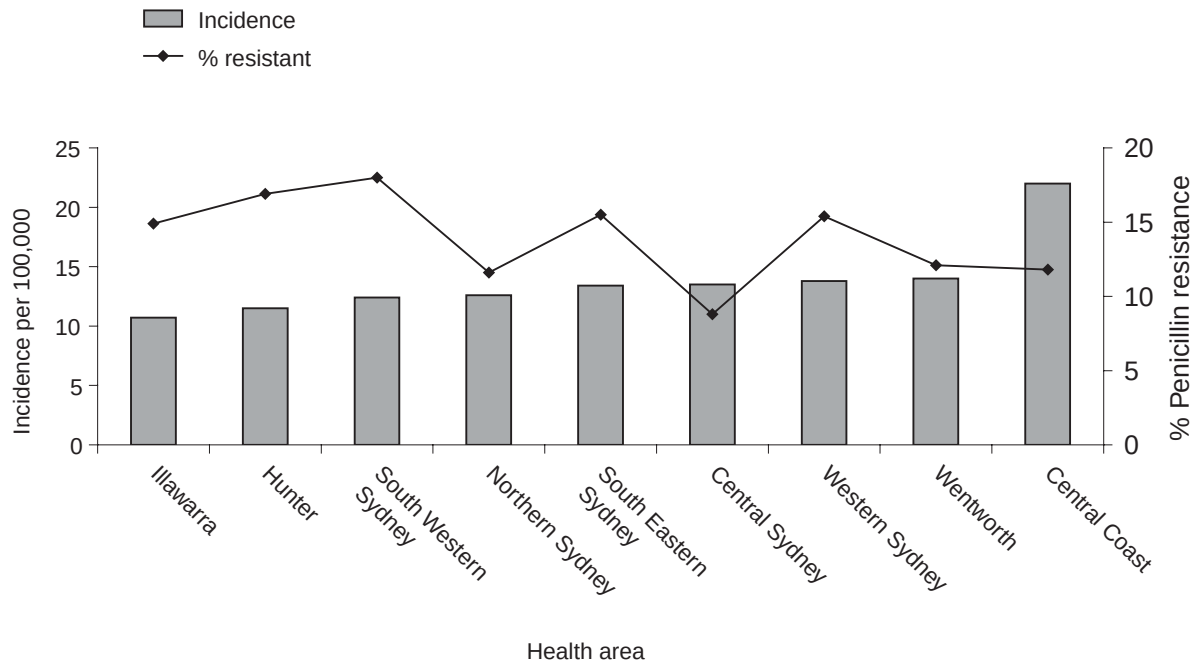
Age (years)	Bacteraemia		Pneumonia		Meningitis		Other focal*		Total
	N	(%)	*N*	(%)	*N*	(%)	*N*	(%)	
0–1	405	(66)	94	(15)	79	(13)	39	(6)	617
2–4	216	(68)	79	(25)	17	(5)	7	(2)	319
5–14	59	(59)	31	(31)	7	(7)	3	(3)	100
15–39	57	(15)	291	(77)	23	(6)	5	(1)	376
40–64	89	(18)	342	(71)	45	(9)	6	(1)	482
≥65	172	(16)	883	(80)	34	(3)	16	(1)	1105
Total	**998**	**(33)**	**1720**	**(57)**	**205**	**(7)**	**76**	**(3)**	**2999**

*Other focal diseases included cellulitis, arthritis and epiglottitis.

Source: The Metropolitan NSW Pneumococcal Study.

FIGURE 1

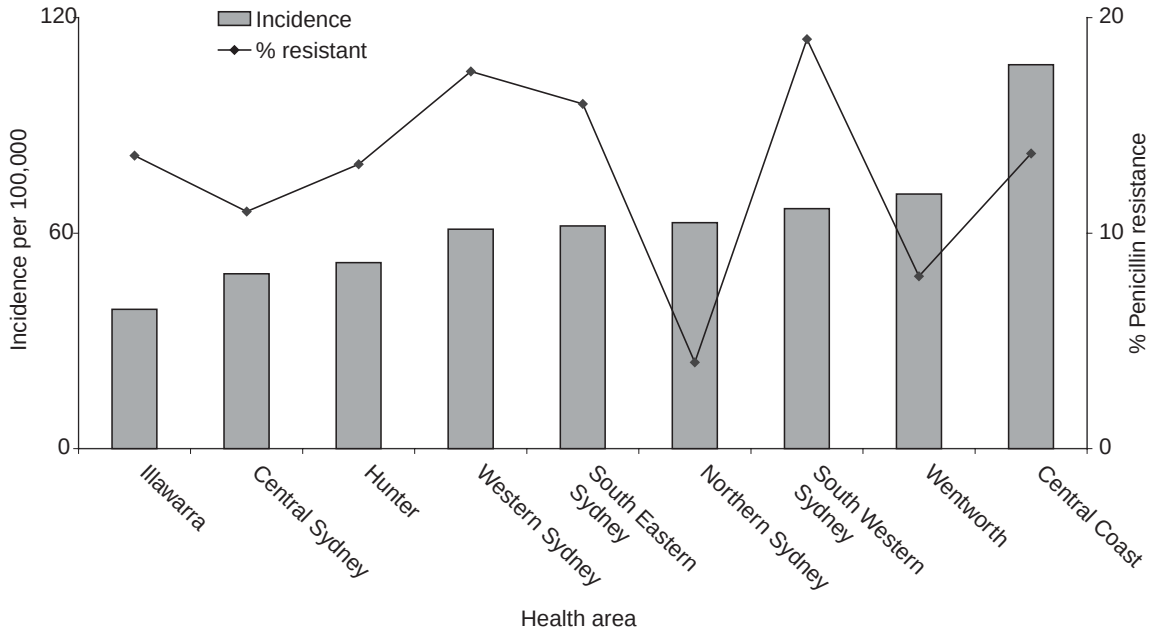
INCIDENCE OF INVASIVE PNEUMOCOCCAL DISEASE AND PREVALENCE OF PENICILLIN RESISTANCE FOR ALL AGES, METROPOLITAN NSW, 1997–2001



Source: The Metropolitan NSW Pneumococcal Study.

FIGURE 2

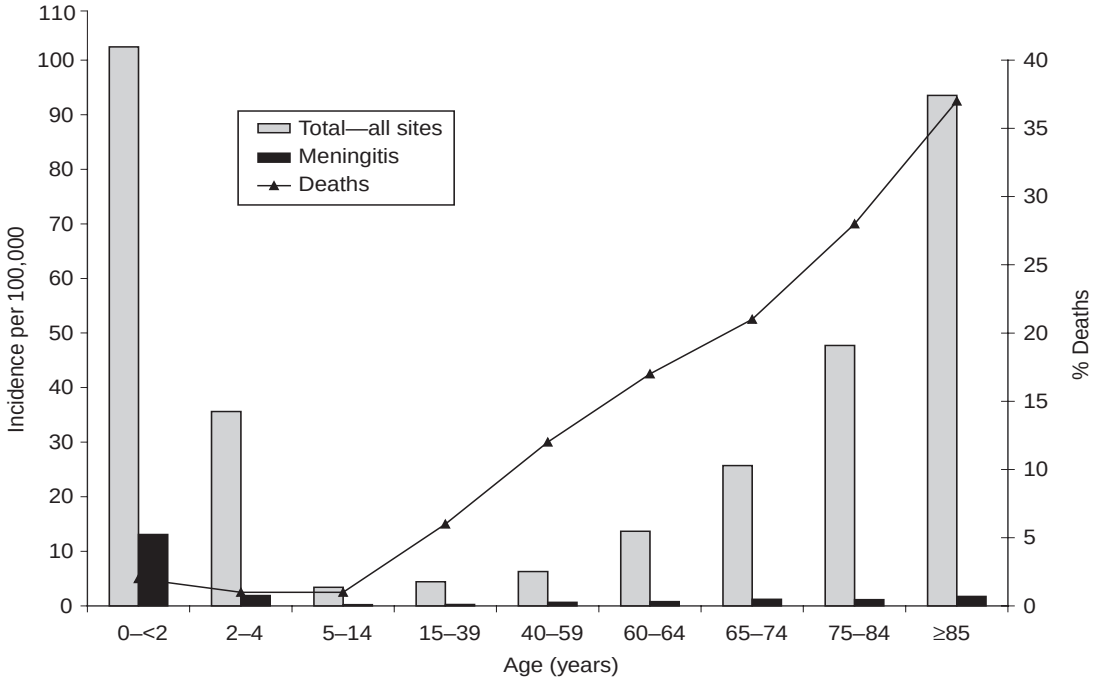
INCIDENCE OF INVASIVE PNEUMOCOCCAL DISEASE AND PREVALENCE OF PENICILLIN RESISTANCE FOR CHILDREN AGED LESS THAN FIVE YEARS, METROPOLITAN NSW, 1997–2001



Source: The Metropolitan NSW Pneumococcal Study.

FIGURE 3

AGE-SPECIFIC INCIDENCE AND MORTALITY FOR INVASIVE PNEUMOCOCCAL DISEASE, METROPOLITAN NSW, FOR ALL SITES AND FOR MENINGITIS ALONE, 1997–2001



Source: The Metropolitan NSW Pneumococcal Study.

15–64 years, and 20/118 (17 per cent) in those 65 years and over. In those with underlying illness, the corresponding figures were 7/168 (four per cent) in those 0–14 years, 76/551 (14 per cent) in those 15–64 years, and 288/979 (29 per cent) in those 65 years and over.

DISCUSSION

These data from metropolitan health areas of NSW show a similar pattern to that demonstrated previously, with respect to age-specific incidence and pattern of infection, as well as the prevalence of underlying conditions and age-specific mortality.[2] The total annual incidence of disease in children aged 0–2 years increased slightly from 95.2 to 102.4 per 100,000, as did the incidence of meningitis (12.5 to 13.1 per 100,000). The seasonal distribution of cases—with a preponderance in the colder months of the year in temperate climates—is in keeping with previous reports.

The serogroup distribution of cases in this extended period of surveillance remained similar to that previously documented and to reports from North America,[1] and other areas of Australia,[2] which do not have large Indigenous populations. Interestingly, the level of penicillin resistance found in these sterile site pneumococcal isolates—higher than in many other areas of Australia in 1997—has declined overall. However, this report highlights the substantial variations in incidence and particularly in penicillin resistance, seen between regions covered by the metropolitan health areas. It should be noted, however, that standard methodology for testing penicillin resistance was not used and that re-testing of all isolates in the same laboratory may have resulted in some re-classification. This is unlikely to be of sufficient magnitude to alter the broad findings.

Are these observed differences real, or are they related to case ascertainment, as documented in South Carolina?[7] Higher burdens of pneumococcal disease have previously been shown to correlate with lower socioeconomic status,[8] although diagnostic practices, especially in indications for blood culture, may also account for some of the variation seen. This, however, is unlikely to account for differences in the prevalence of antibiotic resistance, which are more likely to be related to the introduction of certain antibiotic-resistant clones or to local patterns of antibiotic use.

Another important issue with respect to vaccination programs, both for 23-valent pneumococcal polysaccharide vaccine and 7-valent conjugate pneumococcal vaccine is the prevalence of predisposing conditions by age.[9] With respect to polysaccharide vaccine, most people in the over 65 years age group, for whom the vaccine is currently recommended, have at least one

predisposing medical condition and so should be under regular medical review. With respect to the current program of funded pneumococcal conjugate vaccine, which for non-Indigenous children includes only a restricted range of conditions, only a minority of children with IPD will be eligible.

CONCLUSION

These data provide an expanded picture of the profile of IPD in a representative Australian urban region—the metropolitan area health services within Sydney, the Hunter and the Illawarra. They are a useful baseline against which the effect of potential vaccination programs, both for polysaccharide vaccine in the elderly and conjugate vaccine in infants, can be evaluated prior to IPD becoming notifiable in NSW in 2001.

ACKNOWLEDGEMENTS

The following hospitals and laboratories and scientists contributed isolates and clinical data, which made this study possible.

Australian Diagnostic (Mr Raj Parmer), Barratt and Smith (Mr Bob Sinclair), Concord Hospital (Dr Tom Gottleib, Ms Candice Wolfson), Davis Campbell and de Lambert (Dr de Lambert, Mr Steven Hodges), Douglas Hanly Moir (Dr Ian Chambers, Mr Richard Jones), Gosford Hospital (Mr Bruce Beaman), Hampson's Pathology (Mr Paul Handsaker), Hunter Area Pathology Service (Dr John Ferguson, Mr C Ashurst-Smith), Illawarra Area Pathology Service (Dr Peter Newton, Mr David Andriske, Mr Nelson Dennis), Institute of Clinical Pathology and Medical Research, Westmead Hospital (Ms Ansuya Sharma, Mr Tom Olma, Mr David Smith), Macquarie Pathology (Mr David McFarlane), Medisan (Mr Duncan Schroeter, Mr Tony Pavic, Mr Andrew Jarrett), Nepean Hospital (Dr Roger Wilson, Mr David Rose, Dr James Branley), PALMS (Dr Clarence Fernandez, Ms Judith Kelly), Royal Alexandra Hospital for Children (Mr Bill Leach, Dr Michael Watson, Ms Gail Stewart), Royal Prince Alfred Hospital (Prof Richard Benn, Ms Barbara Yan), South Eastern Area Laboratory Microbiology Service (Ms Sue Mahrer), St Vincent's Hospital (Dr Jock Harkness, Ms Robyn Timmins, Mr Damien Stark), South Western Sydney Area Pathology Service (Mr Stephen Neville, Dr Iain Gospell), St George and Sutherland Hospitals (Dr Peter Taylor, Mr Chinmoy Mukerjee), Sydney Adventist Hospital (Dr Huang Jensen), Southern Pathology (Mr Mark Formby) Laverty Pathology (Mr David Rankin, Dr Len Moaven).

Queensland Health Scientific Services (Ms Denise Murphy) provided serotyping services prior to 1999.

The Metropolitan NSW Pneumococcal Study was supported by a Public Health Research and Development Grant from the National Health and Medical Research Council.

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AUSTRALIA'S NATIONAL SEROSURVEILLANCE PROGRAM

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Serosurveillance is an important component of any comprehensive surveillance system for vaccine preventable diseases. Disease notification data are necessary to detect outbreaks and can provide timely epidemiological profiles of a disease. However, the incidence of a disease is often under-estimated by notifications, especially when a proportion of cases are asymptomatic. If this proportion changes with age, or if cases are clinically misdiagnosed, then notification data may present biased information. Serosurveillance is therefore the gold standard for measuring immunity in a population, and complements disease surveillance. The data from serosurveillance are also an essential contribution to mathematical modelling, which can predict the potential for cases in the future, and thus when—and in which age groups—intervention is required to prevent an epidemic. This article describes Australia's national serosurveillance program, which is an important source of information for public health action.

CONDUCTING SEROSURVEILLANCE

There are two methods that can be used to obtain sera for a serosurvey. The ideal method is to collect sera from subjects randomly selected to represent the population. The second more pragmatic approach is to use a sample of sera submitted for diagnostic testing that would otherwise have been discarded. The national serosurveillance program in Australia uses the latter approach.

In the first serosurvey conducted in 1999, 52 public and private diagnostic laboratories throughout Australia were invited to provide samples of residual sera. Approximately 13,000 sera from patients aged one year to over 90 years were collected from 45 laboratories.

Serosurveillance using a convenience sample

Our methodology was modelled on that used for serosurveillance in England and Wales, which began in 1986–87 to coincide with the introduction of the measles–mumps–rubella (MMR) vaccine in 1988. Each year since then they have collected sera from specific age groups, and every five years sera are collected from across the entire age range.[1]

Serosurveillance using a population-based random sample

The alternative approach to convenience sampling is population-based random sampling. In the USA sera are collected as part of the National Health and Nutritional Examination Survey program (NHANES). This program includes periodic national surveys based on a multistage probability-sample design and involves a household interview and physical examination.[2] The last survey (NHANES III) was conducted in 1988–1994, when approximately 40,000 sera from persons aged two months and over were collected and used to determine immunity to tetanus, measles, rubella, hepatitis B and C, and HIV.[2–7] In The Netherlands, a population-based random sample of sera, designed specifically for serosurveillance, is collected using a two-stage cluster sampling technique.[8] The first such collection was in 1995–96, when nearly 10,000 sera were obtained to examine for immunity to diphtheria, poliomyelitis, measles, mumps, rubella, *Haemophilus influenzae* type b, and hepatitis A, B and C.[8–15]

Advantages and disadvantages of population-based sampling

Serosurveillance programs in both the USA and The Netherlands collect detailed information about risk factors and the vaccination status of participants. This is a major advantage of the population-based random sampling methodology over the opportunistic collection method. It also permits over-sampling of particular at-risk groups, so that appropriate sample sizes are obtained for subgroup analyses. In addition, risk factors associated with low levels of immunity can be identified allowing vaccination programs to be targeted appropriately. For example, in the USA, susceptibility to tetanus was associated with certain sub-populations.[2]

The major disadvantage with random sampling is that it is more costly and time consuming than collecting a convenience sample. A study in Victoria by Kelly et al. estimated the cost of retrieval and storage per antibody tested using a random cluster sample to be about seven times more than the equivalent cost for a convenience sample.[16]

Comparing serosurveys

To allow comparisons between laboratory methods and differing immunisation programs, a European Sero-Epidemiology Network (ESEN) was established in 1996.[17] The network aims to coordinate and standardise serosurveillance for vaccine preventable diseases in Europe. Panels of sera representing a range of immunity levels are prepared by a designated reference laboratory. These are then tested by each country using their usual testing method and calibrated against the reference laboratory's results by way of a standardisation equation. This equation is then applied to the serum bank collected in each country to convert the results into standard reference laboratory units. The first ESEN project looked at five vaccine preventable diseases (measles, mumps, rubella, pertussis and diphtheria) and involved six countries (Denmark, France, Germany, Italy, The Netherlands and the United Kingdom). The results for measles, mumps and rubella have been published and show promise although there is still some residual lack of comparability after standardisation.[18]

A second ESEN project (ESEN2) is now under way and will include more countries and additional vaccine-preventable diseases (varicella and hepatitis A and B). In Australia, the National Centre for Immunisation Research

TABLE 1

DISEASES EXAMINED IN THE FIRST AUSTRALIAN NATIONAL SEROSURVEY TOGETHER WITH THE COLLECTION DATES, AGE RANGES, SAMPLE SIZES AND STATUS OF EACH SURVEY

Disease	Collection date	Age groups tested (years)	Sample size *N*	Status of survey (publication)
Diphtheria	May 1997–Jan 1999	5–70+	1,953	Completed
Hepatitis A	1998	1–60+	3,043	Completed [25]
Hepatitis B	March 1998–May 1999	1–18	1,735	Completed[17]
Hepatitis C	Jun 1996–Dec 1998	1–70+	2,800	Completed
Measles	1996–98	1–18	2,936	Completed[21–23]
		19–49	2,126	
Measles	Jan–Jun 1999	1–18	2,918	Completed.[17,21,22]
Mumps	1996–98	1–59	2,787	Completed
Mumps	Jan–Jun 1999	1–18	1,249	Completed[17]
Pertussis	1998	1–65+	1,022	Completed
Polio	1998	1–65+	1,816	Completed
Rubella	1996–98	1–18	2,859	Completed[21,22]
		19–49	1429	
Rubella	Jan–Jun 1999	1–18	2,947	Completed[17,21,22]
Tetanus	Feb 1997–Mar 1999	5–70+	2,884	Completed
Varicella	1996–98	1–49	2,027	Completed[17]

Source: National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases.

and Surveillance of Vaccine Preventable Diseases (NCIRS), in collaboration with the Institute of Clinical Pathology and Medical Research (ICPMR), will be participating in ESEN2.

BIASES IN SEROSURVEYS

Biases in population-based random samples

To be confident that a sample is unbiased, a well-randomised, population-based sample with a 100 per cent response rate is required. In practice, however, this is impossible to achieve and non-participation is usually quite high in randomised surveys. In a Victorian study using a three-stage random cluster sample from school-aged children, the school response rate was 59 per cent and the rate for students consenting to provide sera was between 32 and 39 per cent.[16] Participation in the NHANES III survey was higher at 77.4 per cent, although rates were much lower for children aged 6–11 years (52.7 per cent).[2] In The Netherlands serosurvey, the participation rate was 55 per cent.[8]

Low response rates may lead to non-participation bias if participation is related to disease immunity. In The Netherlands serosurveys, some demographic characteristics were available from a municipal database on all eligible individuals.[19] These were examined: non-participants were more likely to be unmarried, not Dutch in origin, and live in highly urbanised areas. The latter two factors could to be related to immune status and thus lead to a biased estimate of immunity. The risk of infection may be greater in urban areas compared with small towns, due to the higher population density. Nationalities other than Dutch are also likely to have differing immunity because of variations in vaccination programs and disease incidence between countries. Some adjustment can be made by over sampling the under-represented groups and weighting the seroprevalence estimates.[2,19] However this does not always reduce the bias, especially when there are other unmeasured differences between participants and non-participants.

Biases in convenience samples

As with random samples, convenience samples may also be biased. However, because less is known about participants in convenience samples compared with those from a random sample, any potential biases are more difficult to identify and control for when estimating seroprevalence.[1,20] In Australia, we reduced the potential for selection bias by enrolling most (86.5 per cent) major laboratories in the country with the majority of samples from ambulatory subjects rather than hospitalised patients. We have also been able to demonstrate that our convenience sample of sera gave similar results to those obtained from a prospectively collected, random sample from school-aged children in Victoria for immunity levels to measles, mumps, rubella, hepatitis B and varicella.[16] However, for some diseases (such as hepatitis C) for which seropositive individuals may be over-sampled due to increased diagnostic testing, opportunistic collections may not yield accurate estimates of immunity, although the distribution of immunity by age and over time may still provide useful information.

AUSTRALIA'S FIRST SEROSURVEY

Methodology

Australia's first national serosurvey aimed to provide a national picture of immunity to each disease examined within each age group surveyed. In each age group for both males and females, states and territories were sampled proportionally to their 1997 population size. Sample sizes

TABLE 2

EXAMPLES OF DISEASES, AGE RANGES AND SAMPLE SIZES THAT MAY BE EXAMINED IN THE SECOND AUSTRALIAN NATIONAL SEROSURVEY TOGETHER WITH THE RATIONALE FOR EACH SURVEY

Disease	Age range (years)	Sample size *N*	Rationale
CMV	1–59	3,593	Precise estimate of immunity
EBV	1–59	3,655	Precise estimate of immunity
Helicobacter	1–59	2,410	Precise estimate of immunity
Hepatitis A*	1–59	2,605	Update (precise estimate) of immunity
Hepatitis B core antibody*	1–59	1,760	Update (precise estimate) of immunity
Hepatitis B surface antibody*	1–59	2,580	1–2 years—effect of universal infant vaccination (compare with first serosurvey) 12–17 years—compare states with and without school-based programs Other age groups—update (precise estimate) of immunity
Measles*	1–34	3,560	18–34 years—effect of young adult campaign (compare with first serosurvey) 1–18 years—update (precise estimate) of immunity
Rubella*	1–34	3,605	As per measles
Varicella*	1–5	380	Effect of vaccine pre funding (compare with first serosurvey)

*also tested in the first serosurvey

CMV: cytomegalovirus EBV: Epstein-Barr virus.

Source: National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases.

were calculated to achieve confidence intervals of approximately +/- five per cent for each age group, based on the expected level of immunity to each disease. This provided a precise estimate of immunity for Australia as a whole in each age group; however, the sample sizes calculated did not provide appropriate power for a precise estimate of immunity in each individual state and territory.

Except for the pertussis serology (which was performed in Italy) all testing was performed at the Centre for Infectious Diseases and Microbiology (CIDM), Institute of Clinical Pathology and Medical Research (ICPMR) at Westmead Hospital, Westmead.

Timing

The main reason for the timing of the first national serosurveys was to contribute to the evaluation of the Measles Control Campaign (MCC), which was conducted in the second half of 1998.[21] Two convenience samples of sera were collected to do this. The first comprised 9,341 sera collected from individuals aged from one year to over 90 years in the two years prior to the campaign. The second was of 3,513 sera from 1–18-year-old children collected between January and May 1999. Participating laboratories were requested to exclude sera from subjects who were known to be immunocompromised; to have received multiple transfusions in the previous three months; be infected with human immunodeficiency virus; or to have had serum collected for diagnosis of measles. Only one sample from any subject was tested.

Results

The first serosurvey has provided a wealth of information. Not only were we able to provide a qualitative measure of the success of the MCC,[20] we have been able to determine the age-specific immunity to several diseases (Table 1). These serological profiles demonstrate the effect of past and current vaccination policies, as well as natural infection on immunity. In addition the profiles have been used to determine those age groups now most at risk of infection, which has enabled appropriately targeted interventions. For example, the MCC measles serology identified a cohort of young adults with a low level of immunity.[22] To improve their immunity, this group were targeted by a MMR vaccination campaign conducted in 2001.[23]

Data from the first serosurvey have and will continue to be a particularly valuable ingredient in the mathematical modelling conducted by NCIRS. The measles serology results have been used to predict when another epidemic may occur and what must be achieved to prevent it from occurring.[25] The pre-vaccination serosurvey on varicella immunity has provided data to calculate epidemiological parameters such as the age-specific force of infection (that is, the incidence rate in the non-immune population), the average age of infection and the average number of susceptibles infected per case in a completely susceptible population. These data provide us with a better understanding of the current epidemiology of varicella and also with the information needed to model the impact of different vaccination scenarios. Modelling is now under way based on the methodology used in Canada and the United Kingdom.[26]

THE FUTURE OF SEROSURVEILLANCE IN AUSTRALIA

The first national serosurveys have been extremely useful but only provide a snapshot of immunity at one time. For diseases whose epidemiology does not change over time, a one-off serosurvey may be sufficient. However, after

vaccination is introduced, or when the incidence of infection is changing over time, ongoing serosurveillance is required. In addition, we would like to examine immunity to other diseases and the serum bank is now severely depleted. With these points in mind, collection is currently under way for the second serosurvey. We are using the same methodology as that used in the first serosurvey and estimate that at least 5,000 serum specimens need to be collected from ages 1–59 years to perform tests that are currently under consideration (Table 2).

Given the results of the first serosurvey, the second is likely to provide us with just as many interesting findings to guide vaccination activity and policy development. Looking further ahead, NCIRS plans to conduct regular serosurveys as part of its surveillance program.

ACKNOWLEDGEMENTS

We thank the staff of the 45 laboratories who provided the sera for the first national serosurvey.[27] The laboratory staff at the ICPMR, especially Ros Escott, and the nurses at the Centre for Immunisation Research, Westmead, are thanked for their help in processing and testing the sera.

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VACCINE PREVENTABLE DISEASES AND VACCINATION COVERAGE IN AUSTRALIA, 1999–2000

In 2002, the National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases (NCIRS) prepared the second comprehensive report on the epidemiology of vaccine preventable diseases and vaccination coverage in Australia. The report reviews the most recently available data about notifications (1999–2000), hospitalisations (1998–99 to 1999–00), and deaths (1998–2000), for diseases targeted by the Australian Standard Vaccination Schedule in 2000 (measles, mumps, pertussis, diphtheria, tetanus, rubella, Hib disease, hepatitis B, influenza, and polio), as well as four other vaccine preventable diseases that were not on the schedule in 2000 (varicella, hepatitis A, pneumococcal disease, and meningococcal disease). Recent trends in vaccination coverage using data from the Australian Childhood Immunisation Register (ACIR) are also reported. The second report provides an update of, and comparison with, the data presented in the first report (1993–1998).

There were continued declines in notification rates for Hib disease, measles, and rubella. These diseases are now close to being eliminated in Australia. Pertussis remained the most commonly notified disease preventable by childhood vaccination. Influenza accounted for the highest number of hospitalisations and deaths of any vaccine preventable disease. In the review period, vaccination coverage targets reached those set by the *Immunise Australia Program*.

This report is a valuable resource for health professionals. It provides evidence of the effect of recent and ongoing initiatives in disease control and a baseline against which further changes can be measured. The report was published by the Commonwealth Department of Health and Ageing as a supplement of *Communicable Diseases Intelligence* (May 2002). Printed copies can be obtained by contacting the NCIRS by telephone on (02) 9845 3069, or by fax on (02) 9845 3082. Electronic copies can be downloaded from the website at **www.cda.gov.au/cdihtml.htm**.

IMMUNISATION COVERAGE: AUSTRALIA 2001

During 2001, the National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases (NCIRS) conducted five studies to examine the true level of immunisation coverage in Australia compared with Australian Childhood Immunisation Register (ACIR) data, and the effect of the *Immunise Australia Program* initiatives on coverage. Each study involved a nationally representative survey of children selected from the ACIR. Information was obtained from parents by computer-assisted telephone interviews.

The five studies, which are presented as discrete chapters in the report *Immunisation Coverage: Australia 2001*, are:

- the accuracy of the ACIR in estimating coverage at 12 and 24 months of age;
- the validity of the 'third-dose assumption' to estimate coverage;
- immunisation coverage in inner urban areas;
- the influence of parent incentive payments on immunisation;
- measles vaccine coverage in 5-year old children.

The findings of the five studies demonstrate that: overall, high immunisation coverage for vaccines due in the first two years of life has been achieved in Australia, with 94 per cent for receipt of all scheduled vaccines due before 12 months, and 90 per cent for those due before 24 months of age (both estimates are higher than those calculated from ACIR data); the 'third-dose assumption' is valid and necessary to prevent underestimation of immunisation coverage; lower coverage estimates for inner urban areas of Australia's capital cities are more a result of under-reporting to the ACIR than underimmunisation; linkage of immunisation status to parent payments (the maternity allowance and the child care benefit) has encouraged both uptake and timeliness of immunisation; as Australia approaches measles elimination, 93 per cent of 5-year-old children were estimated to be immune to measles through vaccination (which is adequate, at a national level, to prevent sustained measles outbreaks).

The report *Immunisation Coverage: Australia 2001* provides valuable information for immunisation practitioners, researchers, and policy makers. The report was published by the Commonwealth Department of Health and Ageing. Printed copies can be obtained by contacting the NCIRS by telephone on (02) 9845 3069, or by fax on (02) 9845 3082. Electronic copies can be downloaded from the website at **www.health.gov.au/pubhlth/immunise/report.pdf**.

FACT*SHEET*

HAND, FOOT AND MOUTH DISEASE

WHAT IS HAND, FOOT AND MOUTH DISEASE?

Hand, foot and mouth disease is generally a mild illness caused by viruses called coxsackievirus or enterovirus. It is not a serious illness and has nothing to do with the animal disease called foot and mouth disease. It mainly occurs in children under 10 years of age but can also occur in older children and adults.

HOW CAN IT AFFECT YOU?

Coxsackievirus or enterovirus infection may cause no symptoms at all or only very mild symptoms. When symptoms do occur, they include blisters that start as small red dots which later become ulcers. Blisters appear inside the cheeks, gums, and on the sides of the tongue, as well as on the hands and feet. In infants, sometimes blisters can be seen in the nappy area. Blisters usually last for seven to 10 days. Children can sometimes have a low fever, sore throat, tiredness, feel off colour and may not eat for a day or two. Very rarely, the coxsackieviruses can cause other illnesses that affect the heart, brain, or lining of the brain (meningitis), lungs, or eyes.

HOW COMMON IS IT?

Hand, foot and mouth disease is a common disease and outbreaks may occur among groups of children; for example, in child care centres.

HOW IS THE INFECTION SPREAD?

Hand, foot and mouth disease is usually spread by person-to-person contact. The virus is spread from the faeces of an infected person to the mouth of the next person by contaminated hands. It is also spread by secretions from the mouth or respiratory system, and by direct contact with the fluid in blisters.

It usually takes between three and five days after contact with an infected person before blisters appear. As long as there is fluid in the blisters, they remain infectious. The virus can remain in faeces for several weeks.

HOW IS IT TREATED?

Usually no treatment is needed. Paracetamol will relieve fever and discomfort. Do not give children aspirin. If the headache is severe, or if fever persists, consult a doctor.

HOW CAN IT BE PREVENTED?

- Good hygiene is the best protection: wash hands with soap and water after going to the toilet, before eating, after wiping noses, and after changing nappies or soiled clothing.
- Avoid sharing cups, eating utensils, items of personal hygiene (for example: towels, washers and toothbrushes), and clothing (especially shoes and socks).
- Thoroughly wash any soiled clothing.
- Ensure the mouth and nose are covered when coughing and sneezing. Wipe the nose and mouth with tissues, dispose of used tissues and then wash your hands.

HOW CAN SPREAD OF THE DISEASE BE CONTROLLED?

Children with hand, foot and mouth disease should be excluded from school or childcare facilities until their blisters have dried.

The illness should be reported to the director of the childcare centre or school principal.

For more information contact your local public health unit, community health centre, or doctor.

April–May 2003

NSW HEALTH
Working as a Team

TRENDS

Summaries of case notifications through to March 2003 are shown in Figure 1, Tables 3 and 4.

BLOOD-BORNE AND SEXUALLY TRANSMISSIBLE INFECTIONS

Quarterly report: HIV notifications to end of December 2002

Tables 1 and 2 summarise recent trends in human immunodeficiency virus (HIV) disease in NSW.

New HIV diagnoses

Preliminary data indicate that notifications of new HIV diagnoses plateaued in 2002, with 350 cases reported up to the end of December (Table 1). This number compares with 348 in 2001 and 360 in 2000. Of the 350 new diagnoses of HIV in 2002, 92 per cent were in men, 90 per cent were in people aged between 20 and 49 years, and 86 per cent lived in the Sydney metropolitan area (Table 2). Male-to-male sexual contact (with or without a history of injecting drug use) was reported as a risk factor for over two-thirds of cases, and heterosexual contact (as the only risk factor) for 15 per cent. Eight cases (two per cent) reported injecting drug use as their only risk factor.

AIDS diagnoses and AIDS deaths

Preliminary data for 2002 indicate that the number of acquired immunodeficiency syndrome (AIDS) diagnoses continued to fall in 2002 (to 66, compared with 74 in 2001 and 118 in 2000). Similarly, deaths from AIDS declined to 13 in 2002, compared with 35 in 2001 and 70 in 2000 (Table 2). Compared with people newly diagnosed with HIV infection, people reported with AIDS were more frequently men, older, resident outside of Sydney, and reported male-to-male sex as their prime risk factor for infection.

GLOSSARY OF TERMS

New HIV diagnosis refers to a person who is diagnosed for the first time with human immunodeficiency virus (HIV) infection.

Newly acquired HIV infection refers to a person with a new HIV diagnosis who tested HIV negative or reported a seroconversion illness in the 12 months before HIV diagnosis

AIDS refers to a person with HIV infection who develops one of several infections, malignancies, or other medical conditions indicating immune depression consistent with the definition of the acquired immunodeficiency syndrome (AIDS).

AIDS death refers to a person who has died of any cause after being diagnosed with AIDS.

TABLE 1

NOTIFICATION OF HIV INFECTION, AIDS AND AIDS DEATHS BY YEAR, NSW, 1981–2002

	HIV		AIDS		AIDS deaths	
Year	*N*	*%*	*N*	*%*	*N*	*%*
1981	1	0.01	1	0.02	1	0.03
1982	1	0.01	1	0.02	0	0.00
1983	2	0.02	3	0.06	1	0.03
1984	206	1.60	30	0.59	6	0.17
1985	1005	7.84	91	1.77	46	1.32
1986	1107	8.64	162	3.16	108	3.10
1987	1642	12.81	251	4.89	143	4.10
1988	1153	9.00	321	6.26	139	3.99
1989	991	7.73	356	6.94	239	6.85
1990	821	6.41	425	8.29	326	9.35
1991	826	6.45	443	8.64	344	9.86
1992	701	5.47	432	8.42	330	9.46
1993	596	4.65	480	9.36	379	10.87
1994	501	3.91	553	10.78	423	12.13
1995	538	4.20	473	9.22	356	10.21
1996	453	3.53	366	7.14	272	7.80
1997	429	3.35	200	3.90	125	3.58
1998	407	3.18	173	3.37	69	1.98
1999	378	2.95	109	2.13	63	1.81
2000	360	2.81	118	2.30	70	2.01
2001	348	2.71	74	1.44	35	1.00
2002	350	2.73	66	1.29	13	0.37
Total	**12816**	**100**	**5128**	**100**	**3488**	**100**

TABLE 2

CHARACTERISTICS OF NSW RESIDENTS REPORTED WITH HIV INFECTION, AIDS, OR WHO HAVE DIED FROM AIDS, 1981 TO DECEMBER 2002

Characteristic	All cases 1981–Dec 2002						Cases for 2001						Jan–Dec 2002					
	HIV		AIDS		AIDS deaths		HIV		AIDS		AIDS deaths		HIV		AIDS		AIDS deaths	
	N	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
Gender																		
Female	675	5.3	207	4.0	118	3.4	32	9.2	5	6.8	2	5.7	24	6.9	1	1.5	0	0.0
Male	11862	92.6	4908	95.7	3361	96.4	310	89.1	69	93.2	33	94.3	321	91.7	64	97.0	13	100.0
Transgender	24	0.2	13	0.3	9	0.3	0	0.0	0	0.0	0	0.0	2	0.6	1	1.5	0	0.0
Not stated	255	2.0	0	0.0	0	0.0	6	1.7	0	0.0	0	0.0	3	0.9	0	0.0	0	0.0
Age																		
0–2	27	0.2	7	0.1	3	0.1	0	0.0	0	0.0	1	2.9	1	0.3	0	0.0	0	0.0
3–12	36	0.3	11	0.2	8	0.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
13–19	208	1.6	13	0.3	9	0.3	3	0.9	0	0.0	0	0.0	1	0.3	0	0.0	0	0.0
20–29	4048	31.6	758	14.8	538	15.4	84	24.1	6	8.1	3	8.6	78	22.3	3	4.5	1	7.7
30–39	4910	38.3	2126	41.5	1432	41.1	146	42.0	26	35.1	19	54.3	156	44.6	21	31.8	4	30.8
40–49	2427	18.9	1505	29.3	1019	29.2	75	21.6	25	33.8	8	22.9	81	23.1	30	45.5	6	46.2
50–59	779	6.1	534	10.4	349	10.0	21	6.0	12	16.2	2	5.7	20	5.7	11	16.7	2	15.4
60+	276	2.2	174	3.4	130	3.7	9	2.6	5	6.8	2	5.7	11	3.1	0	0.0	0	0.0
Not stated	105	0.8	0	0.0	0	0.0	10	2.9	0	0.0	0	0.0	2	0.6	0	0.0	0	0.0
Exposure																		
Male homosexual–bisexual	7641	59.6	4158	81.1	2900	83.1	220	63.2	56	75.7	25	71.4	236	67.4	47	71.2	12	92.3
Male homosexual–bisexual and IDU	305	2.4	203	4.0	137	3.9	19	5.5	0	0.0	3	8.6	11	3.1	8	12.1	0	0.0
Injecting drug use	432	3.4	102	2.0	52	1.5	19	5.5	3	4.1	0	0.0	8	2.3	0	0.0	1	7.7
Heterosexual	911	7.1	311	6.1	147	4.2	55	15.8	7	9.5	4	11.4	52	14.9	10	15.2	0	0.0
Haemophilia-–Coagulation	114	0.9	52	1.0	46	1.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Blood–Tissue recipient or NSI*	119	0.9	104	2.0	90	2.6	0	0.0	0	0.0	1	2.9	0	0.0	0	0.0	0	0.0
Vertical	37	0.3	14	0.3	7	0.2	0	0.0	0	0.0	1	2.9	1	0.3	0	0.0	0	0.0
Undetermined	3198	25.0	34	0.7	17	0.5	16	4.6	2	2.7	0	0.0	19	5.4	1	1.5	0	0.0
Not stated	59	0.5	150	2.9	92	2.6	19	5.5	6	8.1	1	2.9	23	6.6	0	0.0	0	0.0
Residence																		
Greater Sydney**	7139	55.7	4286	83.6	2930	84.0	307	88.2	56	75.7	28	80.0	302	86.3	52	78.8	11	84.6
Rest of New South Wales	852	6.6	685	13.4	423	12.1	39	11.2	17	23.0	7	20.0	38	10.9	14	21.2	2	15.4
Unknown	4825	37.6	157	3.1	135	3.9	2	0.6	1	1.4	0	0.0	10	2.9	0	0.0	0	0.0
Grand Total	12816	100	5128	100	3488	100	348	100	74	100	35	100	350	100	66	100	13	100

Data source: NSW HIV–AIDS database, CDB, NSW Department of Health. Recent HIV data may contain duplicates.
* Needle-stick injury
** Greater Sydney area health services include Central Sydney, North Sydney, Western Sydney, Wentworth, South West Sydney, and South East Sydney.

Note that recent reports of HIV diagnoses may include duplicate notifications, and that reports of HIV, AIDS, and deaths are likely to increase over time as late notifications are received.

VECTOR-BORNE DISEASES

Notifications of arboviruses remain below seasonal expectations. Most notifications received in February and March were for Barmah Forest virus infection.

ZOONOSES

Case study: Brucellosis—Travellers beware

The Western Sydney Centre for Public Health reported a case of brucellosis in February 2003. The woman had lived in the Middle East and arrived in Australia in late 2002. She presented to a GP in January 2003 with fever and pain in her left thigh. She was later admitted to hospital. Her symptoms persisted. It subsequently emerged that she had been partially treated for brucellosis before leaving the Middle East. Treatment with tetracycline was prescribed and she was re-admitted to hospital where *Brucella* species were detected in blood cultures.

Brucellosis is acquired through the ingestion of raw milk, or unpasteurised dairy products, or through broken skin when handling tissues, blood, body fluids, and discharges of animals infected with *Brucella* species. Rarely, inhalation of infected aerosols causes disease in laboratory personnel. Aerosolisation is also considered a potential vehicle for dissemination in bioterrorist attacks. Person-to-person transmission of brucellosis has not been documented. In NSW, one to two cases of brucellosis have been reported annually over the last five years.

This case highlights three important messages:

1. Although rare in Australia, due principally to the effective control of the disease in the cattle and dairy industries, brucellosis remains endemic in some countries. Overseas travellers should be advised against consuming unpasteurised dairy products and handling the tissues or body fluids of animals when visiting farms. Identifying the source of infection is important, as locally-acquired cases may indicate the failure of control measures.
2. Brucellosis as a differential diagnosis is seldom considered by health care workers. It should be taken into account when symptoms including fever, sweating and chills, headache, weakness, arthralgia, depression, and weight loss are present in a patient with possible exposures in the five to 60 days before onset. Confirmation with blood culture or paired serology is essential. Laboratories must report all cases to their local public health unit. It is also helpful if clinicians notify suspected cases.
3. Language, and social and cultural factors, may act as barriers for people reporting a relevant medical history to their health care providers and health authorities. It is important that attempts to obtain information are made in a sensitive, supportive, and non-threatening environment.

RESPIRATORY AND OTHER DISEASES

Notifications of Legionnaires' disease, meningococcal disease, and invasive pneumococcal disease were in line with seasonal expectations.

VACCINE-PREVENTABLE DISEASES

Measles

No case of measles has been reported in NSW now for over seven months.

Case study: Tetanus

South Eastern Sydney Public Health Unit reported a case of tetanus in an elderly man who was admitted to hospital in February. He reported that he had injured his ankle with a rusty garden stake in January. On admission, he was noted to have a sore throat, breathing difficulties, and an ulcer on his ankle. He developed hypertonia and muscle spasms, and was transferred to an intensive care unit for ventilation. A clinical diagnosis of tetanus was made. His immunisation history was uncertain, however he reported no recent tetanus vaccinations.

Tetanus is a life-threatening disease caused by a toxin of the spore-forming bacteria *Clostridium tetani*. *C. tetani* spores survive in soil and, if they enter a wound, can grow and produce tetanus toxin. Tetanus follows an incubation period of three to 21 days, resulting in muscle rigidity, painful spasms and, among other things, respiratory failure. Tetanus is preventable through immunisation.

Immunisation against tetanus is recommended for all children at ages two, four, and six months, with boosters at 18 months and four years of age. Further boosters are recommended at 15–19 years and 50 years of age. Unimmunised adults should receive a primary course of three doses given at least a month apart, and then two boosters at 10-year intervals. Management of tetanus-prone wounds depends on a history of vaccination and the type of wounds sustained, and may involve a dose of tetanus toxoid, and tetanus immunoglobulin (see the *Australian Immunisation Handbook* for details).

ENTERIC DISEASES

Salmonellosis

February

The NSW Department of Health received 275 notifications of salmonellosis in February, of which 48 per cent were due to the *Salmonella enterica* serovar Typhimurium (*S. Typhimurium*)(STM). The most commonly notified phage types were STM 170 and STM 197. Public health units in areas where cases have been notified have been asked to

interview at least two cases of both of these infections to help identify any common risk factors. Other serovars with notable increases in February include *S. chester*, *S. infantis*, and *S. virchow*. Northern Sydney Public Health Unit investigated five cases of *S. virchow* but no common links were identified.

March

In March, there was an increase in notification of a number of Salmonella serovars. There were 18 cases of *S.chester* reported compared with no cases in 2002 and five cases in 2001. STM 170 and 197 continued to be reported frequently. Interviews with cases were conducted but these did not reveal either a likely source of infection or links between the cases. No source for the increase in *S. virchow* phage type 19 in February was determined.

Listeriosis

Three cases of listeriosis were notified in February and two cases in March. Of these, three had underlying immunocompromising conditions. No common links have been found among the cases.

Haemolytic Uraemic Syndrome

One case of Haemolytic Uraemic Syndrome (HUS) was reported in March in a four-year-old girl.

Outbreaks

Eleven of twenty-four people who attended a private party in the Illawarra Area became ill with diarrhoea and vomiting in February. The *Salmonella* phage type STM 135a was isolated from three stool samples and *Salmonella* species were isolated from a sample of left over food. Interviews with party-goers who became ill could not determine the particular food responsible for the outbreak.

Three other outbreaks of gastroenteritis were reported in February. Two of these occurred in aged care facilities, one of which was confirmed to be caused by a Norovirus (the new name for Norwalk virus).

The Hunter Public Health Unit recently investigated an outbreak of gastroenteritis among students and staff following a secondary school camp. Of the 96 people on the camp, 19 reported symptoms that included fever, diarrhoea, vomiting, and abdominal cramping. Two cases had bloody bowel motions. *Campylobacter* was isolated from three of the four stool samples collected. The most likely source of infection was cooked take-away chickens. These chickens had been held at a temperature between 5–60 degrees Celcius for over four hours before being served and leftovers were also consumed the following day. Poor quality drinking water was another possible source of infection. Samples of tank water and untreated dam water available through local taps at the campsite both contained raised coliform counts and *E. coli* but no other bacterial pathogens were isolated.

SEVERE ACUTE RESPIRATORY SYNDROME (SARS)

Summary of SARS investigations

In the week ending 25 April 2003, there were two people identified in NSW who had fever and respiratory symptoms within 10 days of being in a SARS-affected area. Both recovered well and were released from hospital. In total, 33 patients have been investigated for SARS in NSW since 17 March 2003, including eight people with pneumonia. None are thought to have SARS.

Background

An epidemic of atypical pneumonia was first noted in southern China in November 2002. Subsequent transmission to travellers and their contacts led the World Health Organization to issue a global alert on 15 March 2003. The disease, which included fever and respiratory symptoms, was named Severe Acute Respiratory Syndrome or SARS.

The case definition for suspected SARS included a person who visited an affected area, or who had close contact with a SARS case in the previous 10 days, who develop fever (>38 °C) and cough, shortness of breath, or difficulty breathing. Probable cases have a chest X-ray indicating pneumonia or respiratory distress syndrome (RDS) in the absence of another cause. However, because no causative pathogen is identified in 40 per cent of patients with community-acquired pneumonia in normal circumstances, many patients fitting this definition may well have a disease other than SARS.

A new coronavirus has now been identified as the pathogen that causes SARS. Until specific diagnostic tests for the new coronavirus are validated, definitive diagnosis of SARS remains difficult.

Methods

Active surveillance for SARS in NSW began on 17 March 2003. Hospitals and general practitioners were alerted to report possible cases to their public health unit, and to use SARS infection control precautions. The current history of all patients under investigation are reviewed by a national expert committee to determine the probability of SARS in each patient.

Findings

As of the 20 April, the Communicable Diseases Branch of the NSW Department of Health has been notified of 33 people who have been investigated for possible SARS. Four people had onset of fever in February, 13 in March, and 16 in April.

Of these 33 patients, 20 (61 per cent) were male and their ages ranged from six months to 74 years (median = 43 years). Five patients (16 per cent) were aged 0–5 years, two patients (six per cent) were aged 6–19 years, nine patients (27 per cent) were aged 20–39, 11 patients (33

per cent) were aged 40–59, and six patients (18 per cent) were older than 60 years.

Twenty-one patients (64 per cent) resided in metropolitan Sydney and eight (24 per cent) in other parts of NSW. Four patients (12 per cent) were overseas visitors.

Clinical features

All 33 patients reported fever and cough. Fifteen patients (47 per cent) also reported shortness of breath, and 12 patients (38 per cent) reported difficulty breathing.

Twenty-five patients (76 per cent) had fever and cough but either had no chest X-ray or their X-ray showed no evidence of pneumonia. An alternative diagnosis was subsequently confirmed for seven of these cases (influenza A [1], parainfluenza [2], mycoplasma [1], streptococcus pneumoniae [1], and typhoid [1]). These patients are thought unlikely to have SARS, even in the absence of an alternative diagnosis.

Of the eight patients (24 per cent) with pneumonia confirmed by chest X-ray, one was subsequently diagnosed with influenza A, one was diagnosed with mycoplasma, one was diagnosed with streptococcus pneumoniae, two had X-rays inconsistent with SARS, two responded rapidly to antibiotics, and one had only limited exposure to a SARS affected area (in transit). One person remains under investigation for possible SARS.

Eighteen patients (55 per cent) were hospitalised. None has been admitted to intensive care and none have died.

Exposure

All 33 patients reported being in an affected country, including 19 (58 per cent) in Hong Kong, eight (24 per cent) in Singapore, three (nine per cent) in China, two (six per cent) in Hanoi, Vietnam, and one (three per cent) in Toronto, Canada. Several people visited more than one affected area.

For eight patients (24 per cent), their only exposure was time spent in transit at airports (range: 1–7 hours). Of the remaining 25 people who were travellers, the mean length of stay in an affected country was nine days, (median five days; range: one to 58 days). The earliest travel to an affected area was identified as 2 February 2003. Three patients were residents of affected areas.

No patient reported close contact with a person known to have SARS. No health care worker caring for patients being investigated for SARS have been notified to NSW Health.

Airport screening

No cases of SARS have been identified from surveillance of inbound passengers at Sydney International Airport. Medical staff at the airport review between one and eight travellers per day for SARS.

For more information, access the NSW Department of Health website at:
www.health.nsw.gov.au/public-health/alerts/sars/index.html

NSW PUBLIC HEALTH BULLETIN

The *NSW Public Health Bulletin* is a publication of the NSW Department of Health.
The editor is Dr Lynne Madden, Manager, Public Health Training and Development Branch.
Dr Michael Giffin is the managing editor.

The Bulletin aims to provide its readers with population health data and information to support effective public health action.

The Bulletin is indexed by MEDLINE and *Index Medicus*.

Submission of articles

The preferred length of Bulletin articles is 1500 words. Tables and figures may be additional to that. News, comments, and other reports should be 500–600 words.

All manuscripts should contain a short introductory abstract that reflects the structure of the manuscript.

References should be set out in the Vancouver style.

Send submitted manuscripts on paper and in electronic form, either on disc (Word for Windows is preferred), or by email.

The manuscript must be accompanied by a letter signed by all authors.

Full instructions for authors are available on request from the managing editor.

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FIGURE 1

REPORTS OF SELECTED COMMUNICABLE DISEASES, NSW, JANUARY 1998 TO MARCH 2003, BY MONTH OF ONSET

Preliminary data: case counts in recent months may increase because of reporting delays.
Laboratory-confirmed cases only, except for measles, meningococcal disease and pertussis
BFV = Barmah Forest virus infections, RRV = Ross River virus infections
LI = Legionella longbeachae infections, Lp = L. pneumophila infections
Gp C and Gp B = disease due to serogroup C and serogroup B infection, other/unk = other or unknown serogroups

NSW population	
Male	50%
<5	7%
5–24	28%
25–64	52%
65+	13%
Rural*	42%

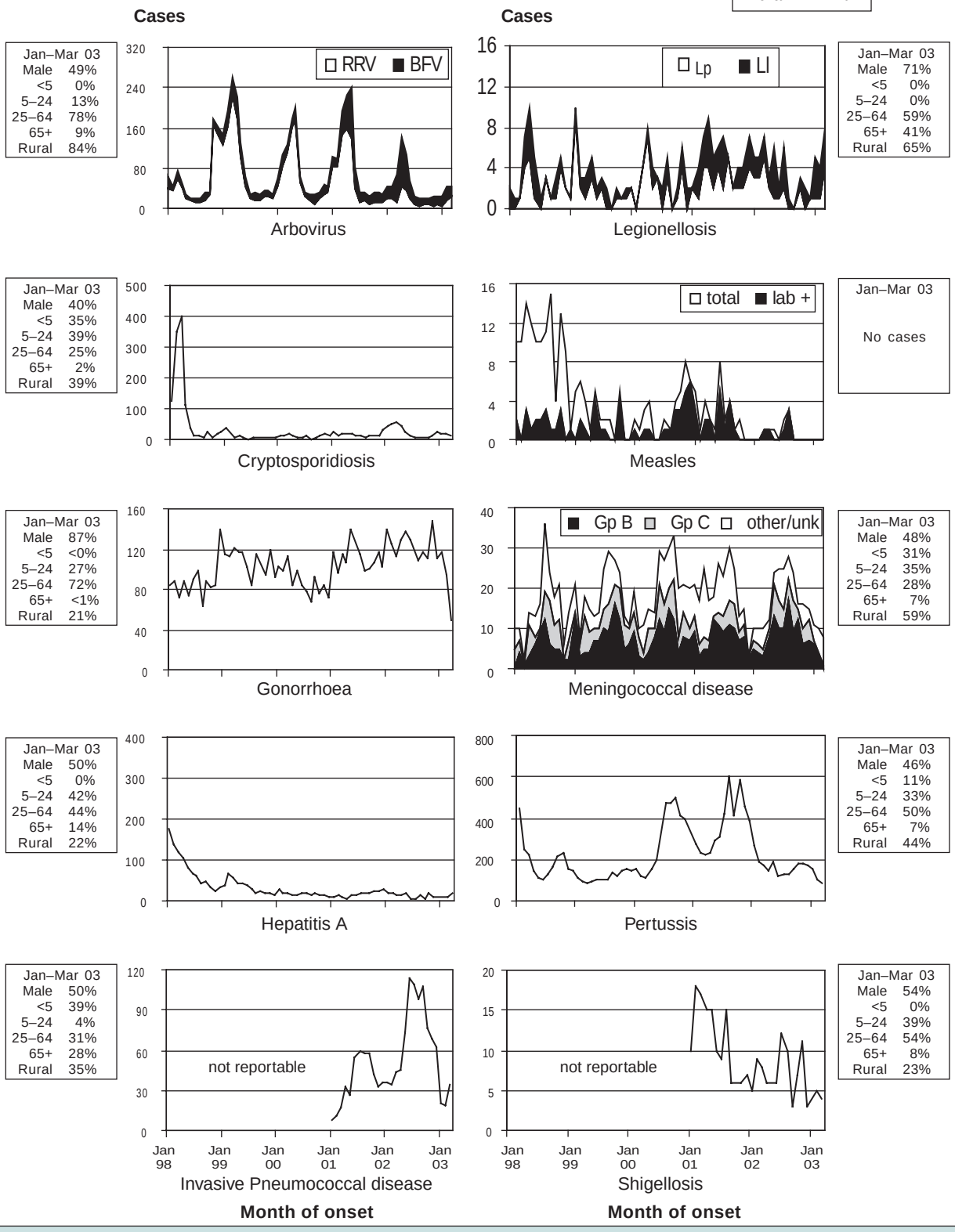

TABLE 3 REPORTS OF NOTIFIABLE CONDITIONS RECEIVED IN FEBRUARY 2003 BY AREA HEALTH SERVICES

Condition	Area Health Service																		Total	
	CSA	NSA	WSA	WEN	SWS	CCA	HUN	ILL	SES	NRA	MNC	NEA	MAC	MWA	FWA	GMA	SA	CHS	for Feb†	To date†
Blood-borne and sexually transmitted																				
Chancroid*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlamydia (genital)*	45	42	46	16	47	23	49	26	104	14	19	19	11	16	8	30	12	3	537	1,085
Gonorrhoea*	-	6	7	2	7	-	2	1	35	-	-	1	-	1	5	1	-	1	69	215
Hepatitis B - acute viral*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	10
Hepatitis B - other*	12	30	35	3	15	5	8	4	43	3	3	1	1	2	4	1	-	4	174	490
Hepatitis C - acute viral*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	5
Hepatitis C - other*	72	36	80	31	13	35	50	31	59	20	24	6	6	7	12	14	15	50	565	1,161
Hepatitis D - unspecified*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Syphilis	12	1	4	-	14	-	1	3	32	2	-	2	-	-	4	-	2	1	78	153
Vector-borne																				
Barmah Forest virus*	-	-	-	-	-	-	6	-	-	1	9	2	-	-	1	-	3	-	22	44
Ross River virus*	-	-	-	-	-	-	3	1	-	1	-	2	1	-	1	-	-	-	9	15
Arboviral infection (Other)*	2	2	4	-	2	1	-	2	-	-	2	-	-	-	-	1	1	-	17	23
Malaria*	-	-	2	-	4	-	-	-	3	-	-	-	-	-	-	-	1	-	11	29
Zoonoses																				
Anthrax*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brucellosis*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2
Leptospirosis*	-	1	-	-	-	-	-	-	-	-	4	2	-	-	-	-	-	-	7	12
Lyssavirus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Psittacosis*	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	2	5
Q fever*	-	-	-	-	-	-	-	-	-	3	6	4	16	3	2	-	-	1	35	74
Respiratory and other																				
Blood lead level*	-	2	-	-	-	1	3	2	4	-	-	1	1	2	18	-	-	-	34	137
Influenza*	-	-	-	-	-	-	-	1	5	-	-	1	-	-	-	-	-	-	7	34
Invasive pneumococcal infection*	-	2	1	1	3	1	2	-	3	-	-	-	-	1	-	-	2	-	16	48
Legionella longbeachae infection*	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	2	5
Legionella pneumophila infection*	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	2
Legionnaires' disease (Other)*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leprosy	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Meningococcal infection (invasive)*	-	1	1	1	1	2	1	-	-	-	1	-	-	-	-	-	1	-	9	22
Tuberculosis	4	-	6	1	1	-	1	-	9	-	-	-	-	-	-	-	1	-	23	70
Vaccine-preventable																				
Adverse event after immunisation	1	-	-	-	1	1	-	-	-	1	-	-	-	-	3	2	-	-	9	18
H. *Influenzae b* infection (invasive)*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Measles	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mumps*	-	2	1	-	-	1	-	-	1	1	-	-	-	-	-	-	-	-	6	12
Pertussis	10	13	13	3	14	6	30	-	18	5	11	6	-	3	-	3	2	2	139	304
Rubella*	-	-	-	-	-	-	1	1	2	-	-	-	-	-	-	-	-	-	4	5
Tetanus	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	1
Enteric																				
Botulism	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cholera*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cryptosporidiosis*	-	3	2	1	2	-	1	2	2	-	1	3	-	-	-	-	-	-	17	36
Giardiasis*	1	7	12	11	10	3	10	7	15	1	5	2	3	1	1	-	1	-	90	155
Haemolytic uraemic syndrome	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Hepatitis A*	-	-	3	-	-	2	-	-	2	-	-	-	-	-	-	-	-	-	7	16
Hepatitis E*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Listeriosis*	-	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-	-	-	3	4
Salmonellosis (not otherwise specified)*	14	31	25	19	29	13	15	17	38	16	18	4	9	8	3	6	10	-	276	542
Shigellosis*	-	2	-	1	-	1	-	-	1	-	-	-	-	-	-	-	-	-	5	10
Typhoid and paratyphoid*	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	7
Verotoxin producing *E. coli**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

* lab-confirmed cases only + includes cases with unknown postcode ** HIV and AIDS data are reported separately in the *NSW Public Health Bulletin* each quarter

CSA = Central Sydney Area
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MNC = North Coast Area
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MAC = Macquarie Area
MWA = Mid Western Area
FWA = Far West Area
GMA = Greater Murray Area
SA = Southern Area
CHS = Corrections Health Service

TABLE 4 REPORTS OF NOTIFIABLE CONDITIONS RECEIVED IN MARCH 2003 BY AREA HEALTH SERVICES

Condition	Area Health Service																		Total for Mar†	To date†
	CSA	NSA	WSA	WEN	SWS	CCA	HUN	ILL	SES	NRA	MNC	NEA	MAC	MWA	FWA	GMA	SA	CHS		
Blood-borne and sexually transmitted																				
Chancroid*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlamydia (genital)*	71	61	62	21	4	26	52	19	78	17	24	30	11	20	-	23	11	3	535	1,669
Gonorrhoea*	12	7	8	3	-	-	4	4	37	2	3	1	-	2	1	4	-	-	91	342
Hepatitis B - acute viral*	1	1	-	-	-	-	1	-	4	-	-	-	-	-	-	-	-	-	7	18
Hepatitis B - other*	69	29	40	5	1	3	11	2	40	-	-	5	1	4	-	2	1	6	220	812
Hepatitis C - acute viral*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	2	8
Hepatitis C - other*	74	37	47	22	4	43	54	40	51	19	29	14	19	22	-	25	6	58	570	1,880
Hepatitis D - unspecified*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Syphilis	9	8	3	3	-	-	-	1	27	2	2	2	-	1	-	-	-	-	60	215
Vector-borne																				
Barmah Forest virus*	-	-	1	-	-	-	2	-	-	10	9	1	-	1	-	-	1	-	25	73
Ross River virus*	1	-	-	-	-	-	6	1	-	8	1	3	-	1	-	2	-	-	23	42
Arboviral infection (Other)*	-	3	-	-	-	-	-	1	2	-	1	-	-	-	-	1	-	-	8	33
Malaria*	-	2	-	1	-	-	2	-	4	2	-	-	-	-	-	-	-	-	11	42
Zoonoses																				
Anthrax*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brucellosis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Leptospirosis*	-	-	-	1	-	-	4	-	-	-	1	2	-	-	-	-	-	-	8	21
Lyssavirus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Psittacosis*	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	2	8
Q fever*	-	1	1	-	-	-	2	1	3	4	2	9	11	3	-	-	1	-	38	110
Respiratory and other																				
Blood lead level*	-	-	-	3	-	-	7	1	1	-	2	-	-	1	-	1	-	-	16	156
Influenza*	6	1	2	-	1	-	-	-	6	-	2	-	-	-	-	-	-	-	19	59
Invasive pneumococcal infection*	2	3	5	3	5	2	3	2	5	-	-	-	2	1	-	7	-	-	40	98
Legionella longbeachae infection*	-	-	1	-	-	3	-	-	-	-	-	-	-	1	-	-	1	-	6	11
Legionella pneumophila infection*	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	4
Legionnaires' disease (Other)*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leprosy	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Meningococcal infection (invasive)*	-	-	2	-	-	1	1	1	1	-	-	-	2	1	-	-	-	-	9	31
Tuberculosis	8	6	2	-	1	-	1	2	7	-	-	1	-	-	-	-	-	-	28	101
Vaccine-preventable																				
Adverse event after immunisation	1	-	-	-	-	2	4	-	1	-	-	-	-	1	-	-	-	-	9	28
H. *Influenzae b* infection (invasive)*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Measles	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mumps*	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	13
Pertussis	11	15	13	4	23	8	23	1	21	1	9	5	1	4	-	4	1	-	144	460
Rubella*	-	-	1	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	3	8
Tetanus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Enteric																				
Botulism	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cholera*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cryptosporidiosis*	2	1	3	2	1	1	1	1	1	2	1	2	-	-	-	-	-	-	18	57
Giardiasis*	6	12	9	10	4	2	15	1	11	1	-	4	7	4	-	4	1	-	91	251
Haemolytic uraemic syndrome	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	2
Hepatitis A*	2	1	4	-	3	-	-	-	4	1	-	-	1	1	-	1	-	-	18	35
Hepatitis E*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Listeriosis*	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	2	6
Salmonellosis (not otherwise specified)*	6	35	26	13	22	5	13	5	25	25	12	6	7	5	-	10	8	-	224	781
Shigellosis*	-	-	-	1	1	-	-	1	1	-	1	-	-	-	-	-	-	-	5	15
Typhoid and paratyphoid*	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	4	11
Verotoxin producing *E. coli**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

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