Communicable Diseases Intelligence

Quarterly Report

Volume 27

Issue No 3

2003

ISBN 0725-3141

Website

http://www.cda.gov.au/index.htm

Contributions

Contributions covering any aspects of communicable diseases are invited. All contributions are subject to the normal refereeing process. Instructions to authors can be found in *Commun Dis Intell* 2003;27:130-132.

Subscriptions and contacts

Communicable Diseases Intelligence is produced every quarter by:

Surveillance and Epidemiology Section
Communicable Diseases Branch
Department of Health and Ageing
GPO Box 9848, (MDP 6)
CANBERRA ACT 2601;
Telephone: +61 2 6289 8245
Facsimile: +61 2 6289 7791
Email: cdi.editor@health.gov.au.

This journal is indexed by *Index Medicus*, Medline and the Australasian Medical Index

Disclaimer

Opinions expressed in *Communicable Diseases Intelligence* are those of the authors and not necessarily those of the Department of Health and Ageing or the Communicable Diseases Network Australia. Data may be subject to revision.

Front cover: Surveillance and Epidemiology Section, Australian Government Department of Health and Ageing.
Images sourced from the Centers for Disease Control and Prevention Public Health Image Library, courtesy of Dr WA Clark, James Volk, the WHO EPI Information System and the Centers for Disease Control and Prevention

Printed by Union Offset, Canberra

Contents

Surveillance of adverse events following immunisation: Australia, 2000–2002

Glenda Lawrence,[1] Robert Menzies,[1] Margaret Burgess,[1] Peter McIntyre,[1] Nicholas Wood,[1] Ian Boyd,[2] Patrick Purcell,[2] David Isaacs[3]

Abstract

The Adverse Drug Reactions Advisory Committee (ADRAC) database collates notifications of adverse events following immunisation (AEFI) from across Australia. The data were analysed for vaccines received between 1 January 2000 and 30 September 2002. Dose-based AEFI reporting rates were calculated using denominator data from the Australian Childhood Immunisation Register and annual national influenza vaccination coverage surveys. The majority of the 2,409 AEFI records analysed described non-serious events, principally injection site reactions; 10.5 per cent (n=253) described AEFIs with outcomes defined as 'serious'. Ten deaths were recorded but only one, following yellow fever vaccine, was causally related to immunisation. The average annual population-based reporting rate was 4.5 per 100,000 population. Vaccine dose-based AEFI reporting rates were 2.2 per 100,000 doses of influenza vaccine for adults aged 40 years and over and 14.6 per 100,000 doses of all scheduled vaccines for children aged less than 7 years. The most frequently reported type of adverse event was injection site reaction following receipt of an acellular pertussis-containing vaccine, particularly among children in the age groups scheduled to receive their fourth or fifth doses of the vaccine (overall reporting rate 67 per 100,000 doses). The data highlight the safety of vaccines in Australia, and illustrate both the utility of available immunisation coverage data to estimate dose-based AEFI reporting rates and the value of the ADRAC database as a surveillance tool for monitoring AEFIs nationally. *Commun Dis Intell* 2003;27:307–323.

Keywords: AEFI, adverse events, vaccines, surveillance, immunisation

Introduction

The term 'adverse event following immunisation (AEFI)' describes any serious or unexpected adverse event that occurs after immunisation that may be related to the vaccine itself or to its handling or administration.[1] An adverse event may be *coincidentally* associated with the *timing* of immunisation without necessarily being caused by the vaccine or the immunisation process.

Routine ongoing surveillance of AEFIs after a vaccine is licensed allows the detection of rare, late-onset, unexpected and population-specific adverse events that are difficult to detect in pre-licensure vaccine trials.[1,2] Surveillance also helps identify specific problems related to the manufacture, storage or administration of a vaccine, and allows monitoring of trends over time. AEFI surveillance and the regular reporting of surveillance data help build and maintain public confidence in immunisation programs.[1,2,3] This is increasingly important as the incidence of vaccine preventable diseases declines[4] as a result of successful immunisation programs, and the community focuses more on vaccine safety.[3]

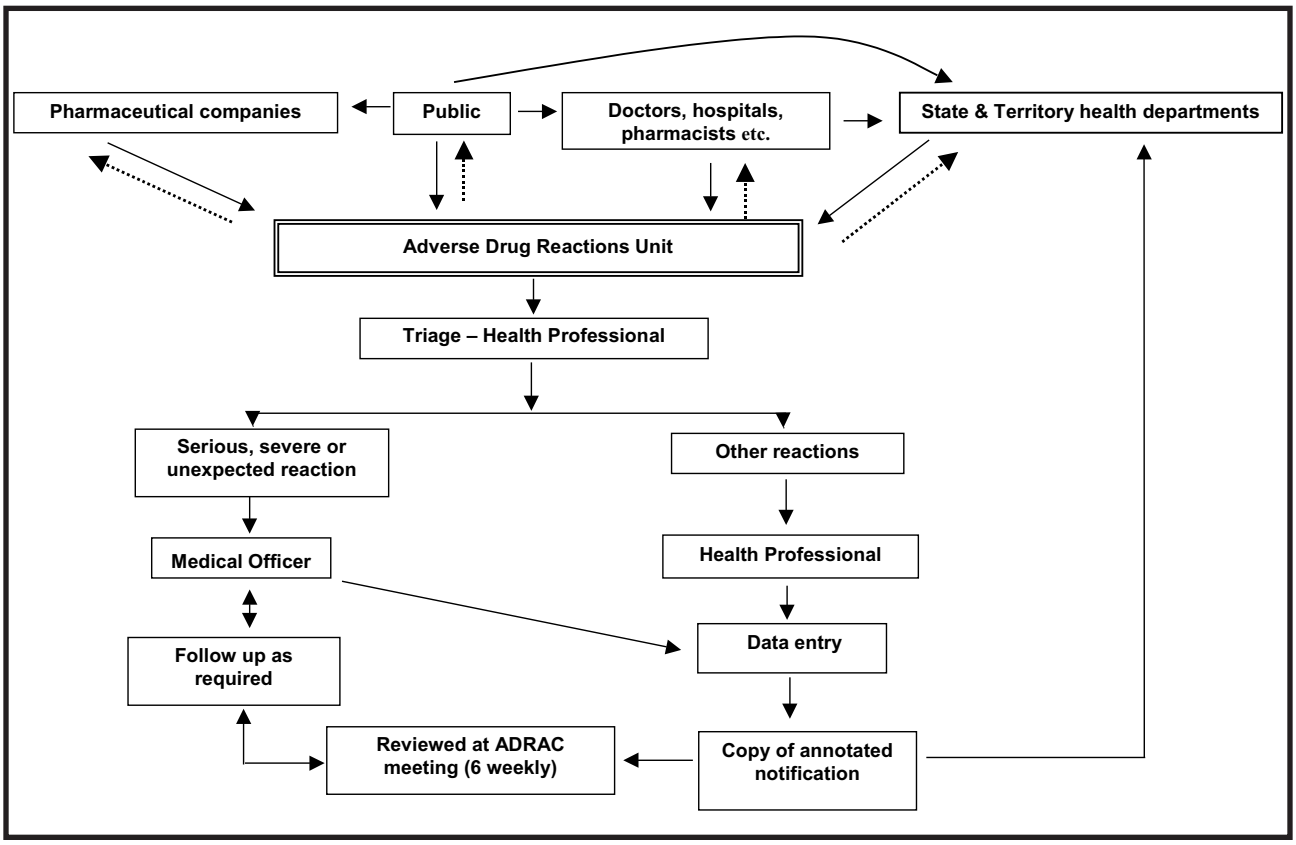
Overview of passive AEFI surveillance in Australia

Australia has had a passive AEFI surveillance system in place for many years, which has undergone a number of changes over time. The Adverse Drug Reactions Unit (ADRU), which is part of the Therapeutic Goods Administration and provides the secretariat for the Adverse Drug Reactions Advisory Committee (ADRAC), has been responsible for the collation and review of all Australian AEFI notifications since May 2000. Notifications are either sent directly to the ADRU by reporters, or via state and territory health departments (Figure 1).

1. National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases, Children's Hospital at Westmead, and the University of Sydney, New South Wales
2. Adverse Drug Reactions Unit, Therapeutic Goods Administration, Commonwealth Department of Health and Ageing, Canberra
3. Adverse Drug Reactions Advisory Committee and the Children's Hospital at Westmead, New South Wales

Corresponding author: Dr Glenda Lawrence, National Centre for Immunisation Research and Surveillance, Locked Bag 4001, Westmead NSW 2145. Telephone: +61 2 9845 0520. Facsimile: +61 2 9845 3082. Email: glendal@chw.edu.au

Figure 1. Flow diagram of Adverse Event Following Immunisation surveillance in Australia



Arrows indicate the directions of information transfer. Dotted lines indicate acknowledgment of receipt of an AEFI notification by the Adverse Drug Reactions Unit. All notifications are reviewed by the Adverse Drug Reactions Advisory Committee which meets at six-weekly intervals.

All state and territory health departments encourage doctors, other health professionals and members of the public to notify suspected AEFIs to a relevant authority and request notification of specific AEFIs that are listed and defined in the *Australian Immunisation Handbook*.[5] However, AEFI surveillance methods differ somewhat between the states and territories. Legislation in New South Wales, Queensland, the Northern Territory and Western Australia requires doctors and hospitals to notify the respective health department of suspected AEFIs[5] and notifications are investigated by local public health staff. In South Australia and the Australian Capital Territory, notification of AEFIs is not a legislated requirement although both jurisdictions request notification to their respective health departments and investigate notified cases. Victoria and Tasmania require all suspected AEFIs to be notified directly to the ADRU.

At the ADRU, AEFI notifications are investigated and managed following internationally consistent protocols[6,7] (Figures 1 and 2). A causality rating is assigned to each AEFI using the criteria described in the Box, which describes the level of certainty that suspected vaccines or drugs caused the reported AEFI. All AEFI notifications are reviewed by ADRAC at six-weekly committee meetings and summary data are forwarded to the World Health Organization (WHO) annually and as required.

Scope of this report

This report provides an overview of the AEFI notification data collected in the ADRAC database for vaccines received between 1 January 2000 and 30 September 2002 (33 months). The study period was chosen based on the transition to the centralised collation of all Australian AEFI reports in the ADRAC database in May 2000, and the changeover to a new ADRAC database in mid-November 2002. The time frame encompasses several important changes in childhood immunisation in Australia:

(i) universal hepatitis B vaccination was introduced into the Australian Standard Vaccination Schedule (ASVS) for babies born on or after 1 May 2000,[5]

(ii) in May 2001, the 7-valent pneumococcal conjugate vaccine (7vPCV) was added to the ASVS for children in specific risk groups;[5] and

(iii) the varicella vaccine and meningococcal C conjugate vaccine (MenCCV) became available for use in Australia in early 2000 and late 2001, respectively.

Methods

Data source

De-identified information was released to the National Centre for Immunisation Research and Surveillance for all drug and vaccine adverse event notifications entered into the ADRAC database between 1972 and 18 November 2002.

ADRAC database records were eligible for inclusion in the analysis of AEFIs if:

- a vaccine was recorded as 'suspected' of involvement in the reported adverse event *and*
- either

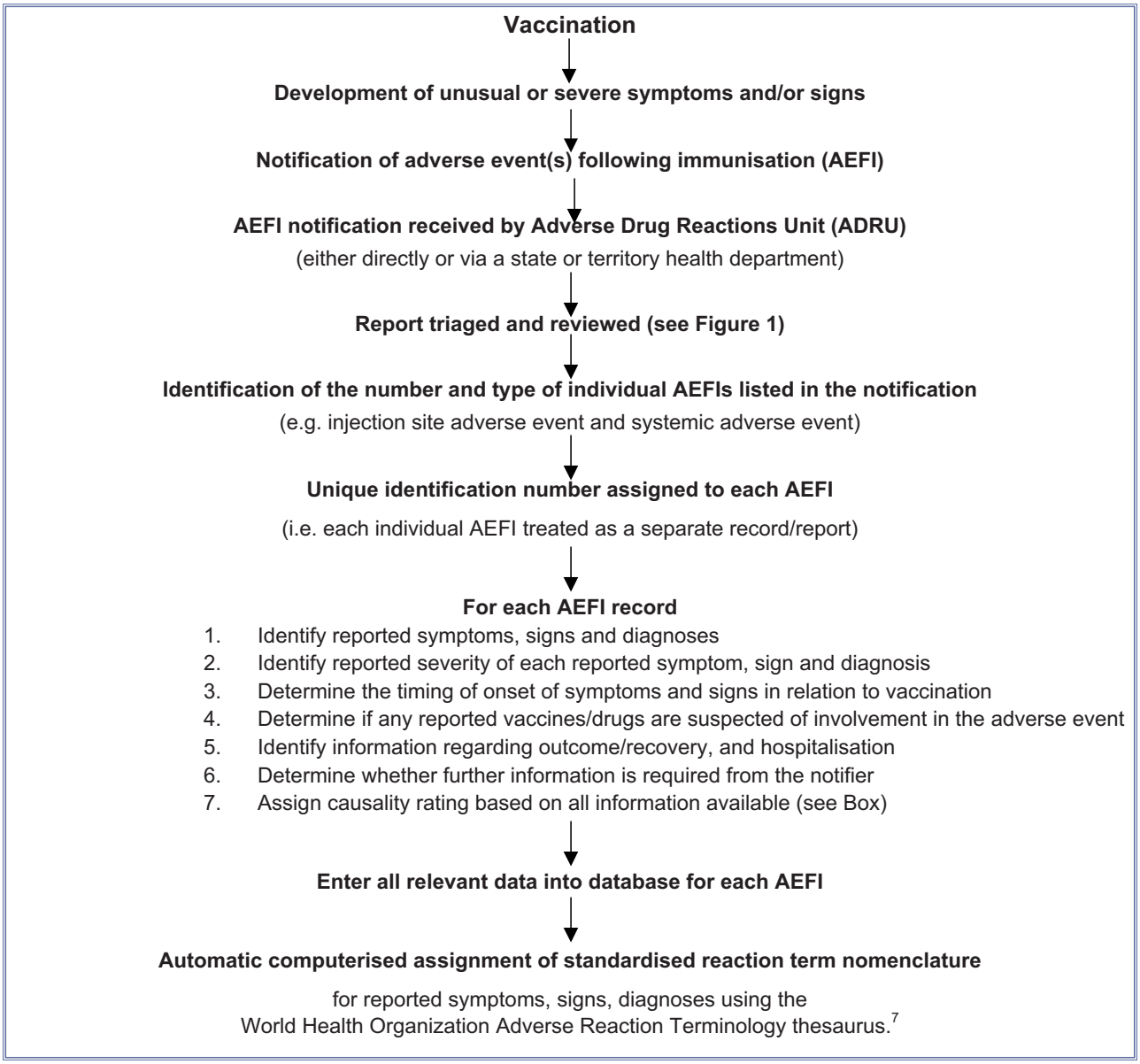
  a) the vaccination occurred between 1 January 2000 and 30 September 2002

  or

  b) if no vaccination date was recorded, the date of onset of symptoms or signs occurred between 1 January 2000 and 30 September 2002.

It was not possible to identify and link AEFI records* that arose from the same AEFI notification. Nevertheless, the number of notifications that generated the AEFI records included in the analysis was estimated from information provided by ADRU staff and by comparison of the dates of birth, onset and notification for a subset of AEFI records in the database.

Figure 2. Flow chart showing processing of notifications of adverse events following immunisation by staff of the Adverse Drug Reactions Unit



* Note that the terms 'AEFI record' and 'AEFI notification' have specific meanings in this report. One 'AEFI notification' (a report to a relevant authority) may generate more than one 'AEFI record' in the ADRAC database if a number of adverse events are described in the notification (e.g. a local injection site adverse event and a systemic adverse event – Figure 2). This report is based on 'AEFI records'.

Box. Criteria used to determine the causality rating* of a notified adverse event

The basic criteria used by the Adverse Drug Reactions Advisory Committee in determining causality ratings are consistent with international World Health Organization criteria and are as follows:

Certain

(a) A reaction in association with a single drug/vaccine which is confirmed by re-challenge; or

(b) reaction in association with a single drug/vaccine which is confirmed by laboratory data specifically implicating that drug/vaccine; or

(c) reaction whose onset is immediately following the administration of a single drug/vaccine (within five minutes if injection was the method of administration); or

(d) reaction with a precise spatial correlation with the administration of a single drug/vaccine (e.g. at the exact site of injection).

Probable

(a) A reaction with a close temporal or spatial (e.g. skin) correlation with the administration of a single drug/vaccine; or

(b) reaction is in reasonable temporal association with a single drug/vaccine and recovery on withdrawal of the drug/vaccine if no other drug/vaccine is withdrawn and no therapy given; or

(c) an uncommon clinical phenomenon associated with the administration of a single drug/vaccine and the reasonable exclusion of other factors.

Possible

(a) An alternative explanation exists; or

(b) more than one drug/vaccine is suspected† in association with the adverse event; or

(c) data are incomplete; or

(d) recovery follows withdrawal of more than one drug/vaccine; or

(e) the time relationship is not clear; or

(f) the outcome of the reaction is not recorded; or

(g) recovery follows therapy in addition to withdrawal of the drug/vaccine.

* Modified from information provided by the Adverse Drug Reactions Advisory Committee.

† ADRAC will always code as suspected, the drug/vaccine implicated by the notifier of the suspected adverse event. On some occasions, however, the Committee may suspect other drugs/vaccines whose commencement has a reasonable temporal relationship with the onset of the event.

Study definitions of AEFI outcomes and reactions

AEFI outcomes were defined as 'serious' or 'non-serious' using information recorded in the ADRAC database and criteria similar to those used by the World Health Organization[6] and the United States of America (US) Vaccine Adverse Events Reporting System (VAERS).[8] An AEFI was defined as 'serious' if the record indicated that the person had recovered with sequelae, required attendance or treatment at a hospital, experienced a life-threatening event, or died.

Typically, each AEFI record listed multiple symptoms, signs and diagnoses, and their equivalent World Health Organization standardised adverse reaction terms. The WHO standardised terms were used to create a set of reaction categories for analysis. First, reaction terms were grouped to create reaction categories analogous to the AEFIs listed and defined in the *Australian Immunisation Handbook*.[5] The categories were less specific than those defined in the *Australian Immunisation Handbook* because the investigators had to rely on information recorded in the ADRAC database rather than complete clinical notes. Specific reaction categories were then created for all remaining WHO reaction terms that were mentioned in more than 1 per cent of AEFI records. Finally, terms mentioned in less than 1 per cent of AEFI records were grouped into broader reaction categories based on the organ system where the reaction was manifested (e.g. other-gastrointestinal, other-neurological). A panel of four clinicians with expertise in AEFIs and two epidemiologists reviewed the reaction category definitions.

Data analysis

All data analyses were performed using the SAS version 8.02 computer program.[9] The distribution of AEFI records was analysed by age, gender, jurisdiction and type of reporter (e.g. health department, doctor, public). Average annual population-based reporting rates were calculated for each state or territory and by age group using 2001 mid-year census data obtained from the Australian Bureau of Statistics.

The frequency and age distribution of AEFI outcomes and reaction term categories were calculated. The frequency of each vaccine listed as 'suspected' of involvement in the reported adverse event was also calculated. The age distribution and the proportion of AEFI records for each vaccine was calculated where: (i) the vaccine was the only suspected vaccine or drug; (ii) the AEFI record was assigned a 'certain' or 'probable' causality rating; and (iii) the AEFI was defined as 'serious. Because many AEFI records listed more than one suspected vaccine and several reaction terms to describe an adverse event, column totals in the relevant tables exceed the number of AEFI records analysed.

Dose-based AEFI reporting rates were estimated for children aged less than 7 years for seven childhood ASVS vaccines (DTPa, DTPa-hepB, Hib, Hib-hepB, hepB, polio and MMR), and for adults aged 40 years and over for influenza vaccine. The number of administered doses of each of the seven childhood ASVS vaccines was calculated from the Australian Childhood Immunisation Register (ACIR), a national population-based register of >99 per cent of children aged less than 7 years. Vaccine doses administered between 1 January 2000 and 30 September 2002 were estimated for the age groups <1 year, 1 to <2 years, and 2 to <7 years (i.e. the age at vaccination). The number of administered influenza vaccine doses was estimated from the 2000, 2001 and 2002 annual national influenza coverage surveys[10,11,12] and mid-2001 population estimates for the 40–64 years and 65 years age groups. Dose-based AEFI reporting rates could not be determined for other vaccines and age groups due to the lack of reliable denominator data for the number of vaccine doses distributed or administered.

Results

There were 2,409 AEFI records entered into the ADRAC database where the date of vaccination or onset of a reported adverse event occurred between 1 January 2000 and 30 September 2002. This corresponded to approximately 2,050 AEFI notifications, and indicates that approximately 15 per cent of AEFI notifications generated more than one AEFI record.

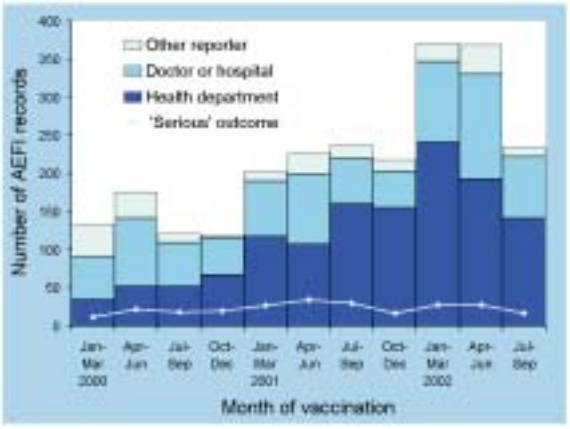
Two hundred and fifty-three AEFI records (10.5%) were defined as 'serious' (i.e. recovery with sequelae, requiring hospital treatment, experiencing a life-threatening event or death). In total, 1,041 (43%) AEFI records were assigned causality ratings of 'certain' (n=939) or 'probable' (n=102).

AEFI reporting sources and trends

The distribution, sources and population-based reporting rates of AEFIs for each state or territory are shown in Table 1. The overall average annual AEFI reporting rate was 4.5 per 100,000 population. This increased from 2.8 per 100,000 population for the 12 months January–December 2000 to 6.1 per 100,000 population for the 12 months October 2001–September 2002. The average annual population-based AEFI reporting rates varied considerably between the states and territories. Generally, the more populous jurisdictions (i.e. New South Wales, Victoria, Queensland) had the lowest AEFI reporting rates. Reporting rates for AEFIs assigned a 'certain' or 'probable' causality rating, or those defined as 'serious', were less variable across jurisdictions than the overall AEFI reporting rates. The relative contribution of each type of reporter (i.e. health department, doctor/hospital, other) varied by jurisdiction and was related to jurisdictional differences in AEFI notification requirements.

The distribution of AEFI records by quarter of vaccination is shown in Figure 3. The number per quarter ranged from 133 records in January–March 2000 to 371 in January–March 2002 (median: 218). Trends over time by type of reaction category and vaccine type are shown in Figures 4 and 5 and described later in the report. Although the proportion

Figure 3. Reporter type and outcome records of adverse events following immunisation, ADRAC database, 1 January 2000 to 30 September 2002, by month of vaccination



For reports where date of vaccination was not recorded, date of onset was used as a proxy for vaccination date.

Table 1. Distribution and population-based reporting rates of adverse events following immunisation ADRAC database, 1 January 2000 to 30 September 2002, by jurisdiction

Jurisdiction	AEFI records		Rate per 100,000 population*			Reporter type		
			Overall	'Certain' or 'probable' causality rating†	'Serious' outcome‡	Health department	Doctor or hospital	Other§
	n	%				%	%	%
Australian Capital Territory	194	8.1	22.5	5.8	0.8	93	7	<1
New South Wales	544	22.6	3.0	1.3	0.5	53	43	3
Northern Territory	86	3.6	15.8	7.0	1.3	81	13	6
Queensland	305	12.7	3.1	1.3	0.3	48	47	5
South Australia	448	18.6	10.8	5.7	0.5	78	22	<1
Tasmania	30	1.2	2.3	1.2	0.2	0	97	3
Victoria	349	14.5	2.6	1.1	0.3	11	78	12
Western Australia	299	12.4	5.7	2.9	0.4	83	15	2
Australia¶	154	6.4	na	na	na	na	na	na
Total	2,409	100	4.5	2.0	0.5	55	35	10

AEFI Adverse event following immunisation.

* Average annual rates per 100,000 population, calculated using 2001 mid-year population census data (Australian Bureau of Statistics).

† See the Box for criteria used to assign causality ratings.

‡ AEFI records defined as 'serious' (see Methods and Table 3).

§ Includes reports from pharmacists (n=21), the public (n=78) and pharmaceutical companies (n=143).

|| Percentages were calculated using the number of reports for the specific jurisdiction as the denominator e.g. 93 per cent of the 194 AEFI reports from the Australian Capital Territory were reported to ADRAC by the health department, 7 per cent by doctors or hospitals and < 1 per cent by other reporters.

¶ Records where the jurisdiction in which the AEFI occurred was not reported or was unclear. These included AEFIs notified by pharmaceutical companies (n = 143) and by the Australian Vaccination Network (n=11).

na Not applicable

of AEFIs reported by state and territory health departments increased from May 2000 onwards, when jurisdictional reporting to the ADRU commenced, the number defined as 'serious' remained relatively constant (median 22; range 12–34 per quarter).

Age and gender distribution

In all, 62 per cent (n=1,496) of AEFI records involved children aged less than 7 years. The average annual population-based reporting rates were highest for children aged less than two years, the age group that receives the greatest number vaccinations (Table 2). Overall, there were more AEFI records for females, although the male to female ratio differed by age group (Table 2).

AEFI outcomes and reactions

The majority of records were defined as 'non-serious' (55%) while 10.5 per cent had outcomes defined as 'serious' (Table 3). Fewer 'serious' AEFIs were assigned 'certain' or 'probable' causality ratings compared with 'non-serious' AEFIs (23% versus 46%). Death was recorded as the outcome in

Table 2. Age and gender distribution of records of adverse events following immunisation, ADRAC database, 1 January 2000 to 30 September 2002

Age group (years)	Total		Male to female ratio	Rate* per 100,000 population
	n	%		
<1	442	18.3	1:0.8	62.5
1 to <2	632	26.2	1:0.8	89.7
2 to <7	422	17.5	1:0.8	11.7
7 to <20	152	6.3	1:1.4	1.6
20 to <65	503	20.9	1:3.0	1.6
65	209	8.7	1:2.2	3.1
Unknown	49	2.0	1:2.3	na
Total	2,409	100.0	1:1.2	4.5

* Average annual rate estimated using mid-2001 population census data (Australian Bureau of Statistics).

na Not applicable.

10 AEFI records (Table 3). Only one death (an adult who received a yellow fever vaccination) was thought to be causally related to vaccination[13,14] Thirty-four per cent of AEFI records were either missing relevant information (10%) or indicated that the person had not recovered at the time of notification (24%). Many of the latter group are likely to be reports of injection site reactions that had not resolved at the time of the notification.

The distribution and frequency of reactions mentioned in AEFI records are shown in Tables 4 and 5. In Table 4, only the reaction categories analogous to those listed in the *Australian Immunisation Handbook*[5] are shown. In Table 5, other reaction categories are listed in descending order of frequency. Injection site reactions were the most commonly mentioned category of reaction (n=1,072 or 42% of AEFI records), both overall and among the AEFIs of interest listed in the *Australian Immunisation Handbook*[5] (Table 4). This was followed by fever (18%), rash (16%) and allergic reactions (10%). There was a large increase over time in the number of AEFI records involving injection site reactions compared with those involving fever, rash and allergic reactions (Figure 4). The peak in notifications of injection site reactions for vaccines received in the first six months of 2002, shown in Figure 4, corresponds in time with the peak in the number of AEFI records shown in Figure 3.

Figure 4. Frequently reported reactions by month of vaccination, records of adverse events following immunisation, ADRAC database, 1 January 2000 to 30 September 2002

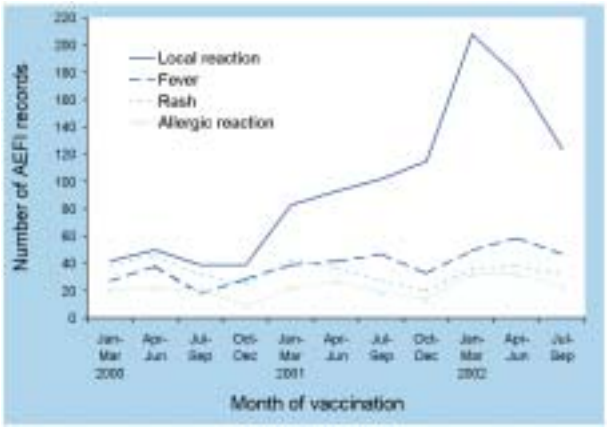


Table 3. Outcomes shown in records of adverse events following immunisation, ADRAC database, 1 January 2000 to 30 September 2002

Outcome	AEFI records		'Certain' or 'probable' causality rating†		Age group‡			
					< 7 years		7 years	
	n	%	n	%§	n	%§	n	%§
Non-serious: total	1,333	55.3	611	46	885	66	430	32
Not recovered at time of report	576	23.9	259	45	309	54	253	44
Not known (missing data)	247	10.3	113	46	160	65	78	32
Serious	253	10.5	58	23	142	56	103	41
recovered with sequelae	7		4		3	43	4	57
hospital admission	210		46		120	57	84	40
emergency department	21		8		12	57	8	38
life-threatening event	29		6		13	45	15	52
death	10		1		5	50	5	50
Total	2,409	100	1,041	43	1,496	62	864	36

AEFI Adverse event following immunisation.

* Percentages relate to the total number of adverse event following immunisation (AEFI) records (n=2,409).

† Causality ratings were assigned to AEFI records using criteria described in the Box.

‡ AEFI records where age or date of birth was not recorded are not shown.

§ Percentages relate to the number of AEFI records with the specific outcome, e.g. of 1,333 AEFI records with a 'non-serious' outcome, 46 per cent had causality ratings of 'certain' or 'probable' and 66 per cent were for children aged less than 7 years.

|| Categories are not mutually exclusive; an AEFI record may be counted in more than one 'serious' category (e.g. 'life-threatening event' and 'hospital treatment').

Table 4. Reactions of interest* listed in records of adverse events following immunisation, ADRAC database, 1 January 2000 to 30 September 2002

Reaction*	AEFI records	Single reaction reported†		Certain/probable causality rating‡		Age group§			
						<7 years		7 years	
	n	n	%	n	%	n	%	n	%
Injection site reaction	1,072	767	72	885	83	753	70	305	28
Fever	429	48	11	59	14	294	69	125	29
Rash	377	85	23	96	25	256	68	117	31
Allergic reaction	242	64	26	58	24	110	45	127	52
Abnormal crying	123	32	26	11	9	122	99	0	0
Convulsions	70	16	23	9	13	58	83	11	16
Lymphadenopathy/itis¶	54	13	24	18	33	22	41	30	56
Arthralgia	51	4	8	9	18	5	10	44	86
HHE**	33	13	39	8	24	30	91	1	3
hypotonia/hypokinesia**	41	3	7	4	10	36	88	3	7
Anaphylactoid reaction††	20	8	40	7	35	3	15	13	65
Arthritis	20	5	25	0	0	1	5	19	95
Abscess	16	12	75	13	81	11	69	5	31
Thrombocytopenia	11	1	9	1	9	5	45	6	55
Death	10	4	36	1	9	5	45	5	45
Encephalopathy	9	2	22	3	33	3	33	6	67
Brachial neuritis	4	2	50	1	25	0	0	4	100
Meningitis	4	2	50	0	0	3	75	1	25
Orchitis	4	2	50	0	0	0	0	4	100
Encephalomyelitis	3	0	0	0	0	1	33	2	67
Guillain-Barré syndrome	3	1	33	0	0	0	0	3	100
Parotitis	3	2	67	0	0	2	67	1	33
Sepsis	2	0	0	1	50	0	0	2	100
Osteomyelitis	1	0	0	0	0	1	100	0	0
Acute flaccid paralysis	0	0	0	0	0	0	0	0	0
Osteitis	0	0	0	0	0	0	0	0	0
SSPE‡‡	0	0	0	0	0	0	0	0	0
Toxic shock syndrome	0	0	0	0	0	0	0	0	0

AEFI Adverse event following immunisation.

* Reaction term variables were created for the AEFIs of interest listed in the *Australian Immunisation Handbook*, 7th edition, p 22–3 and 271–5[5] as described in Methods section.

† AEFI records where only one reaction was reported.

‡ See the Box for causality criteria.

§ AEFI records not shown if age or date of birth was missing.

|| Percentages relate to the number of AEFI records in which the specific reaction term was listed, e.g. of 1,072 AEFI records listing injection site reaction, 72 per cent listed only one type of reaction while 83 per cent had causality ratings of 'certain' or 'probable' and 70 per cent were for children aged less than 7 years.

¶ Includes lymphadenitis following BCG vaccination (n=2) and the more general term of 'lymphadenopathy'.

** Hypotonic-hyporesponsive episode (HHE). The separate reaction term of 'hypotonia/hypokinesia' indicates records where 'HHE' was not listed but other terms describing an HHE or similar event were.

†† Includes anaphylactoid reactions plus events reported as 'anaphylaxis' but coded in the database as 'anaphylactoid reaction'.

‡‡ Subacute sclerosing panencephalitis.

Table 5. 'Other'* reactions listed in records of adverse events following immunisation, ADRAC database, 1 January 2000 to 30 September 2002

Reaction*	AEFI records	Single reaction reported†		Certain/probable causality rating‡		Age group§			
						<7 years		7 years	
	n	n	%	n	%	n	%	n	%
Vomiting	117	5	4	10	9	72	62	43	37
Headache	110	5	5	19	17	8	7	99	90
Malaise	109	8	7	21	19	31	28	72	66
Fatigue	100	1	1	20	20	36	36	60	60
Nausea	97	3	3	22	23	9	9	81	84
Pain (nos)	85	2	2	60	71	34	40	50	59
Irritability	78	5	6	10	13	78	100	0	0
Pallor	78	2	3	16	21	58	74	18	23
Myalgia	75	3	4	11	15	4	5	69	92
Oedema (nos)	62	3	5	43	69	36	58	26	42
Diarrhoea	52	10	19	6	12	30	58	19	37
Increased sweating	50	0	0	16	32	10	20	40	80
Dizziness	46	3	7	15	33	1	2	44	96
Anorexia	45	0	0	6	13	31	69	13	29
Somnolence	42	1	2	5	12	33	79	9	21
Coughing	41	1	2	3	7	21	51	20	49
Varicella or herpes zoster	41	18	44	0	0	25	61	13	32
Purpura	38	5	13	20	53	32	84	6	16
Dyspnoea	37	1	3	9	24	14	38	21	57
Abdominal pain	35	0	0	3	9	11	31	23	66
Rhinitis	35	2	6	3	9	18	51	16	46
Syncope	34	5	15	9	26	10	29	21	62
Paraesthesia	30	3	10	9	30	0	0	29	97
Influenza-like illness	29	4	14	5	17	9	31	18	62
Pharyngitis	28	1	4	1	4	10	36	17	61
Agitation	27	3	11	3	11	23	85	3	11
Flushing	27	0	0	12	44	7	26	20	74
Chest pain	24	1	4	6	25	0	0	23	96
Other – neurological	105	7	7	19	18	48	46	56	53
Cardiovascular	80	5	6	16	20	38	48	38	48
Body as a whole	62	5	8	12	19	20	32	41	66
Special senses	61	2	3	9	15	17	28	40	66
Respiratory	58	7	12	7	12	33	57	24	41
Gastrointestinal	49	5	10	10	20	12	24	35	71
Psychological	33	2	6	7	21	13	39	19	58
Skin	31	2	6	7	23	14	45	17	55
Inflammation	21	2	10	3	14	13	62	8	38
Metabolic/endocrine	19	2	11	1	5	7	37	12	63
Musculo-skeletal	17	1	6	5	29	4	24	13	76
Haematological	14	1	7	2	14	2	14	12	86
Renal/urogenital	9	0	0	1	11	1	11	8	89
Miscellaneous	7	3	43	0	0	5	71	2	29

* Reaction terms not listed in the *Australian Immunisation Handbook*[5] but included in adverse event following immunisation (AEFI) records in the ADRAC database. The top part of the table shows reaction terms included in 1 per cent or more of AEFI records; the bottom part of the table shows reaction terms grouped by organ system that were included in less than 1 per cent of AEFI records.

† AEFI records where only one reaction was reported.

‡ See the Box for causality criteria.

§ AEFI records not shown if age or date of birth was missing.

|| Percentages relate to the number of AEFI records in which the specific reaction term was listed e.g. of 1,072 AEFI records listing injection site reaction, 72 per cent listed only one type of reaction while 83 per cent had causality ratings of 'certain' or 'probable' and 70 per cent were for children aged less than 7 years.

nos Not otherwise specified.

Of reactions not listed in the *Australian Immunisation Handbook,* gastrointestinal symptoms of nausea, vomiting and diarrhoea were the most frequently recorded (Table 5). Reactions mentioned in less than 1 per cent of AEFI records are shown grouped by organ system category in the lower portion of Table 5. Neurological symptoms and signs were the most commonly reported category; the most frequent were hypoaesthesia (n=13) and tremor (n=11).

Vaccines and AEFI

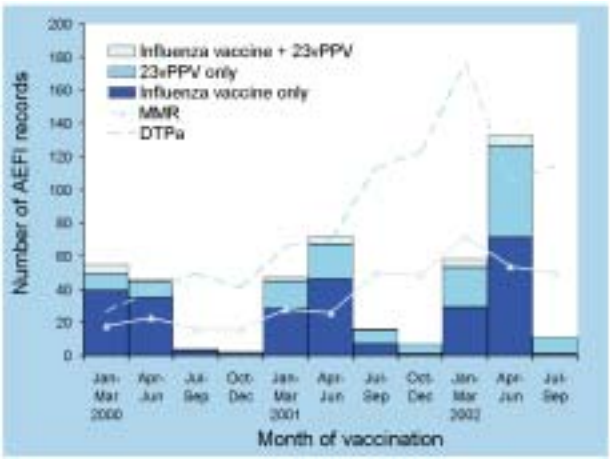
Twenty-nine vaccines were recorded as 'suspected' of involvement in the adverse events described in the 2,409 AEFI records analysed (Table 6). They included all vaccines recommended in the ASVS, plus vaccines recommended to travellers and specific risk groups (e.g. hepatitis A, Japanese encephalitis and Q fever vaccines) and the more recently licensed vaccines such as the varicella and meningococcal C conjugate vaccines.

The most frequently suspected group of vaccines were those containing pertussis, diphtheria and tetanus antigens (i.e. DTPa and DTPa-hepB); suspected in 1,163 (48%) reports (Table 6). Influenza (n=289) and 23-valent polysaccharide pneumococcal (23vPPV) (n=173) vaccines were suspected in the majority of AEFI records for people aged 7 years and over. The proportion of AEFI records where only one vaccine was suspected of involvement in the reported adverse event differed by vaccine, as did the proportion assigned causality ratings of 'certain' or 'probable', or defined as 'serious' (Table 6).

Table 7 focuses on AEFIs defined as 'serious'. The proportion of 'serious' AEFI records assigned causality ratings of 'certain' or 'probable' varied by vaccine. While Hib and polio vaccines were among the most frequently listed vaccines in 'serious' AEFI records, only a small proportion of these records were assigned 'certain' or 'probable' causality ratings (Table 7).

AEFI reporting trends over time differed by vaccine (Figure 5). The peaks in reported adverse events following vaccination in the first six months of 2002, shown in Figure 3, corresponded with a seasonal peak in AEFIs reported for influenza and/or 23vPPV vaccines among adults (Figure 5) and an increasing number of AEFIs reported for DTPa vaccine among children. The peaks in AEFIs reported for DTPa and MMR vaccinations in January–March 2002 corresponds to the commencement of the school year. A larger number of vaccinations are given at this time of the year than at other times (data not shown).

Figure 5. Selected frequently suspected vaccine types records of adverse events following immunisation, ADRAC database, 1 January 2000 to 30 September 2002, by month of vaccination



Abbreviations of vaccine types are listed in the appendix.

Dose-based AEFI reporting rates

Scheduled vaccines for children aged <7 years

Dose-based AEFI reporting rates for children aged less than 7 years for seven scheduled vaccines are shown in Table 8. Reporting rates differed by age and vaccine type. Much of the difference in reporting rates across age groups was attributable to DTPa vaccine. The apparently high AEFI reporting rate for children aged less than one year for MMR vaccine (54.2 records per 100,000 recorded doses) was estimated from only 15 records, all for children aged 11 months at the time of vaccination. Similarly, the rate for DTPa-hepB vaccine for children aged 1 to <2 years was estimated from only 10 AEFI records (Table 8).

Dose-based rates of the most commonly reported reaction types differed by vaccine type (Figure 6). Injection site reactions were reported for DTPa vaccine at a rate of 27.9 per 100,000 recorded doses, compared with rates of less than 8 per 100,000 recorded doses for other vaccines. The higher overall dose-based AEFI reporting rates for DTPa vaccine and for children aged over one year were related to injection site reactions (Figure 7). Dose-based reporting rates of injection site reactions following DTPa vaccination were 69 per 100,000 for children aged 1 to <2 years and 64 per 100,000 for children aged 2 to <7 years. These ages correspond to the timing of the fourth and fifth doses, respectively, of a DTPa vaccine.

Table 6. Vaccine types listed as 'suspected' in records of adverse events following immunisation, ADRAC database, 1 January 2000 to 30 September 2002

Suspected vaccine type*	AEFI records	One suspected vaccine or drug only†		'Certain' or 'probable' causality rating‡		'Serious' outcome§		Age group			
								<7 years		7 years	
	n	n	%¶	n	%¶	n	%¶	n	%¶	n	%¶
DTPa	923	565	61	498	54	54	6	915	99	4	< 1
Hib	419	31	7	37	9	67	16	412	98	0	0
MMR	336	125	37	49	15	49	15	293	87	37	11
Polio	326	8	2	9	3	50	15	299	92	22	7
Influenza	289	257	89	110	38	43	15	0	0	275	95
DTPa-hepatitis B	240	58	24	54	23	36	15	234	98	1	< 1
23vPPV	173	144	83	99	57	19	11	8	5	160	92
Hepatitis B	145	117	81	51	35	23	16	37	26	101	70
Varicella	128	109	85	15	12	19	15	89	70	35	27
dT	100	85	85	63	63	5	5	2	2	96	96
Hib-hepatitis B	59	10	17	8	14	6	10	59	100	0	0
MenCCV	46	46	100	18	39	5	11	30	65	15	33
Q fever	37	37	100	21	57	5	14	1	3	36	97
Hepatitis A	34	19	56	2	6	6	18	2	6	32	94
Hepatitis A+B	32	25	78	7	22	1	3	2	6	28	88
Typhoid	27	10	37	1	4	6	22	0	0	27	100
JE	26	18	69	6	23	3	12	0	0	26	100
Pneumococcal (nos)	22	16	73	11	50	3	14	5	23	17	77
Rabies	17	10	59	1	6	2	12	0	0	17	100
Yellow fever	14	5	36	1	7	5	36	0	0	14	100
Tetanus	10	10	100	6	60	0	0	1	10	8	80
BCG	7	6	86	2	29	0	0	3	43	3	43
Men4PV	6	1	17	0	0	2	33	0	0	6	100
7vPCV	5	0	0	0	0	1	20	5	100	0	0
Cholera	4	1	25	1	25	0	0	0	0	4	100
Measles-mumps	4	0	0	0	0	0	0	3	75	1	25
Meningococcal (nos)	4	2	50	1	25	0	0	2	50	2	50
Rubella	2	2	100	1	50	0	0	1	50	1	50
Pertussis	1	1	100	0	0	1	100	1	100	0	0
Total**	2,409	1,717	71	1,041	43	253	11	1,496	62	864	36

AEFI Adverse event following immunisation.

* See appendix for abbreviations of vaccine types.

† AEFI records where only one vaccine was suspected of involvement in a reported adverse event.

‡ Causality ratings were assigned to AEFI records using criteria described in the Box.

§ 'Serious' outcomes are defined in the Methods section (see Table 3 also).

|| AEFI records not shown if age or date of birth was missing.

¶ Percentages are calculated for the number of AEFI records where the specific vaccine was suspected of involvement in the AEFI, e.g. DTPa vaccine was listed as 'suspected' in 923 AEFI records; this was the only suspected vaccine in 61 per cent of the 923 AEFI records, 54 per cent had 'certain' or 'probable' causality ratings, 6 per cent were defined as 'serious' and 99 per cent were for people aged less then 7 years.

** Total number of AEFI records analysed, not the total in each column.

Table 7. Causality ratings of adverse events following immunisation defined as 'serious', ADRAC database, January 2000 to September 2002, by suspected vaccine type and age group

Suspected vaccine type*	'Serious' outcome†	'Certain' or 'probable' causality rating‡		Total
		Age group§		
		< 7 years	7 years	
	n	n	n	n
Hib	67	4	0	4
DTPa	54	10	0	10
Polio vaccine	50	1	0	1
MMR	49	5	0	6§
Influenza	43	0	7	9§
DTPa-hepB	36	5	0	5
HepB	23	2	6	8
23vPPV	19	0	7	7
Varicella	19	2	2	4
HepA	6	0	0	0
Hib-hepB	6	0	0	0
Typhoid	6	0	0	0
Q fever	5	0	2	2
dT	5	0	1	1
MenCCV	5	1	0	1
Yellow fever	5	0	1	1
JE	3	0	1	1
Pneumococcal¶	3	0	1	1
Meningococcal¶	2	0	1	1
Rabies	2	0	0	0
Hepatitis A + B	1	0	1	1
Pertussis	1	0	0	0
7vPCV	1	0	0	0
Total	253	27	28	58§

AEFI Adverse event following immunisation

* The vaccine type was recorded as 'suspected' of involvement in the reported adverse event. See appendix for abbreviations of vaccine types.

† AEFI records defined as 'serious' (see Table 3 and Methods).

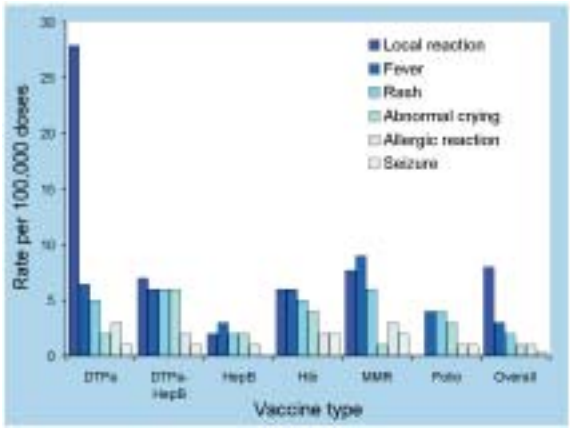
‡ Causality ratings were assigned to AEFI records using the criteria described in the Box.

§ AEFI records not shown where age or date of birth was missing.

Total number of AEFI records analysed, not the total in each column.

¶ Not otherwise specified.

Figure 6. Rates of frequently reported reactions per 100,000 vaccine doses administered to children aged less than 7 years for recommended vaccine types, records of adverse events following immunisation, ADRAC database, 1 January 2000 to 30 September 2002



Abbreviations of vaccine types are listed in the appendix.

Figure 7. Rates of selected frequently reported adverse per 100,000 administered doses of DTPa, ADRAC database, 1 January 2000 to 30 September 2002, by age group (DTPa dose number)

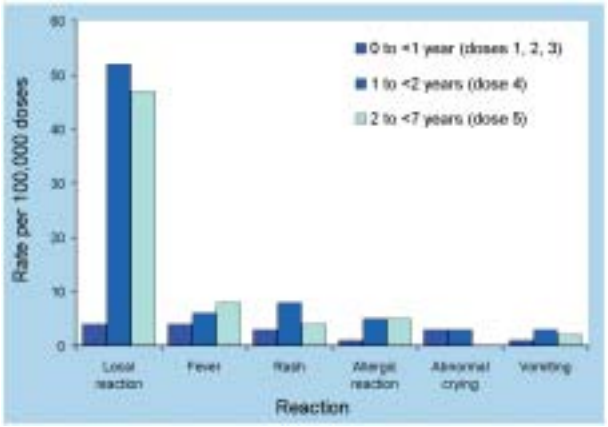


Table 8. Reporting rates of adverse events following immunisation per 100,000 vaccine doses* for children aged less than 7 years, ADRAC database, 1 January 2000 to 30 September 2002

Suspected vaccine type† or AEFI category‡		Age group (years)			Overall
		<1	1 to <2	2 to <7	
DTPa	AEFI records (n)§	153	451	311	915
	Vaccine doses (n)*	1,026,027	650,740	483,820	2,160,587
	Rate per 100,000 doses	14.9	69.3	64.3	42.3
DTPa-hep B	AEFI records (n)	217	10	na	227
	Vaccine doses (n)	891,482	10,237	na	901,719
	Rate per 100,000 doses	24.3	97.7	na	25.2
Hib	AEFI records (n)	239	162	11	412
	Vaccine doses (n)	1,518,623	596,402	34,983	1,784,257
	Rate per 100,000 doses	15.7	27.2	31.4	23.1
Hib-hebB	AEFI records (n)	44	13	na	57
	Vaccine doses (n)	365,751	103,676	na	469,427
	Rate per 100,000 doses	12.0	12.5	na	12.1
HepB¶	AEFI records (n)	21	6	10	37
	Vaccine doses (n)	212,871	75,415	66,671	354,957
	Rate per 100,000 doses	9.9	8.0	15.0	10.4
Polio	AEFI records (n)	230	8	64	302
	Vaccine doses (n)	1,914,883	34,630	446,130	2,395,643
	Rate per 100,000 doses	12.0	23.1	14.3	12.6
MMR	AEFI records (n)	15	129	150	294
	Vaccine doses (n)	27,678	629,062	448,458	1,105,198
	Rate per 100,000 doses	54.2	20.5	33.4	26.6
Total‡	AEFI records (n)	409	589	345	1,339
	Vaccine doses (n)	5,591,564	2,100,162	1,480,062	9,168,788
	Rate per 100,000 doses	7.3	28.0	23.3	14.6
'Certain' or 'probable' causality rating‡	AEFI records (n)	86	306	194	586
	Vaccine doses (n)	5,591,564	2,100,162	1,480,062	9,168,788
	Rate per 100,000 doses	1.5	14.6	13.1	6.4
'Serious' outcome‡	AEFI records (n)	61	50	19	130
	Vaccine doses (n)	5,591,564	2,100,162	1,480,062	9,168,788
	Rate per 100,000 doses	1.1	2.4	1.3	1.4

AEFI Adverse event following immunisation

* Number of vaccine doses recorded on the Australian Childhood Immunisation Register and administered between 1 January 2000 and 30 September 2002.

† AEFI records where the vaccine was one of those listed as 'suspected' of involvement in the reported adverse event. See appendix for abbreviations of vaccine names.

‡ AEFI category includes all records (i.e. total), those assigned 'certain' or 'probable' causality ratings, and those defined as 'serious' where at least one of the seven vaccines shown in the table was suspected of involvement in the reported adverse event. Causality ratings were assigned using the criteria shown in the Box1. The definition of a 'serious' outcome is described in the Methods section.

§ Number of AEFI records in which the vaccine was coded as 'suspected' and the vaccination was administered between 1 January 2000 and 30 September 2002.

|| The estimated rate of adverse events records per 100,000 vaccine doses recorded on the ACIR.

¶ Includes the birth dose of hepatitis B vaccine.

na Not applicable as the vaccine is not recommended in the Australian Standard Vaccination Schedule for children aged 2 to < 7 years.

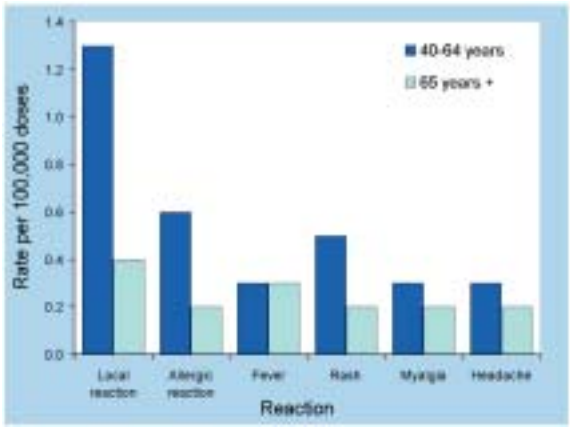
Influenza vaccine and adults aged ≥ 40 years

Influenza vaccine was suspected of involvement in 289 AEFI records. Of these, 205 (71%) were for people aged 40 years and over. The dose-based AEFI reporting rates are shown in Table 9 and Figure 8. Rates were higher among vaccinees aged 40 to 64 years than among the older age group. The most frequently reported adverse events following influenza vaccination were injection site reactions and allergic reactions (0.7 and 0.4 per 100,000 doses, respectively). There were three reports of Guillain-Barré syndrome following influenza vaccination (Table 4).[8] This is a reporting rate of approximately 0.03 per 100,000 doses or 3.2 per 10 million doses.

Discussion

This report analysing AEFI notifications to the ADRU over a period of 33 months highlights the safety of vaccines in Australia. Over 9 million doses of seven ASVS vaccines were administered to children aged less than 7 years and a similar number of influenza vaccine doses were administered to adults 40 years and over during the 33-month period. The corresponding dose-based AEFI reporting rates were 14.6 per 100,000 doses of scheduled vaccine doses for children under 7 years and 2.2 per 100,000 doses of influenza vaccines for adults aged 40 years and over. The majority of AEFIs reported were injection site reactions and non-serious systemic events.

Figure 8. Rates per 100,000 doses of the most frequently reported adverse events following influenza vaccination, ADRAC database, 1 January 2000 to 30 September 2002, by age group



There were two major findings of this study. The first estimates of national dose-based AEFI reporting rates for the most commonly used vaccines in Australia allows direct comparisons of AEFI reporting rates over time, between vaccines and between surveillance systems. The observed increase over time in ADRAC notifications related to injection site reactions following receipt of a fourth or fifth dose of a DTPa vaccine shows that the surveillance system, despite its limitations, is sufficiently sensitive to detect this known AEFI.

Table 9. Dose-based reporting rates of adverse events following immunisation with influenza vaccine,* ADRAC database, January 2000 to September 2002, by age group

AEFI category†		Age group (years)		Overall
		40 to 64	65	
Total	AEFI records (n)‡	124	81	205
	Vaccine doses (n)*	3,761,200	5,589,700	9,350,900
	Rate per 100,000 doses§	3.3	1.4	2.2
'Certain' or 'probable' causality rating†	AEFI records (n)	51	23	74
	Vaccine doses (n)	3,761,200	5,589,700	9,350,900
	Rate per 100,000 doses	1.4	0.4	0.8
'Serious' outcome†	AEFI records (n)	11	16	27
	Vaccine doses (n)	3,761,200	5,589,700	9,350,900
	Rate per 100,000 doses	0.3	0.3	0.3

AEFI Adverse events following immunisation

* Number of administered influenza vaccine doses estimated from the 2000, 2001 and 2002 annual national influenza coverage surveys,[10,11,12] and mid-2001 census data (Australian Bureau of Statistics).

† AEFI category includes all records, those assigned 'certain' or 'probable' causality ratings, and those defined as 'serious' where influenza vaccine was suspected of involvement in the reported adverse event. Causality ratings were assigned using the criteria shown in the Box. The definition of a 'serious' outcome is shown in the Methods section.

‡ Number of AEFI records in which influenza vaccine was 'suspected' and the vaccination was administered between 1 January 2000 and 30 September 2002.

§ The estimated rate of adverse events records per 100,000 administered doses of influenza vaccine

Several studies have shown higher rates of severe injection site reactions, particularly extensive limb swelling, following receipt of a fourth or fifth dose of acellular pertussis-containing vaccines (e.g. DTPa) than after the first three doses of these vaccines or following fourth or fifth doses of the previously used whole cell pertussis vaccines (DTPw).[8,15,16,17] These injection site reactions are characteristic of the acellular pertussis vaccines. Despite being extensive, they are usually associated with minimal discomfort, resolve without sequelae and should not contraindicate further vaccination. Importantly, studies show that rates of systemic adverse reactions are lower among children receiving acellular pertussis vaccines than whole cell pertussis vaccines.[8,15,17]

The trend and disproportionate increase in AEFI notifications following receipt of a DTPa vaccine, compared with MMR vaccine (which is given at similar ages as the fourth and fifth doses of DTPa) (Figure 5), reflects changes in the DTPa vaccine funding policy for different jurisdictions and birth cohorts.[4] In South Australia and the Northern Territory, all children received free DTPa vaccines instead of DTPw for all five scheduled doses from August 1997. There, children started receiving their fourth dose of DTPa from early 1999 and fifth dose from mid-2001 onwards. The other states and territories commenced funding all five doses of DTPa in February 1999. These children started receiving their fourth DTPa dose from mid-2001 and fifth dose from early 2003. Extensive injection site reactions following the fourth, then fifth, dose of a DTPa vaccine were first observed in South Australia and the Northern Territory and have now been seen in all jurisdictions as more children have received four doses of a DTPa vaccine. Further increases in the number of notifications of injection site reactions are expected as more children progress to receive their fifth dose of a DTPa vaccine.

AEFI notification rates

The overall average annual population-based AEFI reporting rate for the 33-month period analysed was 4.5 per 100,000 population. This was similar to that averaged over 11 years for the US VAERS system of 4.4 per 100,000 population.[8] In general, the more populous Australian States and Territories had lower population-based reporting rates than the less populous ones. This has also been observed in the USA and Canada.[8,18] Reasons are unclear but the rates of AEFIs with outcomes defined as 'serious' or assigned ADRAC causality ratings of 'certain' or 'probable' were less variable across jurisdictions than overall reporting rates (Table 1). This pattern suggests large differences in the sensitivity of the individual state and territory AEFI surveillance systems. This is likely to be related, to some extent, to known differences in notification and case investigation procedures. Further study to evaluate and compare AEFI surveillance methods across jurisdictions would help to elucidate this.

The proportion of AEFI records with outcomes defined as 'serious' was comparable with US VAERS data (14.5% compared with 10.5% for ADRAC data), although there are differences between the two systems in the methods used to estimate numerator and denominator data.[8] There were also similarities between the two systems in dose-based AEFI reporting rates for specific vaccines. In 2001, the highest VAERS dose-based reporting rate was for the DTPa vaccines (27.5 per 100,000 distributed doses).[8] The USA data also showed an increasing trend in the number of reports for acellular pertussis-containing vaccines per 100,000 distributed doses, and the number of reports for injection site reactions following fourth or fifth doses of acellular pertussis vaccines.[8]

Limitations of passive AEFI surveillance

Caution is required when interpreting the AEFI data presented here. The AEFI reporting rates cannot be interpreted as true incidence rates. Like all passive surveillance data, AEFI data are subject to under-reporting, over-reporting and reporting biases that are difficult to measure.[1,2,3] There is under-reporting of less serious adverse events and of those sustained by adults. In contrast, there is over-reporting of serious events *coincidentally* associated with the timing of immunisation, particularly for newer vaccines and among children. AEFI records assigned ADRAC causality ratings of 'certain' or 'probable' fulfil stricter criteria than those rated as 'possible', and usually involve only one vaccine (see Box). There are a wide range of reasons why a reported AEFI might be assigned a 'possible' causality rating including insufficient information, the existence of a plausible alternative explanation or more than one vaccine or drug being administered at a time, as is frequently the case in infants and the elderly. The causality rating assigned to each AEFI record describes the likelihood that a suspected vaccine(s) was associated with the reported adverse event at the level of the individual patient. This is not the same as the epidemiological concept of 'causality', which applies at the population level. Specific epidemiological studies are required to investigate the broader question of whether a vaccine is causally associated with a specific adverse event at the population level. Such studies are often implemented as a result of 'signals' detected through passive AEFI surveillance.[15,19]

In Australia, passive AEFI surveillance is complemented by specialist clinics in several jurisdictions[17] that function as sentinel surveillance sites for more serious AEFIs. Enhanced AEFI surveillance during ad-hoc immunisation campaigns, such as the 1998 Measles Control Campaign, also

plays an important role.[20] Data linkage methods, similar to the US Vaccine Safety Datalink methods[21] are currently being piloted in Australia. If successful, they will provide an important adjunct to passive AEFI surveillance. Internationally, the Brighton Collaboration is developing and evaluating standardised AEFI case definitions and guidelines for AEFI surveillance, which may be applicable in Australia.[22]

Conclusions

The data reported here illustrate the high level of vaccine safety in Australia, particularly at a time of high vaccination coverage rates and resulting low rates of vaccine preventable diseases.[4] Recent examples include the dramatic decline in hospitalisations and deaths among children since 1993, following the introduction of Hib vaccine into the ASVS, and the large reductions in measles and rubella infection rates following changes to the MMR vaccination schedule in the mid-late 1990s.[4] The benefits of immunisation far outweigh the risks of adverse events following immunisation, particularly since the majority of those reported are not serious, and many that are serious are only coincidentally associated with immunisation.

The ADRAC database provides a valuable resource of Australian AEFI surveillance data. The data have been assessed using protocols consistent with international practice allowing comparison with AEFI surveillance data from other countries particularly the USA. Routinely collected immunisation coverage data from the ACIR and the annual national influenza coverage surveys have allowed the estimation of national dose-based AEFI reporting rates for the first time. As denominator data become available about the number of doses administered or distributed for other vaccines, the estimation of dose-based AEFI reporting rates will become more complete. While continued effort is required to maintain and improve AEFI surveillance in Australia, regular analysis and reporting of the data and dose-based AEFI reporting rates will provide important information for immunisation service providers, program managers and the general public.

Acknowledgments

We thank Brynley Hull for calculating vaccine doses from ACIR data. The National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases is supported by the Commonwealth Department of Health and Ageing, the New South Wales Department of Health and the Children's Hospital at Westmead, Australia.

Appendix

Abbreviations of vaccine types

BCG	Bacille Calmette-Guèrin (i.e. tuberculosis)
dT	diphtheria and tetanus
DTPa	diphtheria-tetanus-pertussis (acellular)
DTPa-hepB	combined diphtheria-tetanus-pertussis (acellular) and hepatitis B
HepB	hepatitis B
Hib	*Haemophilus influenzae* type b
Hib-hepB	combined *Haemophilus influenzae* type b and hepatitis B
JE	Japanese encephalitis virus
Men4PV	meningococcal polysaccharide tetravalent
MenCCV	meningococcal C conjugate
MMR	measles-mumps-rubella
7vPCV	7-valent pneumococcal conjugate
23vPPV	23-valent pneumococcal polysaccharide
polio	poliomyelitis (oral and inactivated)

References

1. Mansoor O, Shin S, Maher C, and the Immunization Focus of WPRO. Immunization safety surveillance: guidelines for managers of immunization programmes on reporting and investigating adverse events following immunization. Manila: World Health Organization Regional Office for the Western Pacific; 1999. Available from: http://whqlibdoc.who.int/wpro/1994-99/WPRO_EPI_99.01.pdf
2. Ellenberg SS, Chen RT. The complicated task of monitoring vaccine safety. *Public Health Reports* 1997;112:10–19. Available from: http://www.cdc.gov/ nip/vacsafe/research/phr.htm
3. Chen RT, DeStefano F, Pless R, Mootrey G, Kramarz P, Hibbs B. Challenges and controversies in immunization safety. *Infectious Disease Clinics of North America* 2001;15:21–39.
4. McIntyre PB, Gidding HF, Gilmore R, Lawrence G, Hull B, Horby P, *et al*. Vaccine preventable diseases and vaccination coverage in Australia, 1999–2000. *Commun Dis Intell* 2002;26 Suppl:i–xi:1–111. Available from: http://www.cda.gov.au/pubs/cdi/2002/cdi26suppl/pdf/vpd99_00.pdf
5. National Health and Medical Research Council. *The Australian Immunisation Handbook*. 7th ed. Canberra: AGPS; 2000.
6. Uppsala Monitoring Centre. WHO Collaborating Centre for International Drug Monitoring. Available from: http://www.who-umc.org
7. Uppsala Monitoring Centre. *Adverse Drug Reaction Terminology*. Uppsala Sweden: World Health Organization; 2001. Available from: http://www.who-umc.org/pdfs/ardguide.pdf
8. Zhou W, Pool V, Iskander JK, English-Bullard R, Ball R, Wise RP, *et al*. Surveillance for safety after immunization: Vaccine Adverse Event Reporting System (VAERS)—United States, 1991–2001. *MMWR Morb Mortal Wkly Rep* 2003;52 SS–1:1–24.
9. The SAS system for Windows (computer software). Version 8.02. Cary, NC: SAS Institute Inc.; 1999.
10. Taylor A, Wilson D, Dal Grande E, Gill T. *National influenza survey—a population survey of vaccination uptake in Australia*. Adelaide: South Australian Department of Human Services; 2000.
11. Roy Morgan Research. *Quantitative research to evaluate the Department's influenza vaccine program for older Australians*. Sydney: Roy Morgan Research; 2001.
12. Australian Institute of Health and Welfare. *2002 influenza vaccine survey: summary results*. Canberra: Australian Institute of Health and Welfare; 2003.
13. Chan RC, Penney DJ, Little D, Carter IW, Roberts JA, Rawlinson WD. Hepatitis and death following vaccination with 17D–204 yellow fever vaccine. *Lancet* 2001;358:121–122.
14. Mortimer PP. Yellow fever vaccine: vaccination is necessary despite recent adverse reports. *BMJ* 2002;324:439.
15. Rennels MB, Deloria MA, Pichichero ME, Losonsky GA, Englund JA, Meade BD, *et al*. Extensive swelling after booster doses of acellular pertussis-tetanus-diphtheria vaccines. *Pediatrics* 2000;105:e12.
16. Jackson LA, Carste BA, Malais D, Froeschle J. Retrospective population-based assessment of medically attended injection site reactions, seizures, allergic responses and febrile episodes after acellular pertussis vaccine combined with diphtheria and tetanus toxoids. *Pediatr Infect Dis J* 2002;21:781–786.
17. Wood N. Immunisation adverse events clinics. *NSW Public Health Bulletin* 2003;14:25–27.
18. Health Canada. Adverse events temporally associated with vaccines – 1992 report. *Can Commun Dis Rep* 1995;21:F1–F9
19. Murphy TV, Gargiullo PM, Marsoudi MS, *et al*. Intussusception among infants given an oral rotavirus vaccine. *N Engl J Med* 2001;344:564–572 [erratum appears in *N Engl J Med* 2001;344:1564].
20. Burgess MA, Heath TC, McIntyre PB. The Measles Control Campaign and immunisation adverse events. *Commun Dis Intell* 1998;22:136–138.
21. DeStefano F. Vaccine Safety Datalink Research Group. The Vaccine Safety Datalink project. *Pharmacoepidemiol Drug Saf* 2001;10:403–406.
22. Boenhoffer J, Kohl K, Chen R, Duclos P, Heijbel H, Heininger U, *et al*. The Brighton Collaboration: addressing the need for standardized case definitions of adverse events following immunization (AEFI). *Vaccine* 2002;21:298–302.

Progress towards eliminating Hib in Australia: An evaluation of *Haemophilus influenzae* type b prevention in Australia, 1 July 1993 to 30 June 2000

Peter Horby, Robin Gilmour, Han Wang, Peter McIntyre
National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases

Abstract

The status of *Haemophilus influenzae* (Hib) disease and its prevention by vaccination was reviewed for the period 1997 to 2000. This forms the background to a change in national vaccine policy, from the use of two Hib vaccines to the use of PRP-OMP only throughout Australia from May 2000. Notifications of Hib in the 7-year period between 1993 and 2000 declined by 87 per cent among children 0–4 years of age; adjustment for likely under-reporting increase this to a 95 per cent reduction. Among age groups not included in the immunisation program, there was also a substantial decline in notified cases. Overall, a minimum 430 cases and 13 deaths were prevented by Hib immunisation annually in Australia. Enhanced Hib surveillance recorded 532 cases over seven years, with 353 in unvaccinated persons, 74 fulfilling criteria for true vaccine failure and 75 partially immunised. Of unvaccinated cases, 60 and 182 were eligible for routine and catch-up immunisation respectively. Although the overall incidence for 0–4 years of age declined from 15 to 1.2 cases per 100,000 population, the proportion of cases under six months of age increased from 11 per cent to 23 per cent. Overall vaccine effectiveness, estimated using data from the last five years of the program, was 83 per cent (95% CI 71–91%), increasing to 90 per cent (95% CI 83–94%) when adjusted for under-reporting to the Australian Childhood Immunisation Register. Among Aboriginal and Torres Strait Islander people, the incidence of invasive Hib disease fell from 4.6 cases per 100,000 population to 0.7 cases per 100,000 population but the proportion of cases now occurring among Aboriginal or Torres Strait Islander people increased significantly, from 7 to 15 per cent. The Hib immunisation program in Australia has been highly successful. Nevertheless, experience in Australia and elsewhere indicates that continued careful monitoring of Hib disease, with high quality laboratory surveillance, remains important. *Commun Dis Intell* 2003;27:324–341.

Keywords: disease surveillance, disease control, Haemophilus influenzae*, immunisation, vaccination*

Introduction

Haemophilus influenzae type b (Hib) is a bacterium which causes serious morbidity and mortality, particularly in children. Conjugate Hib vaccines were first marketed in Australia in May 1992 for children over 18 months of age, and in January 1993 for children from two months of age. In April 1993, a publicly funded Hib immunisation program was introduced for infants across Australia; this was extended in July 1993 to all children under the age of five years. Up to May 2000, two different Hib vaccines were in general use. The first, conjugated to the outer membrane protein of *Neisseria meningitidis* (PRP-OMP), was used for all children in the Northern Territory and for Indigenous children elsewhere in Australia. The second was conjugated to a mutant diphtheria toxin (HBOC) and was used in other children throughout Australia. In May 2000, the immunisation schedule was changed so that all children in Australia received PRP-OMP. The aim of this report is to describe the public health impact of the first seven years of the Hib immunisation program in Australia.

Invasive *Haemophilus influenzae* type b disease

Haemophilus influenzae occurs widely in humans, both as a colonising and disease-producing organism in the respiratory tract. Different types of *Haemophilus influenzae* can be distinguished on the basis of whether or not they possess a capsule and its characteristics. Non-encapsulated strains are associated with respiratory illness whilst encapsulated strains are associated with invasive

Corresponding author: Assoc. Professor Peter McIntyre, National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases, Locked Bag 4001, Westmead NSW 2145.

disease, that is serious disease where the organism can be isolated from a normally sterile site such as blood or cerebrospinal fluid (CSF). Of the many different capsulated strains, six (designated a-f) are known to cause disease in man. Prior to the introduction of immunisation one capsular serotype, *Haemophilus influenzae* type b, was the cause of nearly all cases of *Haemophilus influenzae* invasive disease.[1,2,3]

Hib can cause a range of clinical illness. The commonest are meningitis, septicaemia and epiglottitis. Other manifestations include cellulitis, pneumonia and septic arthritis. Hib is predominantly a disease of childhood with over 80 per cent of cases worldwide occurring in children aged less than five years.[4] In Australia, invasive Hib has been a notifiable disease in most Australian jurisdictions since 1990.

Haemophilus influenzae type b in Australia before immunisation

Prior to the introduction of immunisation, Hib was the commonest cause of bacterial meningitis in Australian children.[5,6] Special surveys of the incidence of Hib in Australia prior to the introduction of immunisation have produced a range of estimates (Table 1).[2,3,4-9] The different estimates between studies in part reflect the use of different methods for defining and identifying cases, but also represent heterogeneity in the distribution of risk. Aboriginal communities in Australia have rates as much as 10 times higher than non-Aboriginal communities. The high incidence of Hib disease in Aboriginal people is compatible with the high burden of other infectious diseases in this community. A similar picture is seen amongst disadvantaged Indigenous communities in other countries.[4] Non-Aboriginal children in central Australia also appear to be at increased risk of contracting invasive Hib disease.[3]

Haemophilus influenzae type b vaccines and the Australian schedule

Vaccines using the polyribosylribitol phosphate (PRP) polysaccharide of the Hib capsule were first developed in the 1970s, but these vaccines produced a T-cell-independent immune response that was not effective in protecting children aged less than 18 months.[10] Linking the PRP polysaccharide to a protein (conjugation), enhanced the immunogenicity of the vaccine by enabling T-cell stimulation. The first conjugated vaccine against Hib was licensed in Australia in May 1992 for children aged 18 months and over. Vaccines licensed for use in children aged more than six weeks became available in January 1993 (Table 2).

In May 1993 reimbursement of the cost of Hib vaccine was introduced for children born after February 1993.[11,12] In July 1993 a fully funded infant Hib vaccination program was launched, and in August 1993 a catch-up vaccination program for all children aged less than five years was launched (Table 3).

Between 1993 and June 2000, a different Hib schedule was recommended for Indigenous children and non-Indigenous children (Table 4). Studies of Hib epidemiology in the pre-immunisation era showed that Aboriginal children had a higher incidence of invasive Hib disease than non-Aboriginal children and an earlier mean age of onset. Serological evidence suggested that in young infants a single dose of the PRP-OMP vaccine elicited a better immune response than a single dose of the HbOC vaccine.[13] Aboriginal children were therefore recommended to receive PRP-OMP at two and four months with a booster at 12 months whilst non-Aboriginal children were recommended HbOC at two, four and six months with a booster at 18 months. In June 2000 the Hib schedule was changed again with PRP-OMP at two and four months and a booster dose at 12 months being recommended for all children.

Methods

Study period

Hib immunisation became fully funded for all children as part of the Australian Standard Vaccination Schedule in July 1993 and remained unchanged until June 2000. The bulk of this report analyses data on Hib disease by financial year of disease onset. This allows analysis of seven complete years of the program: 1 July 1993 to 30 June 2000.

Data sources

Population denominators

For the years 1991 and 1996 resident populations were derived from the Australian Bureau of Statistics (ABS) Census of Population and Housing. For the intervening years, resident populations are estimated by ABS by adjusting the most recent five yearly Census of Population and Housing for births, deaths and net migrations. When calculating incidence rates by financial year, the estimated resident population for the year beginning the financial year was used. For example, for the financial year 1992–93 the denominator was the estimated resident population for 1992. (At the time of writing, estimated populations of those aged 0, 1, 2, 3 and 4 years were not available for 1999 and therefore the figures for 1998 have been used.)

National Notifiable Diseases Surveillance Scheme

Invasive Hib disease has been part of the National Notifiable Diseases Surveillance Scheme since its inception in 1990. The case definition used for notification of invasive Hib disease to the NNDSS is shown in Figure 1.

Table 1. Studies of the incidence of invasive *Haemophilus influenzae* type b disease in Australian children aged under 5 years

Source	Population	Period	Rate per 100,000
McGregor[2]	ACT	1984–1990	63
Hanna[3]	NT (Aboriginal)	1985–1988	529
	NT (non-Aboriginal)	1985–1988	92
McIntyre[6]	Sydney	1985–1987	39
Gilbert[8]	Victoria	1985–1987	59
Hanna[5]	WA (Aboriginal)	1984–1988	150 (meningitis only)
	WA (non-Aboriginal)	1984–1988	27 (meningitis only)
Markey[9]	NT (all)	1989–1993	141
	NT (Aboriginal)	1989–1993	278

Table 2. Conjugated *Haemophilus influenzae* type b vaccines licensed in Australia

Generic name	Trade name	Hib antigen	Conjugating protein
PRP-D	ProHIBit	Hib capsular polysaccharide	Diphtheria toxoid protein
HbOC	HibTITER	Hib capsular oligosaccharide	Mutant diphtheria toxoid protein (CRM 197)
PRP-OMP	PRP-OMPHIB	Hib capsular polysaccharide	Outer membrane protein of group B meningococcus
PRP-T	Act-HIB	Hib capsular polysaccharide	Tetanus toxoid protein

Table 3. Significant events in *Haemophilus influenzae* type b immunisation practice in Australia, 1992 to 2001

Year	Month	Event
1992	May	PRP-D (ProHIBit) approved for vaccination of infants aged at least 18 months.
1993	January	HbOC (HibTITER) and PRP-OMP (PRP-OMPHIB) marketed for use in children aged at least 2 months.
1993	April	PRP-T (Act-HIB) marketed for use in children aged at least 2 months.
1993	May	Reimbursement of vaccine cost for children born after February 1993.
1993	July	Fully funded national infant immunisation program.
1993	August	Fully funded one dose catch up campaign for children aged less than 5 years.
2000	February	Combined Hib (PRP-OMP)-hepB vaccine approved.

Table 4. Recommended *Haemophilus influenzae* type b immunisation for Indigenous and non-Indigenous Australian children, July 1993 to June 2000

	Recommended vaccine	Primary schedule	Booster dose
Indigenous children	PRP-OMP	2 & 4 months	12 months
Non-Indigenous children	HbOC	2, 4 & 6 months	18 months

Figure 1. Case definition* for notification of invasive *Haemophilus influenzae* type b disease to NNDSS

a) a clinically compatible illness (meningitis, epiglottitis, cellulitis, septic arthritis, osteomyelitis, pneumonia, pericarditis or septicaemia), *and* either
- the isolation of *Haemophilus influenzae* type b (Hib) from blood, *or*
- detection of Hib antigen in a clinical case, *or*
- detection of Gram-negative coccobacilli where the organism fails to grow in a clinical case

or

b) a confident diagnosis of epiglottitis by direct vision, laryngoscopy or X-ray

* Note: The case definition for notification used in Victoria includes only isolates from cases of meningitis or epiglottitis.

Information collected through the NNDSS includes date of onset, age in years, gender and state or territory. A field for Indigenous status exists but is rarely completed. Notifications to NNDSS are through the provisions of local public health legislation; therefore each State or Territory health authority determines which diseases will be notifiable within its jurisdiction.

Although all states and territories were reporting invasive Hib to NNDSS by June 1993, there are a number of anomalies in the earlier Hib notification data. Western Australia did not start notifying cases until March 1993.[14] Although Victoria, Tasmania, the Australian Capital Territory and South Australia did not officially start reporting invasive Hib until 1993, these four States did report substantial numbers of cases to NNDSS in 1991 and 1992. The Northern Territory officially started reporting Hib in 1991 but no cases were reported in 1991.

Due to the uncertainty about when states began reporting and the complexity introduced by trying to exclude certain states or territories from both the numerator and denominator for certain years or parts of years, this report has assumed that all states and territories started reporting in 1991. The effect of this is to underestimate the incidence of Hib in the years preceding the introduction of routine immunisation.

Data on notified cases of invasive Hib were obtained from the National Notifiable Diseases Surveillance Scheme as of 2 July 2001.

Haemophilus influenzae *type b case surveillance scheme*

The Hib case surveillance scheme is an enhanced surveillance system designed to collect supplementary information on cases of invasive Hib not available from the NNDSS. The HCSS was established in January 1994 with data collected retrospectively to 1 July 1993. State and Territory health authority officers complete an enhanced surveillance form for each case of invasive Hib disease. The case definition used to identify cases of invasive Hib disease from the HCSS data is shown in Figure 2.

Figure 2. Case definition used for *Haemophilus influenzae* type b case surveillance scheme data

- Isolation of Hib from a normally sterile site (blood/CSF/joint fluid)

or

- identification of Hib antigen in serum, CSF, joint fluid or urine in the presence of an illness clinically compatible with invasive Hib disease (meningitis, septicaemia, epiglottitis, cellulitis, septic arthritis, osteomyelitis, pneumonia or pericarditis)

or

- a confident clinical diagnosis of epiglottis by direct vision, laryngoscopy or X-ray

Additional information collected through this enhanced surveillance scheme includes date of birth, clinical illness, immunisation status, ethnicity and outcome of the illness. Data on cases of invasive Hib were obtained from the HCSS as of 5 July 2001.

Estimating expected number of cases

In the first instance, the impact of immunisation on invasive Hib disease has been estimated by comparing the observed frequency of cases in the seven years 1993–94 to 1999–00 to the expected frequency in those years, based on the incidence reported in 1991–92 and 1992–93.

Age standardisation has been used to control for the effect of changes in the age structure of the population. The expected number of cases was calculated by multiplying the age-specific incidence rates derived from the aggregated data of 1991–92

and 1992–93 by the population at risk in each age stratum for the years 1993–94 to 1999–00. The age strata used were 0, 1, 2, 3, 4, 5–9, 10–14 and 15+ years. Because the age of some cases reported in 1991–92 and 1992–93 is not known (28/1,049) the pre-immunisation incidence rates used to estimate expected cases are underestimates.

Definitions of vaccine status

A number of definitions were applied to identify eligibility for vaccination and vaccination status of cases (Figure 3). Doses of vaccine given less than 15 days prior to disease onset were excluded from determination of immunisation status.

Vaccine coverage estimates

The Australian Childhood Immunisation Register contains information on the vaccination status of all Australian children born since 1 January 1996 and registered with Medicare. At the time of compiling this report data were available for immunisation encounters up to 30 June 2001.

A second or third dose assumption was used when estimating coverage. If the second PRP-OMP or third HbOC was recorded as having been given, it

Figure 3. Definitions of vaccination eligibility and vaccination status

1. Ineligible for vaccination

Born before 1 August 1988.

2. Catch-up cohort

Born between 1 August 1988 and 28 February 1993 inclusive.

3. Eligible for routine infant immunisation

Born from 1 March 1993 onwards.

4. Fully immunised

- One dose of any Hib vaccine given at age one year or older.
- Two doses of PRP-OMP before the age of one year.
- Three doses of HbOC before the age of one year.

5. Partially immunised

- One dose of any Hib vaccine before the age of one year.
- Two doses of HbOC before the age of one year.

6. Unimmunised

No Hib immunisations.

7. True vaccine failure

Invasive Hib disease (see HCSS case definition) with disease onset more than 14 days after:

- One dose of any Hib vaccine given at age one year or older;
- Second dose of PRP-OMP given before the age of one year;
- Third dose of any Hib vaccine given before the age of one year.

8. Apparent vaccine failure

Invasive Hib disease after:

- One dose of any Hib vaccine before the age of one year;
- Two doses of HbOC before the age of one year;
- One dose of any Hib vaccine given at age one year or older but before sufficient time has elapsed to be true vaccine failure;
- Two doses of PRP-OMP before the age of one year but before sufficient time has elapsed to be true vaccine failure;
- Three doses of HbOC before the age of one year but before sufficient time has elapsed to be true vaccine failure.

was assumed that the preceding doses had also been given. If a child was recorded as having both a second dose of PRP-OMP and a third dose of HbOC the child was categorised as being fully immunised with three doses of HbOC. This approach was used because the majority of children in Australia would have been eligible for the HbOC schedule rather than the PRP-OMP schedule.

Vaccine failure rate

To estimate the vaccine failure rate the number of true vaccine failures was divided by the number of children fully vaccinated. The failure rate was estimated separately for two doses of PRP-OMP before the age of one year and for three doses of HbOC before the age of one year. The number of children fully vaccinated by the age of one year was estimated from the ACIR for children born between 1 January 1996 (when the ACIR started) and 30 June 2000. True vaccine failures were identified for children born during the same period.

Estimating vaccine effectiveness

The screening method was used to assess vaccine effectiveness as this can be performed using data on the vaccination status of cases and the population vaccine coverage (Figure 4).

Figure 4. Formula for assessing vaccine effectiveness using screening method

VE = PPV – PCV / PPV (1 – PCV)

where

VE = vaccine effectiveness

PPV = proportion of population vaccinated (adjusted to exclude partially vaccinated)

PCV = proportion of cases vaccinated (excluding partially vaccinated)

As both age and year of disease onset may be associated with the risk of disease and independently associated with vaccination status, these factors may confound the relationship between vaccination status and disease status. To correct for these two potential confounding factors, vaccine effectiveness was estimated by fitting a logistic regression model as previously described,[15] including age group and year of disease onset as covariates. Seven years, 1993–94 to 1999–00, and four age strata, 6 to 11 months, 12 to 23 months, 24 to 35 months and 36 to 47 months, were entered into the model.

Vaccine effectiveness (VE) was estimated for the primary Hib schedule of two doses of PRP-OMP or three doses of HbOC before the age of one year. VE estimates could not be calculated separately for the HbOC and PRP-OMP schedules because recording of Indigenous status on the ACIR was incomplete. This means that the number of children eligible but not fully vaccinated cannot be determined for each schedule separately.

All the children in the birth cohorts used to calculate vaccine effectiveness were eligible for the infant schedule. Where a child was recorded as having received three doses of a Hib vaccine but the type of vaccine was not recorded it was assumed that the vaccine was HbOC. As for the estimation of vaccine coverage, the second and third dose assumptions were used.

The proportion of cases vaccinated was adjusted to exclude partially vaccinated children. The proportion of cases vaccinated was calculated as the number of cases having received either two doses of PRP-OMP or three doses of HbOC divided by these cases plus unvaccinated cases.

For the purpose of estimating vaccine effectiveness, coverage with either two doses of PRP-OMP or three doses of HbOC was assessed in each of the four years 1996–97, 1997–98, 1998–99 and 1999–00. In each of these years, coverage estimates were stratified by age. The age strata used were 6 to 11.99 months, 12 to 23.99 months, 24 to 35.99 months and 36 to 47.99 months. Because the ACIR only started in 1996, coverage data were not available for any age bands prior to 1996 and for certain age bands after 1996. For years where coverage data were not available, the coverage value for that age band in the closest available year was used (Appendix A).

Coverage in each financial year was estimated by assessing the proportion of each relevant birth cohort who had received either two doses of PRP-OMP or three doses of HbOC by the mid-point of the financial year (1 January). The proportion of the population vaccinated (PPV) was adjusted to exclude partially vaccinated children. PPV was calculated as the number of children fully vaccinated (two doses of PRP-OMP or three doses of HbOC) divided by the number of children fully vaccinated and unvaccinated (no doses of Hib vaccine).

Coverage in catch-up cohort

Of the children who were eligible to receive one dose of Hib vaccine as part of the catch up campaign launched in August 1993, it is not known what proportion actually received the vaccine. An estimate of the proportion of this group vaccinated was calculated using the equation for estimating vaccine efficacy (Figure 4) and assuming vaccine effectiveness of full immunisation (Figure 3) of 90 per cent.

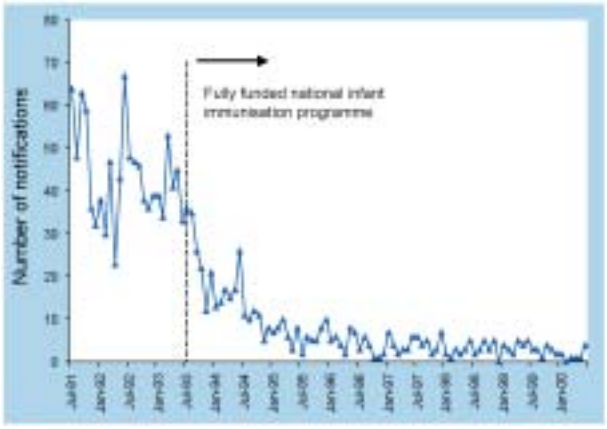
Results

National Notifiable Diseases Surveillance Scheme

Trends by age group over time

As of 2 July 2001, 1,621 cases of invasive Hib disease with disease onset between 1 July 1991 and 30 June 2000 were recorded on the NNDSS database. Overall, 55 per cent of cases were male. The number of notifications has declined substantially since the introduction of routine Hib immunisation (Figure 5). The rate of disease has declined in all age groups, but particularly in children aged less than five years (Figure 6).

Figure 5. Number of notifications of invasive *Haemophilus influenzae* type b disease, Australia, 1 July 1991 to 30 June 2000, by month and year of onset

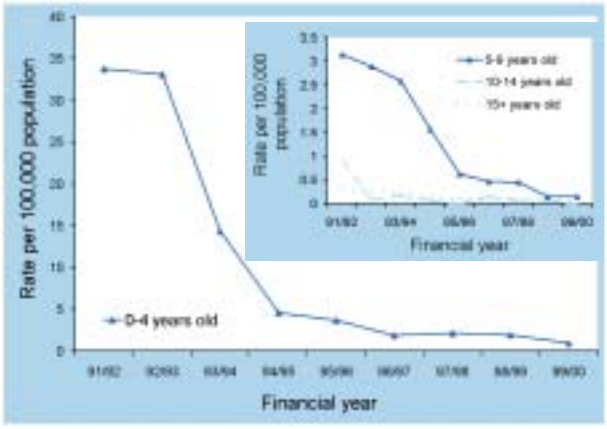


Source: National Notifiable Diseases Surveillance Scheme, 1 July 1991 to 30 June 2000.

Overall, if the age-specific incidence rates observed in 1991–92 and 1992–93 were to have occurred during the seven year period since the introduction of Hib immunisation (July 1993 to June 2000), 3,602 cases of invasive Hib disease would have been expected. However, only 572 cases were reported during this period, 84 per cent less than expected. This means that, over the last seven years, Hib immunisation has prevented more than 3,000 cases of invasive Hib disease. Of these, it would have been expected that around 90 (3%)[4] would have died as a consequence of their infection. Or put another way, Hib immunisation has prevented at least 430 cases and 13 deaths each year in Australia.

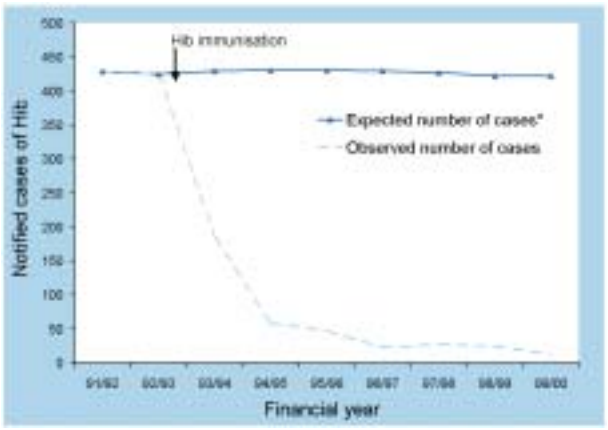
In children aged less than five years, 2,994 cases of invasive Hib disease would have been expected during the seven year post-immunisation period. There were actually 379 cases reported, 87 per cent less than expected (Figure 7).

Figure 6. Rate of invasive *Haemophilus influenzae* type b disease notifications per 100,000 population, Australia, 1991–92 to 1999–00, by financial year of onset and age at onset



Source: National Notifiable Diseases Surveillance Scheme, 1 July 1991 to 30 June 2000.

Figure 7. Observed and expected number of notified cases of invasive *Haemophilus influenzae* type b disease in children aged less than five years, Australia, 1991–92 to 1999–00



Source: National Notifiable Diseases Surveillance Scheme, 1 July 1991 to 30 June 2000.

* Expected number of cases calculated by multiplying the age-specific incidence rates derived from the aggregated data of 1991–92 and 1992–93 by the person years at risk in each age stratum for the years 1993–94 to 1999–00. Age strata used were 0, 1, 2, 3, 4 years.

Estimates of the incidence of invasive Hib disease in children under the age of five years derived from surveys undertaken in the pre-vaccination era are higher than the estimate obtained from the NNDSS data (Table 1). This is probably because there is under-ascertainment of cases through the NNDSS mechanism. Using estimates of invasive Hib disease

obtained from special studies in the pre-vaccination era gives a higher estimate of the effectiveness of the Hib vaccination program in children aged less than five years (Table 5).

Herd immunity effect

Herd immunity refers to the protection from a disease experienced by unvaccinated individuals in a community where there is reduced transmission of the infection as a result of a large proportion of the community being vaccinated. To detect a herd immunity effect as a result of routine Hib immunisation, changes in the incidence of invasive Hib disease in unvaccinated age groups were examined.

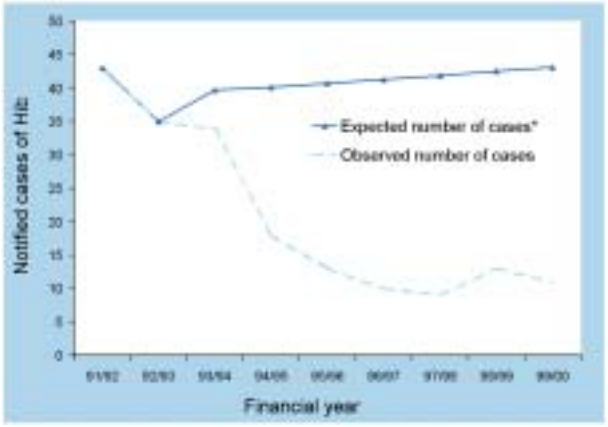
Throughout the period 1993–94 to 1999–00, any person aged 15 years or over would not have been eligible for immunisation. The expected number of cases in persons aged 15 years and older in the seven year period 1993–94 to 1999–00 was 290. The observed number of cases was 108, 63 per cent less than expected (Figure 8).

Between 1993–94 and the end of financial year 1997–98, individuals aged 10–14 years would also have been ineligible to receive Hib vaccination. The expected number of cases in the 10–14 years age group during the five years 1993–94 to 1997–98 was 30. The observed number was six, 80 per cent less than expected.

Trend by state over time

Figure 9 shows the crude incidence rate per 100,000 population for each state and territory in Australia by phases of the immunisation program. Comparing the 1992–93 incidence rate to the 1999–00 incidence rate reveals a reduction of between 86 per cent and 100 per cent in all states and territories (Table 6).

Figure 8. Observed and expected number of notified cases of invasive *Haemophilus influenzae* type b disease in people aged 15 years and older, Australia, 1991–92 to 1999–00



Source: National Notifiable Diseases Surveillance Scheme, 1 July 1991to 30 June 2000.

* Expected number of cases calculated by multiplying the age-specific incidence rate derived from the aggregated data of 1991–92 and 1992–93 by the population at risk for the years 1993–94 to 1999–00.

Hib case surveillance scheme

The Hib case surveillance scheme collects information on each case of Hib disease that is not available from routine notifications. Examination of the HCSS data therefore provides a more detailed picture of the impact of immunisation on the epidemiology of invasive Hib disease, but lacks comparative data from the pre-vaccination period.

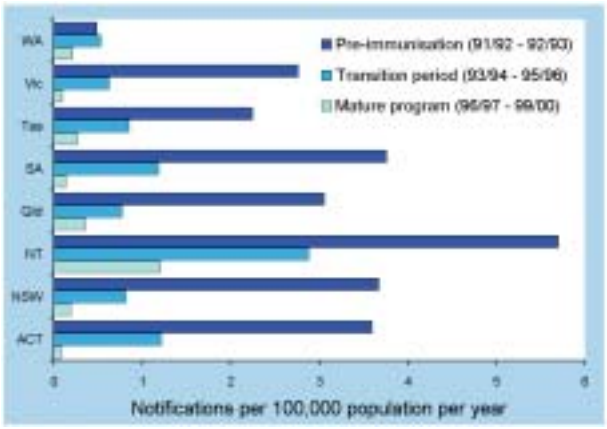
Table 5. Estimated reduction in the incidence of invasive *Haemophilus influenzae* type b in children less than 5 years of age, Australia, 1993–94 to 1999–00

Source	Rate per 100,000 population	Expected number of cases 1993–94 to 1999–00*	Program effectiveness† %
McGregor[2]	63	5,689	93
Hanna[3]	92 (non-Indigenous)	8,308	95
McIntyre[6]	39	3,522	89
Gilbert[8]	59	5,328	93
Markey[9]	50 (non-Indigenous)	4,515	92

* Rate per 100,000 population multiplied by total person years at risk aged less than five years 1993–94 to 1999–00 divided by 100,000. Person years at risk aged less than five years 1993–94 to 1999–00 = 9,030,474.

† [1 –(observed cases in 0–4 year olds 1993–94 to 1999–00/expected)] x 100. Observed cases in 0–4 year olds 1993–94 to 1999–00 = 379.

Figure 9. Incidence of notified cases of invasive *Haemophilus influenzae* type b disease per 100,000 population, Australia, 1991–92 to 1999–00, by state or territory and financial year



Source: National Notifiable Diseases Surveillance Scheme, 1 July 1991 to 30 June 2000.

Table 6. Incidence of notified cases of invasive *Haemophilus influenzae* type b disease per 100,000 population, by state or territory and reduction in incidence between 1992–93 and 1999–00

State or territory	Year		Reduction* %
	1992–93	1999–00	
ACT	2.38	0.33	86
NSW	3.30	0.11	97
NT	11.30	0.52	95
Qld	2.87	0.31	89
SA	3.64	0.13	96
Tas	2.34	0.00	100
Vic	2.45	0.04	98
WA	0.96	0.05	95
Total	3.15	0.13	96

* (1 –(99–00 rate/92–93 rate)) x 100.

As of 5 July 2001, 542 cases of invasive Hib disease with onset between 1 July 1993 and 31 June 2000 were recorded on the HCSS dataset. Five hundred and thirty-two cases satisfied the case definition for invasive Hib disease (Figure 2). The following analysis relates only to the 532 cases meeting the case definition. During the same period 572 cases were reported to the NNDSS. Enhanced surveillance data are therefore available on 93 per cent of notified cases of invasive Hib disease.

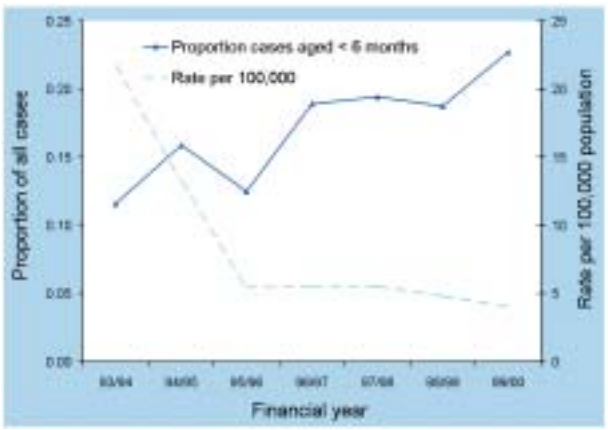
Age

Unlike the NNDSS, which only provides the age of cases in years before 1998, the HCCS provides the date of birth of persons with invasive Hib disease. The rate of disease in children aged less than six months of age is of particular interest, given the use of two different schedules in Australia. The primary HbOC schedule is not complete until six months of age whilst the primary PRP-OMP schedule is complete by four months of age.

During the study period, 77 cases of invasive Hib disease in children aged less than six months were reported to the HCSS. Although the rate of disease in children aged less than six months has declined since the introduction of immunisation, the decline has not been as great as in other age groups. Consequently, a greater proportion of cases now occur in children aged less than six months (Figure 10). This trend is statistically significant (chi-squared test for linear trend, $p<0.05$). Over the time period being studied, the proportion of the population aged less than one year has remained stable at around 1.5 per cent, so this trend is not related to a change in the age structure of the population.

There has also been an increase in the proportion of cases occurring in older age groups. In 1993–94, 12 per cent (29/246) of cases were in people aged 15 years or over. In 1999–00, 30 per cent (7/23) of cases were aged 15 years or over.

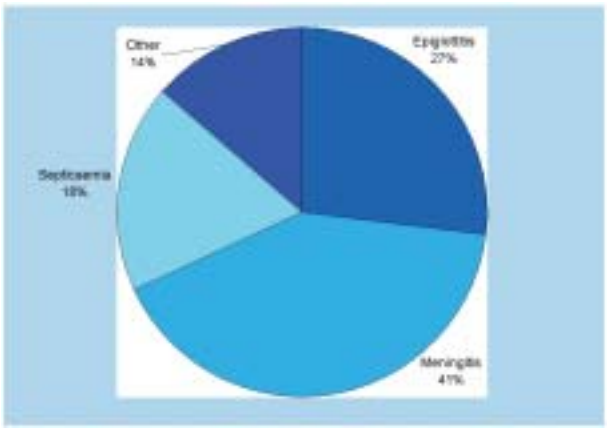
Figure 10. Proportion of all cases reported to HCSS occurring in children aged less than six months and reporting rate per 100,000 children aged less than six months, 1 July 1993 to 30 June 2000



Site of invasive disease

Over the period covered by the HCSS data, the commonest clinical presentation was meningitis followed by epiglottitis (Figure 11).

Figure 11. Cases of invasive *Haemophilus influenzae* type b disease reported to HCSS, Australia, 1 July 1993 to 30 June 2000, by clinical diagnosis, all ages



As shown in previous studies[4,6,16,17] meningitis is the predominant clinical picture in children aged less than five years, whilst epiglottitis is the commonest presentation in older children (Table 7). In infants, meningitis is the presenting clinical picture in 67 per cent of cases. Since the introduction of immunisation there has been a decline in all clinical presentations of invasive Hib disease. In 1993–94 septicaemia accounted for 15 per cent of cases (36/242) whilst in 1999–00 it accounted for 32 per cent (7/22) of cases. However, four of the seven cases in 1999–00 were aged over 25 years, so this change is a reflection of the increased proportion of cases occurring in people aged over 15 years.

Of the 144 epiglottitis cases, 110 were laboratory confirmed by either the isolation of Hib from a normally sterile site or a positive Hib antigen test. Of the 110, the majority (103) had a positive blood culture. Therefore, of the 532 cases reported to HCSS, 6 per cent (34) were based on a clinical diagnosis of epiglottis without laboratory confirmation. The proportion of reported cases based solely on a clinical diagnosis of epiglottitis without laboratory confirmation has not increased over time.

Case-fatality ratio

The case-fatality ratio appears to have been relatively stable over the seven year period with the exception of an unusually high case-fatality ratio in 1999–00 (Table 8).

Of the 26 fatal cases since 1993/94, 15 were male (58%) and two (8%) were Aboriginal or Torres Strait Islander people. Nine deaths occurred in children aged less than five years. The case-fatality ratio in children less than five years old was 2.4 per cent (9/371).

Vaccination status of cases

Information on vaccine status was not available for 30 of the 532 cases (6%) reported to HCSS with disease onset between 1 July 1993 and 30 June 2000.

Of the 502 cases for which information on vaccine status was available, 77 were fully immunised but only 74 (15%) were true vaccine failures, as three cases received the most recent dose of vaccine less than

Table 7. Clinical diagnosis of cases of invasive *Haemophilus influenzae* type b disease reported to HCSS, Australia, 1 July 1993 to June 2000, by age group

Illness	Age group in years					Total
	0 to 4	5 to 9	10 to 14	15 +	Unknown	
Cellulitis	22	1	1	0	0	24
Epiglottitis	76	35	1	29	3	144
Meningitis	192	19	1	6	0	218
Pneumonia	14	2	1	8	0	25
Septicaemia	56	6	3	31	1	97
Septic arthritis	6	2	0	1	0	9
Other	2	1	0	4	0	7
Unknown	3	1	0	4	0	8
Total	371	67	7	83	4	532

15 days prior to disease onset (Figure 12). The median age of the 74 true vaccine failures was 1.9 years and 61 per cent were male. Compared to all other cases combined, a higher proportion of true vaccine failures were of Aboriginal or Torres Strait Islander origin (12% vs 7%). The clinical presentation of true vaccine failures was not different from the clinical presentation of other cases. Of the 45 true vaccine failures who had received at least three doses of any Hib vaccine before the age of one year, 12 had received both the primary course of HbOC and a booster dose at age 18 months.

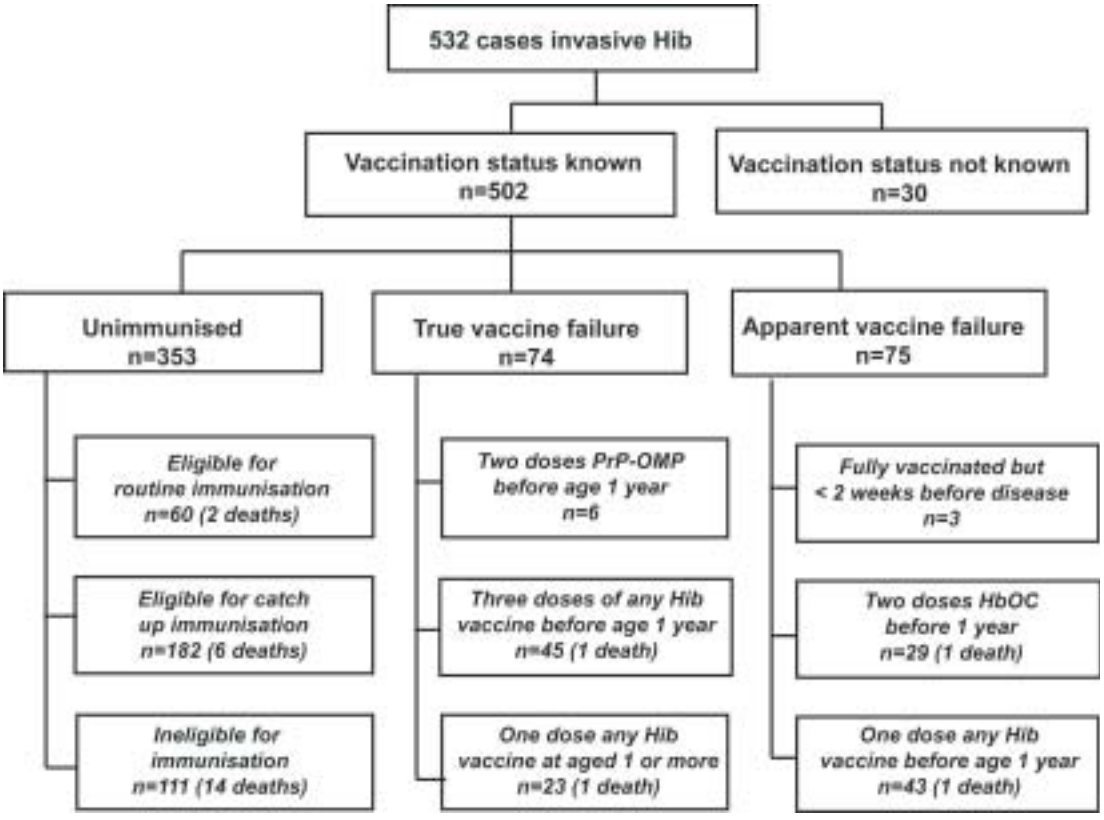
Three hundred and fifty-three cases (70%) were unimmunised: of these, 60 were eligible for routine immunisation and 182 for catch-up immunisation. The median age of the 60 cases eligible for the routine program was eight and a half months, half occurring in the first two years of the immunisation program. Of the 182 cases eligible for catch-up immunisation but receiving no vaccine, 90 per cent were in the first two years of the program. Their median age was 2½ years.

Of the partially immunised children , the median age of the 29 who had received two doses of HbOC before the age of one year was 7.2 months and, of the 43 who had received only one dose of vaccine before the age of one year, 4.7 months.

Table 8. Case-fatality ratio of cases reported to HCSS, Australia, 1 July 1993 to 30 June 2000

Outcome of illness	Financial year of onset							Total
	93/94	94/95	95/96	96/97	97/98	98/99	99/00	
Died	10	5	3	2	2	1	3	26
Survived	225	93	52	30	29	28	17	474
Unknown	7	9	1	5	5	3	2	32
Total	242	107	56	37	36	32	22	532
Case-fatality ratio (%)	4.1	4.7	5.4	5.4	5.6	3.1	13.6	4.9

Figure 12. Vaccination status of 532 cases of invasive *Haemophilus influenzae* type b reported to HCSS, 1 July 1993 to 30 June 2000



Potentially preventable cases

Disease occurring in unimmunised or partially immunised individuals is considered to have been potentially preventable by HbOC immunisation if the individual was aged over 6½ months of age at disease onset. By this age individuals could have received three scheduled doses of HbOC and had two weeks for an immune response to develop. Disease occurring in unimmunised or partially immunised individuals is considered to have been potentially preventable by PRP-OMP immunisation if the individual was aged over 4½ months of age at disease onset. By this age, individuals could have received two scheduled doses of PRP-OMP and had two weeks for an immune response to develop. Children who were not eligible for routine immunisation because they were born before March 1993 have been excluded from this analysis. Using these criteria, of the 532 cases of invasive Hib disease occurring between 1 July 1993 and 30 June 2000, a total of 53 (10%) might have been prevented by more timely HbOC immunisation, and 86 (16%) might have been prevented by more timely PRP-OMP immunisation (Table 9). There is also the possibility that the potential to complete the vaccination schedule with a booster dose at 12 months of age would further reduce cases in the second year of life, depending on relative vaccine effectiveness after various numbers of doses.

Table 9. Age distribution of cases potentially preventable by HbOC vs PRP-OMP vaccine

Immunisation status of case eligible for routine vaccination	Number of cases	Age	
		>4½ months	>6½ months
Unimmunised	60	41	25
Two doses HbOC before age 1 year	29	27	16
One dose of any Hib vaccine before age of 1 year*	38	18	12
Total	127	86	53

* Five cases have been excluded who were not eligible for routine vaccination.

Vaccine failure rate

In the cohort of children born between 1 January 1996 and 30 June 2000, 6 per cent are recorded on the ACIR as having received two doses of PRP-OMP before their first birthday and 82 per cent are recorded as having received three doses of HbOC by their first birthday. However, the ACIR is known to underestimate coverage, particularly in the early years of the Register, so the denominator will be underestimated.

Sixty-eight cases of Hib disease in children born after 1 January 1996 are recorded on the HCSS. Of these, 16 were true vaccine failures. Fourteen had received three doses of HbOC by their first birthday and two had received two doses of PRP-OMP before their first birthday. Based on these denominator estimates, crude vaccine failure rates of 1 in 68,100 for three doses of HbOC before the first birthday, and 1 in 34,732 for two doses of PRP-OMP before the first birthday, can be calculated. This does not take into account the higher disease incidence in many, predominantly indigenous, recipients of PRP-OMP.

Vaccine effectiveness

In the initial logistic regression model, there was no difference in estimated vaccine effectiveness across the four age bands, but there was a significant difference across years. The vaccine effectiveness estimates for the years 1993–94 and 1994–95 were significantly higher than for other years. Since the proportion of the population vaccinated in these two years was extrapolated from data available in later years, the vaccine coverage values for these years are likely to be less accurate than estimates for later years. The model was therefore run again, excluding data from the years 1993–94 and 1994–95.

After this exclusion there was no effect by year or age, so the data were pooled to give an overall estimate of vaccine effectiveness across the years 1995–96 to 1999–00 and ages 6 to 47 months. In this model vaccine effectiveness was 83 per cent, 95 per cent confidence limits 72 per cent to 91 per cent.

The screening method is relatively sensitive to errors in the estimated proportion of the population vaccinated.[18] Vaccine coverage as measured by the ACIR is known to underestimate coverage by between 2 and 5 per cent.[19] To assess the effect of underestimating vaccine coverage on vaccine efficacy the model was re-run with higher values for vaccine coverage. If the estimates of the proportion of the population vaccinated are increased by 3 per cent, vaccine effectiveness becomes 90 per cent, with 95 per cent confidence limits of 83 per cent to 94 per cent.

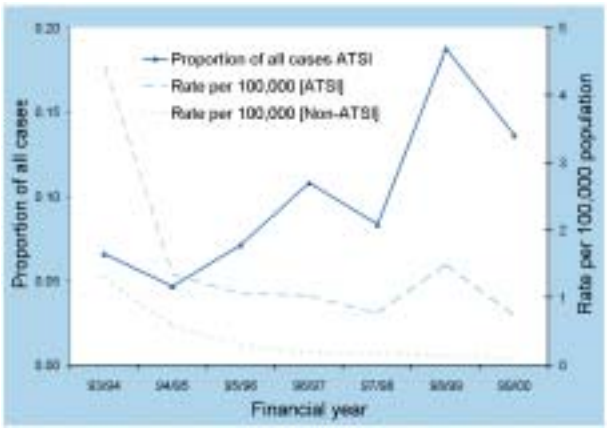
Coverage in the catch-up cohort

Forty-one per cent (221) of cases of invasive Hib disease occurring between 1 July 1993 and 30 June 2000 were children eligible for the catch-up campaign. Of these 221 cases, 182 were unimmunised, 24 fully immunised, six partially immunised and nine of unknown immunisation status. After excluding partially immunised children and cases where immunisation status was unknown, the proportion of cases fully vaccinated was 11.6 per cent (24/206) Assuming a vaccine effectiveness of 90 per cent gave an estimate of the proportion of children eligible for the catch-up campaign who were vaccinated of 57 per cent.

Aboriginal and Torres Strait Islanders

Aboriginal and Torres Strait Islanders status was recorded in 89 per cent (473/532) of reports to HCSS during the period 1 July 1993 to 30 June 2000. The estimated proportion of the Australian population who are of Aboriginal origin is around 2 per cent, yet 8 per cent of cases (41) were recorded as being of Aboriginal origin. There were equal numbers of male and female cases. Since the introduction of immunisation, the absolute number of cases in Aboriginal people has declined; however, there has been an increase over time in the proportion of cases occurring in this population group (Figure 13). As the proportion of the Australian population who are of Aboriginal origin has remained stable over the period 1993–94 to 1999–00, this trend is not related to changes in the proportion of the Australian population that are of Aboriginal origin. The trend is statistically significant (chi-squared test for linear trend, p=0.02).

Figure 13. Proportion of cases of invasive *Haemophilus influenzae* type b disease reported to HCSS who are reported as being of Aboriginal origin, Australia, 1 July 1993 to 30 June 2000



Source of ATSI population data: *The health and welfare of Australia's Aboriginal and Torres Strait Islander people.* Australian Bureau of Statistics, Commonwealth of Australia, 2001.

The median age of the 429 non-Aboriginal cases where age was known was 2.4 years (mean 10.2 years) whereas the median age of the 41 Aboriginal cases was 0.9 years (mean 3.7 years). Of the 26 deaths from invasive Hib between 1 July 1993 and 30 June 2000, two (8%) were recorded as being Aboriginal, and 16 of the 41 Aboriginal cases (39%) were reported from the Northern Territory.

Of the 41 reported Aboriginal cases, 20 had received no vaccinations—10 were eligible for routine immunisation, eight were eligible for a catch-up dose and two were not eligible for immunisation. Nine of the 41 Aboriginal cases (22%) were true vaccine failures, compared to 56 of 432 (13%) cases reported as non-Aboriginal. All nine had received at least two doses of PRP-OMP and five had received three doses of PRP-OMP. No deaths occurred amongst Aboriginal true vaccine failures.

Epiglottitis accounted for 30 per cent (129/432) of invasive Hib cases in non-Aboriginal people but only 5 per cent (2/41) of cases in Aboriginal persons. The case-fatality ratio in cases of Aboriginal origin was 4.9 per cent (2/41) which is similar to the case-fatality ratio of 4.6 per cent (20/432) seen in non-Aboriginal cases.

Discussion

Impact of immunisation on the epidemiology of *Haemophilus influenzae* type b

The introduction of routine Hib vaccination in Australia has resulted in a dramatic and substantial reduction in the incidence of invasive Hib disease. This is the first review of the impact of Hib vaccines nationally since the results of the first three years of the program (July 1993 to June 1996) were reported 1997.[20] In the four years 1996–97 to 1999–00, the average annual rate of invasive Hib disease in children less than five years of age was 1.7 cases per 100,000 population. This compares to a rate of 1.4 cases per 100,000 population in the United States of America (USA) in 1998 and 1999 and 1.6 in 2000,[21] and 1.8 cases per 100,000 population in the United Kingdom (UK) in 2000.[22]

Although the reduction has been most marked in the target population of children aged less than five years, reduced incidence has been seen in all age groups, even those not eligible for immunisation. This herd immunity effect has been seen in other countries[22–26] and demonstrates the impact of widespread immunisation on transmission of Hib in the community. This substantial herd immunity effect occurs because conjugate Hib vaccines prevent not only Hib disease but also carriage of Hib in the nasopharynx.[26-28]

Two methods were used in this study to estimate the impact of Hib immunisation. The first method compared the observed number of notifications with

expected numbers based on notified cases prior to July 1993. Estimates derived in this way are likely to be underestimates for two reasons. Firstly, during the early years of the NNDSS not all states and territories were reporting. Consequently, notification data prior to July 1993 are relatively more incomplete than later notification data. Projected numbers of notifications based on notifications prior to July 1993 are therefore underestimates. Secondly, information on age was missing from a proportion of cases reported to NNDSS in 1991, 1992 and 1993, therefore these cases had to be excluded from the calculation of the age-standardised rates.

The second method used to estimate the impact of Hib immunisation compared the observed number of notifications with expected numbers estimated from special surveys in the pre-Hib immunisation era. Estimates derived using this method are likely to be overestimates. This is because case ascertainment is likely to have been more complete in the pre-vaccination studies than for the routinely collected NNDSS data.

Given that the results of the two estimation methods are likely to represent upper and lower boundaries of the true program effectiveness, it is reasonable to conclude that Hib immunisation has reduced the incidence of Hib in children less than five years by between 87 per cent and 95 per cent.

As in other studies,[22] there is no evidence that immunisation has altered the clinical spectrum of invasive Hib disease. Meningitis remains the commonest presentation in infants and children aged less than five years, with epiglottis being the predominant presentation in older children. In Australia, epiglottis is more common than septicaemia even when epiglottis cases without laboratory confirmation are excluded. In many other countries, septicaemia is commoner than epiglottitis.[29] This feature of the Australian epidemiology of Hib was observed prior to the introduction of immunisation[2,6,8] and has also been observed in several Scandinavian countries.[30] It remains unexplained.

The case-fatality ratios observed since 1993–94 are consistent with previously published reports from Australia[3,6,8] and other developed countries.[21,29,31,32] The reason for the high case-fatality ratio in 1999–00 is not clear, but the low total number of cases does mean that small changes in the number of deaths can result in large changes in the case-fatality ratio.

Since the introduction of immunisation a greater proportion of cases has occurred in children aged less than six months. This reflects the fact that immunisation does not fully protect until the primary course is complete and has been observed elsewhere.[29] The move from HbOC to PRP-OMP may improve this situation in Australia, as the PRP-OMP primary course is completed at four months as opposed to six months, assuming that the effectiveness of two doses of PRP-OMP is at least equivalent to three doses of HbOC.

Overall, the number of reported Hib cases in males slightly exceeds the number reported in females. This pattern was found in pre-immunisation data in Australia[2,6,8] and elsewhere.[32] A pre-vaccination study in the Northern Territory reported a higher rate of Hib disease in Aboriginal females than in Aboriginal males, particularly for *Haemophilus influenzae* meningitis.[3,5] In Aboriginal cases reported to the HCSS since 1993, the gender ratio was equal with more male meningitis cases than female.

Although the incidence of invasive Hib disease has declined substantially in the Aboriginal population, the decline has not been as great as that seen in other populations. Aboriginal people remain at higher risk than other members of the population and now constitute a greater proportion of all cases than in the pre-immunisation period. Between 1996–97 and 1999–00, the average annual incidence rate in Aboriginal children aged less than five years was 6.7 cases per 100,000 population. This remains lower than a rate of 14 cases per 100,000 population reported by the United States of America in American Indian and Alaskan Native children aged less than five years in 1998–2000.[21] Despite the introduction of immunisation, Aboriginal children are still infected at a younger age than non-Aboriginal children. Indigenous populations in other countries suffer higher rates of Hib carriage and disease than non-Indigenous populations despite good vaccine coverage.[24,33,34] Persistent carriage has been implicated in a resurgence of Hib disease in Alaska following a change from PRP-OMP to HbOC for primary immunisation.[34]

The proportion of cases of invasive Hib that present with epiglottitis remains much lower in Aboriginal children than in non-Aboriginal children. Although previous studies in Australia have failed to identify epiglottitis in any Aboriginal children,[3,35,36] two cases were identified through enhanced national surveillance.

Strain typing

The enhanced Hib surveillance scheme does not attempt to verify the strain of *Haemophilus influenzae* reported. It is likely that laboratory capacity to type isolates of *Haemophilus influenzae* is becoming increasingly limited. In the USA, serotype was reported for around 80 per cent of all invasive *Haemophilus influenzae* cases reported between 1998 and 2000 and only 30 per cent of these were type b.[21] Aggregated data from nine European countries between 1996 and 1998 showed that 90 per cent of *Haemophilus influenzae* isolates from children aged under 15 years were typed and 58 per cent of these were type b.[29]

Hanna found that 15 per cent of invasive *Haemophilus influenzae* infections in Aboriginal children were caused by non-type b strains.[3] The continuing higher incidence and the increased vaccine failure rate seen in the Aboriginal population could be partly explained by higher carriage and incidence of non-type b disease in this population group, if some *H. influenzae* isolates were incorrectly identified as type b.[37]

Vaccine effectiveness

Measures of the effectiveness of an immunisation program using observed and expected disease rates cannot separate the direct protection to individuals afforded by immunisation and the indirect protection provided by herd immunity. Vaccine effectiveness estimates using the screening method measure only the direct protective effect of immunisation. Using this method vaccine effectiveness in Australia was high with no observed variation in effectiveness by age.

In the initial logistic regression model the vaccine effectiveness in the years 1993–94 and 1994–95 was significantly higher than other years. These years were excluded from the model as this finding was probably a consequence of inaccurate coverage estimates in these years. In 1993–94 and 1994–95, vaccine coverage was likely to be lower than in later years. However, because data were not available from the ACIR, coverage data for these years was extrapolated from later years. Consequently the 1993–94 and 1994–95 coverage estimates used in the model are probably overestimates, which would inflate vaccine effectiveness estimates. This is because vaccinated cases are actually coming from a smaller population of vaccinated people than is assumed, making the true incidence in the vaccinated population higher than estimated, and falsely raising vaccine effectiveness.

The value of booster doses of Hib conjugate vaccines has been debated for some time.[38–40] Over the seven year immunisation period, the incidence of invasive Hib in children aged 18 to 30 months was about 40 per cent lower than in children aged 6 to 18 months. However, this may not be attributable to the effect of the 18 months HbOC booster dose as pre-immunisation data show an age-dependent risk of disease, with two-year-olds having a 30 per cent lower incidence than one-year-olds.

Vaccine failures

The vaccine failure rate appears to be higher for PRP-OMP than HbOC and higher in Aboriginal children than in non-Aboriginal children. However, since Aboriginal children are at increased risk of Hib compared to non-Aboriginal children, the apparently high failure rate of PRP-OMP in the Aboriginal population may be a reflection of increased exposure to infection in this population rather than of poor vaccine performance. It might also represent a higher rate of non-type b infection, which will not be prevented by Hib vaccination.

Of 114 cases occurring in children eligible for routine vaccination and aged six months or older, 27 (24%) were unimmunised, 30 (26%) were under-immunised, and 51 (45%) were fully immunised. Vaccination status was unknown for six cases. In the USA in 1998–2000 only 35 per cent of Hib cases in children aged six months or older had completed the primary series. Therefore, in Australia vaccine failures appear to constitute a higher proportion of Hib cases than in the USA. A recent collaborative study found that in Australia a similar proportion of Hib cases occurred in vaccinated children as in the UK, Ireland and Germany, but that this was higher than in a number of other European countries.[29] Why this might be so is not clear and warrants enhanced efforts to identify possible reasons for vaccine failures. There is evidence that a significant proportion of vaccine failures are related to underlying immunological or clinical problems,[22,40] data not currently routinely collected in the HCSS.

Surveillance methods

A clinical diagnosis of epiglottitis, without microbiological confirmation, was the criteria for notification of only 6 per cent of Hib cases to the enhanced surveillance system. Seventy per cent of epiglottitis cases were confirmed by blood culture. It is possible that the specificity for Hib disease of a clinical diagnosis of epiglottitis may have changed following the introduction of Hib immunisation. However, as these cases constitute only a small proportion of total epiglottitis, it seems unnecessary to alter the current case definition to exclude clinically identified epiglottitis.

The reasons for the apparently high rate of vaccine failures in Australia and the continued increased risk amongst Aboriginal children are issues which may be at least partially addressed by improving laboratory typing of isolates of *Haemophilus influenzae* and acquiring detailed medical histories in vaccine failures.

Achieving elimination or eradication of *Haemophilus influenzae* type b disease in Australia

Hib is now an infrequent cause of illness in Australia, however control of Hib can be improved. About half the cases occurring in children aged over six months could be prevented by improved timeliness of immunisation. The recent change to the PRP-OMP schedule from the HbOC schedule has the potential to further reduce the number of cases of Hib disease, by decreasing the age at which the primary schedule is completed.

It is conceivable that indigenous Hib disease could be eradicated from Australia, but gaps in our understanding remain. The investigation of vaccine failures, particularly in Aboriginal children, and further characterisation of *Haemophilus influenzae* carriage and disease in this population could help to further improve control of Hib. The re-emergence of Hib in a Native Alaskan population following a change in the vaccine used, recent increases in Hib disease in the UK and the isolation of unusually pathogenic non-b *Haemophilus influenzae* serotypes are all reminders that control of Hib should not be taken for granted.[22,35,41]

It is important that enhanced surveillance of *Haemophilus influenzae* disease at the laboratory and public health level is continued in Australia.

Appendix A

Birth cohorts used to estimate vaccine coverage for vaccine effectiveness estimates

	Financial year			
	1 July 1996–30 June 1997	1 July 1997–30 June 1998	1 July 1998–30 June 1999	1 July 1999–30 June 2000
Encounters up to:	1 January 1997	1 January 1998	1 January 1999	1 January 2000
Age band	Birth cohort	Birth cohort	Birth cohort	Birth cohort
6 to 11.99 months	2 January 1996 to 1 July 1996	2 January 1997 to 1 July 1997	2 January 1998 to 1 July 1998	2 January 1999 to 1 July 1999
12 to 23.99 months	Unavailable	2 January 1996 to 1 January 1997	2 January 1997 to 1 January 1998	2 January 1998 to 1 January 1999
24 to 35.99 months	Unavailable	Unavailable	2 January 1996 to 1 January 1997	2 January 1997 to 1 January 1998
36 to 47.99 months	Unavailable	Unavailable	Unavailable	2 January 1996 to 1 January 1997

Appendix B

Calculation of the proportion of cases in catch-up cohort vaccinated

Denominator = all cases of invasive Hib occurring between 1 July 1993 and 30 June 2000 in children eligible for the catch-up campaign (date of birth 1 August 1988 to 28 February 1993).

Numerator = cases of invasive Hib occurring between 1 July 1993 and 30 June 2000 in fully vaccinated children eligible for the catch up campaign (date of birth 1 August 1988 to 28 February 1993). Excluding partially immunised children (n=6) and vaccination status unknown (n=9).

Calculation

PCV = 24/24+182 = 0.116

VE = PPV – PCV / PPV (1 – PCV)

0.9 = PPV – 0.116 / PPV (1 – 0.116)

0.9 = PPV – 0.116 / 0.884 PPV

Multiply through by 0.884 PPV

0.884 PPV x 0.9 = PPV – 0.116

0.796 PPV = PPV – 0.116

Subtract PPV from each side

– 0.204 PPV = – 0.116

0.204 PPV = 0.116

PPV = 0.116/ 0.204

PPV = 0.57

References

1. Koo W, Oley C, Munro R, Tomlinson P. Systemic *Haemophilus influenzae* infection in childhood. *Med J Aust* 1982;2:77–80.
2. McGregor AR, Bell JM, Abdool IM, Collignon PJ. Invasive *Haemophilus influenzae* infection in the Australian Capital Territory region. *Med J Aust* 1992;156:569–572.
3. Hanna JN. The epidemiology of invasive *Haemophilus influenzae* infections in children under five years of age in the Northern Territory: a three-year study. *Med J Aust* 1990;152:234–236, 238, 240.
4. Peltola H. Worldwide *Haemophilus influenzae* type b disease at the beginning of the 21st century: global analysis of the disease burden 25 years after the use of the polysaccharide vaccine and a decade after the advent of conjugates. [Review] *Clin Microbiol Rev* 2000;13:302–317.
5. Hanna JN, Wild BE. Bacterial meningitis in children under five years of age in Western Australia. *Med J Aust* 1991;155:160–164.
6. McIntyre PB, Leeder SR, Irwig LM. Invasive *Haemophilus influenzae* type b disease in Sydney children 1985 to 1987: a population-based study. *Med J Aust* 1991;154:832–837.
7. Harris A, Hendrie D, Bower C, Payne J, de Klerk, Stanley F. The burden of *Haemophilus influenzae* type b disease in Australia and an economic appraisal of the vaccine PRP-OMP. *Med J Aust* 1994;160:483–488.
8. Gilbert GL, Clements DA, Broughton SJ. *Haemophilus influenzae* type b infections in Victoria, Australia, 1985 to 1987. *Pediatr Infect Dis J* 1990;9:252–257.
9. Markey P, Krause V, Boslego JW, Coplan PM, Dargan JM, Kaplan KM. The effectiveness of *Haemophilus influenzae* type b conjugate vaccines in a high risk population measured using immunization register data. *Epidemiol Infect* 2001;126:31–36.
10. Peltola H, Kayhty H, Sivonen A, Makela H. *Haemophilus influenzae* type b capsular polysaccharide vaccine in children: a double-blind field study of 100,000 vaccinees 3 months to 5 years of age in Finland. *Pediatrics* 1977;60:730–737.
11. McIntyre P. Invasive *Haemophilus influenzae* type b disease. *Aust Fam Physician* 1993;22:1782–1789.
12. McIntyre PB, Chey T, Smith WT. The impact of vaccination against invasive *Haemophilus influenzae* type b disease in the Sydney region. *Med J Aust* 1995;162:245–248.
13. Shapiro ED, Ward JI. The epidemiology and prevention of disease caused by *Haemophilus influenzae* type b. [Review] *Epidemiol Rev* 1991;13:113–142.
14. Annual report of the National Notifiable Disease Surveillance System, 1993. *Commun Dis Intell* 1994;18:518–548.
15. Farrington CP. Estimation of vaccine effectiveness using the screening method. *Int J Epidemiol* 1993;22:742–746.

16. Clements DA, Guise IA, MacInnes SJ, Gilbert GL. *Haemophilus influenzae* type b infections in Victoria, Australia, 1985 to 1989. *J Infect Dis* 1992;165 Suppl 1:S33–S34.

17. Gilbert GL. Epidemiology of *Haemophilus influenzae* type b disease in Australia and New Zealand. *Vaccine* 1991;9 Suppl:S10–3; discussion S25.

18. Orenstein WA, Bernier RH, Hinman AR. Assessing vaccine efficacy in the field. Further observations. *Epidemiol Rev* 1988;10:212–241.

19. Hull B, Lawrence G, MacIntyre CR, McIntyre P. Immunisation coverage: Australia 2001. Canberra: Commonwealth Department of Health and Ageing; 2002.

20. Herceg A. The decline of *Haemophilus influenzae* type b disease in Australia *Commun Dis Intell* 1997:21:173–176.

21. Progress toward elimination of *Haemophilus influenzae* type b invasive disease among infants and children—United States, 1998–2000. *MMWR Morb Mortal Wkly Rep* 2002;51:234–237.

22. Heath PT, McVernon J. The UK Hib vaccine experience. *Arch Dis Child* 2002;86:396–399.

23. Moulton LH, Chung S, Croll J, Reid R, Weatherholtz RC, Santosham M. Estimation of the indirect effect of Haemophilus influenzae type b conjugate vaccine in an American Indian population. *Int J Epidemiol* 2000;29:753–756.

24. Millar EV, O'Brien KL, Levine OS, Kvamme S, Reid R, Santosham M. Toward elimination of *Haemophilus influenzae* type b carriage and disease among high-risk American Indian children. *Am J Public Health* 2000;90:1550–1554.

25. Rushdy A, Ramsay M, Heath PT, Azzopardi HJ, Slack MP. Infant Hib vaccination and herd immunity. *J Pediatr* 1999;134:253–254.

26. Barbour ML, Mayon-White RT, Coles C, Crook DW, Moxon ER. The impact of conjugate vaccine on carriage of *Haemophilus influenzae* type b. *J Infect Dis* 1995;171:93–98.

27. Adegbola RA, Mulholland EK, Secka O, Jaffar S, Greenwood BM. Vaccination with a *Haemophilus influenzae type* b conjugate vaccine reduces oropharyngeal carriage of *H. influenzae* type b among Gambian children. *J Infect Dis* 1998;177:1758–1761.

28. Forleo-Neto E, de Oliveira CF, Maluf EM, Bataglin C, Araujo JM, Kunz LF Jr, *et al*. Decreased point prevalence of *Haemophilus influenzae* type b (Hib) oropharyngeal colonization by mass immunization of Brazilian children less than 5 years old with Hib polyribosylribitol phosphate polysaccharide-tetanus toxoid conjugate vaccine in combination with diphtheria-tetanus toxoids-pertussis vaccine. *J Infect Dis* 1999;180:1153–1158.

29. Handford S, Andrews N, Rushdy A, Ramsay M, Slack M, Heath P. An evaluation of *Haemophilus influenzae* type b (Hib) vaccination and description of risk factors for Hib vaccine failure in Europe 1996–1999. Final Report. London: PHLS Communicable Disease Surveillance Centre; 2002.

30. Claesson BA. Epidemiology of invasive *Haemophilus influenzae* type b disease in Scandinavia. *Vaccine* 1993;11 Suppl 1:S30–S33.

31. Booy R, Hodgson SA, Slack MP, Anderson EC, Mayon-White RT, Moxon ER. Invasive *Haemophilus influenzae* type b disease in the Oxford region (1985–91). *Arch Dis Child* 1993;69:225–228.

32. Anderson EC, Begg NT, Crawshaw SC, Hargreaves RM, Howard AJ, Slack MP. Epidemiology of invasive *Haemophilus influenzae* infections in England and Wales in the pre-vaccination era (1990–2). *Epidemiol Infect* 1995;115:89–100.

33. Singleton R, Bulkow LR, Levine OS, Butler JC, Hennessy TW, Parkinson A. Experience with the prevention of invasive *Haemophilus influenzae* type b disease by vaccination in Alaska: the impact of persistent oropharyngeal carriage. *J Pediatr* 2000;137:313–320.

34. Galil K, Singleton R, Levine OS, Fitzgerald MA, Bulkow L, Getty M, *et al*. Reemergence of invasive *Haemophilus influenzae* type b disease in a well-vaccinated population in remote Alaska. *J Infect Dis* 1999;179:101–106.

35. Bower C, Condon R, Payne J, Burton P, Watson C, Wild B. Measuring the impact of conjugate vaccines on invasive *Haemophilus influenzae* type b infection in Western Australia. *Aust N Z J Public Health* 1998;22:67–72.

36. Hanna JN, Wild BE, Sly PD. The epidemiology of acute epiglottitis in children in Western Australia. *J Paediatr Child Health* 1992;28:459–464.

37. Smith-Vaughan HC, McBroom J, Mathews JD. Modelling of endemic carriage of *Haemophilus influenzae* in Aboriginal infants in Northern Australia. *FEMS Immunol Med Microbiol* 2001;31:137–143.

38. Booy R, Heath PT, Slack MP, Begg N, Moxon ER. Vaccine failures after primary immunisation with *Haemophilus influenzae* type-b conjugate vaccine without booster. [Erratum in *Lancet* 1997;349:1630.] *Lancet* 1997;349:1197–1202.

39. Coen PG, Heath PT, Garnett GP. The Hib immunization programme in the Oxford region: an analysis of the impact of vaccine administration on the incidence of disease. *Epidemiol Infect* 1999;123:389–402.

40. Heath PT, Booy R, Griffiths H, Kimball A, Hindiyeh M, Carroll K, *et al*. Clinical and immunological risk factors associated with *Haemophilus influenzae* type b conjugate vaccine failure in childhood. *Clin Infect Dis* 2000;31:973–980.

41. Adderson EE, Byington CL, Spencer L, *et al*. Invasive serotype a *Haemophilus influenzae* infections with a virulence genotype resembling *Haemophilus influenzae* type b: emerging pathogen in the vaccine era? *Pediatrics* 2001;180:E18.

Surveillance of invasive meningococcal disease in Queensland, 2002

Robyn E Pugh,[1] Helen Smith,[2] Margaret Young[3]

Abstract

During 2002, 124 cases of invasive meningococcal disease were notified in Queensland. This was similar to the previous year (n=128). Four (3.2%) of the cases died. Trends by age and serogroup were generally similar to previous years and were consistent with the overall patterns of this disease in Australia. However, an apparent increase in serogroup C, which infected 41 per cent of cases, needs continued monitoring. This report highlights the need for continued surveillance of morbidity and mortality patterns and management of this disease. Ongoing surveillance will monitor the impact of the National Meningococcal C Vaccination Programme, commenced in early 2003. This report also highlights the need for ongoing community education to ensure people seek medical attention early after onset of the illness. This report shows that when general practitioners considered meningococcal disease as a diagnosis, their patients were admitted to hospital sooner than patients in whom this diagnosis was not initially considered. Acknowledging that early disease may present diagnostic difficulties, further awareness raising amongst general practitioners is required to promote early recognition and referral. ***Commun Dis Intell*** **2003;27:342–351.**

Keywords: invasive meningococcal disease, communicable diseases, surveillance

Introduction

Invasive meningococcal disease (IMD) is notifiable to Queensland Health by laboratories identifying a laboratory confirmed case of disease and also by clinicians, on clinical suspicion of disease. The data are maintained on the Notifiable Conditions database (NOCS), and have been collated since 1993. In 1999, enhanced surveillance for invasive meningococcal disease was established throughout Queensland. Communicable diseases staff of the Public Health Units coordinate public health responses to notified cases and conduct enhanced surveillance. Queensland Health reported on enhanced surveillance for the years 1999,[1] 2000,[2] 2001[3] and 2002.[4] This paper is derived from the 2002 report.

The purposes of this paper are:

- to describe the epidemiology of invasive meningococcal disease in Queensland in 2002;
- to describe risk factors for dying of IMD identified in the four year period since enhanced surveillance began;
- to describe trends of the disease since 1993; and
- to discuss the implications of these findings for ongoing surveillance and control of this disease with particular reference to the introduction of vaccination against *Neisseria meningitidis*.

Methods

The following definitions for confirmed and probable cases of invasive meningococcal disease were used:

> Confirmed cases of invasive meningococcal disease were defined as: a clinically compatible illness with at least one of the following—isolation of *Neisseria meningitidis* from an otherwise sterile body site, *or* detection of gram-negative intracellular diplococci in cerebrospinal fluid (CSF) or petechiae, *or* a positive polymerase chain reaction (PCR) test on CSF, blood or serum, *or* a positive meningococcal antigen test on CSF, *or* detection of meningococcal IgM in serum.

The PCR test has been used in Queensland from 1999 onwards, and the IgM test was introduced in 2000.

1. Senior Epidemiologist, Communicable Diseases Unit, Queensland Health, Brisbane, Queensland
2. Molecular Epidemiologist, Queensland Health Scientific Services, Brisbane, Queensland
3. Acting Manager, Communicable Diseases Unit, Queensland Health, Brisbane, Queensland

Corresponding author: Dr Robyn Pugh, Senior Epidemiologist, Communicable Diseases Unit, Queensland Health, Brisbane, GPO Box 48, Brisbane, QLD 4001. Telephone: +61 7 3234 0942. Facsimile: +61 7 3234 0057.
Email: Robyn.Pugh@health.qld.gov.au or piralko@optusnet.com.au

Probable cases were defined as: a clinically compatible illness with at least one of the following—a petechial or purpuric rash, *or* isolation of *N. meningitidis* from a throat swab *or* close contact with a confirmed case.

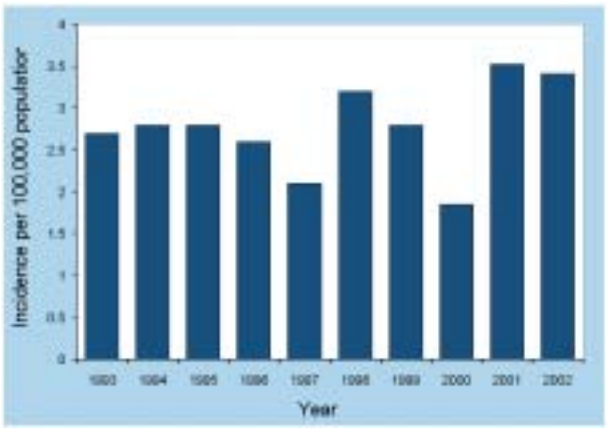
Meningococcal conjunctivitis as diagnosed by isolation of *N. meningitidis* from the conjunctiva of a patient with conjunctivitis is not strictly speaking an invasive disease but is included in surveillance because it may be associated with invasive disease in the patient or with invasive meningococcal disease in a contact.[5] These cases will be reported below but not included in analyses of invasive meningococcal disease.

Public health units seek information on each notified case from the attending medical staff and from the patient or next of kin. A standardised case reporting form is used (Appendix 1). Information on previous years was taken from other published reports and from the database; variation from data in previous reports occurs due to data cleaning and obtaining additional information for the dynamic database. Analysis was performed in Excel, EpiInfo 6[6] and Stata.[7] Chi-square, Yates corrected or Fisher's exact tests were used where appropriate.

Results

There were 124 cases of invasive meningococcal disease in Queensland in 2002. This represented an incidence of 3.4 cases per 100,000 population, which is similar to 2001 and higher than the years between 1993 and 2000 when it ranged between 1.9 and 3.2 cases per 100,000 population (Figure 1). There were also three cases of meningococcal conjunctivitis. These cases are excluded from further analysis of the invasive meningococcal cases in 2002.

Figure 1. Annual incidence per 100,000 population of invasive meningococcal disease, Queensland, 1993 to 2002

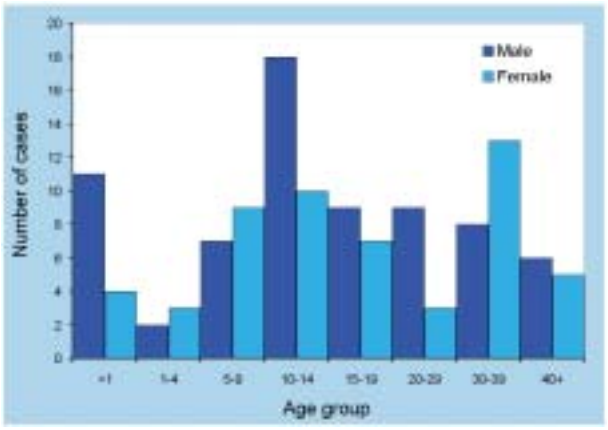


Of the 124 invasive meningococcal cases, 118 (95%) were laboratory-confirmed and 6 (5%) were probable cases. There were four deaths in 2002, representing a case fatality rate of 3.2 per cent. This is not significantly different from the case fatality rate in 2001 of 8.7 per cent (p=0.07).

Age and gender distribution

In Queensland during 2002, 33.9 per cent of all cases of invasive meningococcal disease occurred in children below 10 years of age; 25.0 per cent of all cases were under five years of age; 12.1 per cent were under one year and 12.9 per cent were aged 1–4 years. Persons aged 15–29 years accounted for 35.5 per cent of cases. Of the 124 cases, 70 were males (56%) and 54 were females (44%) (Figure 2).

Figure 2. Number of invasive meningococcal cases, Queensland, 2002, by age group



As in previous years, the rate was highest among infants. The 15–19 year age group had the second highest rate in 2002. The rate for this age group has risen steadily over the last three years such that the rate in the 15–19 year age group in 2002 was significantly higher than the rate for that age group in 2000 ($p<0.05$). In contrast, rates amongst the 1–4 year age group in 2002 were lower than in 2001 and were the lowest for 10 years for this age group, although the difference was not statistically significant ($p>0.05$) (Table 1).

Indigenous status

In 2002, Indigenous status was identified for all cases of invasive meningococcal disease. Of the 124 cases, six (5.5%) were recorded as Indigenous. This is not significantly different from the Queensland population where 3.1 per cent are estimated to be Indigenous (p=0.2). Three of the six Indigenous cases were below five years of age; one was under one year. Of the 31 cases under five years, 9.7 per cent were Indigenous; this also is not significantly different from this age group in Queensland, where 6.2 per cent are estimated to be Indigenous (p=0.6).

Table 1. Age-specific annual incidence of invasive meningococcal disease, Queensland, 1993 to 2002, (age-specific rates per 100,000 population*)

Age group (years)	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
<1	37.4	30.8	28.6	24.2	24.2	33.0	24.2	15.0	28.2	30.2
1–4	16.0	10.3	11.8	10.3	13.4	12.9	10.8	8.2	12.0	8.0
5–9	2.1	1.2	1.7	4.6	0.4	3.3	4.6	1.6	6.1	4.2
10–14	3.2	2.8	1.2	2.0	2.8	2.8	1.2	1.9	2.3	1.9
15–19	4.6	9.3	8.8	7.6	5.5	8.4	6.7	5.3	8.7	10.6
20–29	1.8	2.4	2.8	2.4	1.4	2.6	2.8	1.9	4.9	3.1
30–39	0.6	0.6	1.2	0.4	0.4	0.8	0.4	0.4	0.7	2.2
40+	0.5	1.0	0.9	0.7	0.4	1.2	1.1	0.5	1.0	1.4
Total	2.7	2.8	2.8	2.6	2.1	3.2	2.8	1.9	3.5	3.4

* Rates calculated using 1996 census data for 1993 to 2000, rates for 2001 and 2002 calculated from 2001 estimated resident population

Seasonal variation

As in previous years, the incidence of disease peaked during winter or early spring. Fifty per cent of cases occurred in the four months June to September with August recording the highest number of notifications (23,18.5%).

Clinical presentation

Thirty-five cases (28.2%) had meningitis alone on clinical presentation and 59 (47.6%) presented with septicaemia alone. Sixteen patients (12.9%) had both meningitis and septicaemia (Table 2). This was not significantly different from the disease presentation profile in 2001[3] or 2000[2] (p 0.3). Overall, 82 (66%) of the 124 cases developed a rash during the reporting period; however, 45 (76%) cases with septicaemia presented with a rash (Table 2).

Risk factors

Links with other cases

Of the 124 cases, there was one cluster of epidemiologically and microbiologically linked cases. Two males and two females aged between 19 and 40 years from a central Queensland town and surrounding area presented with invasive meningococcal disease within 37 days in July/August 2002. All four had a good clinical outcome. Three cases were identified as serogroup C and one as a serogroup Y. Not all isolates could be typed, however, the serogroup Y and one of the serogroup C isolates had the same sero-subtype (P1.5) and it was postulated that the serogroup Y may have undergone a capsule change. These cases met the national guideline criteria of a cluster and in addition to usual public health responses, a vaccination program was implemented. Between 20 September and 23 September, 2,299 men and women in the risk age group of 18–40 years, who lived or worked in a 15 kilometre radius of this town since 1 July 2002, were vaccinated. A

Table 2. Clinical presentation of invasive meningococcal disease, Queensland, 2002

Clinical presentation	Number with a rash	Number without a rash	Total number	%
Meningitis	19	16	35	28.2
Septicaemia	45	14	59	47.6
Meningitis + septicaemia	11	5	16	12.9
Septic arthritis	1	3	4	3.2
Eye disease (intraocular)	0	1	1	0.8
Not stated	0	9	9	7.3
Total	82	42	124	100

polysaccharide (serogroups ACW135Y) vaccine was used until stocks were exhausted and the remainder were vaccinated with a conjugate (serogroup C) vaccine. No other cases were detected in this area in 2002.

Child care

Eight sporadic cases had associations with child care centres; six were in the 0–4 age group, one was aged 9 years in after school care and the other was an 18-year-old child care attendant.

Laboratory diagnosis

Of the 118 laboratory-confirmed cases, 94 (80%) cases were diagnosed by isolation of *N. meningitidis* from a clinical specimen and at least one other test. Only 23 (19%) of the 118 were diagnosed by culture alone. Although a total of 51 cases overall had meningococcal DNA detected, 16 of these cases were diagnosed by nucleic acid tests alone, reflecting the benefits to surveillance of these advanced tests. Twenty-six (21%) of the cases were detected using nucleic acid testing, detection of meningococcal IgM in serum and/or antigen tests; the diagnoses of only three of these cases did not include nucleic testing. A total of 68 cases overall had positive microscopy; no cases were diagnosed by microscopy alone.

Serogroups, serotypes and serosubtypes

Of 124 cases, 117 isolates or DNA samples (94.4%) were able to be serogrouped (Figure 3). This is a significantly higher proportion of cases than in 2001 (83%)[3] or 2000[2] (73%) ($p<0.003$). Of the 117 isolates, 59 (50.4%) were serogroup B, 48 (41.0%) were serogroup C and 10 were other serogroups (5 were Y, 4 were W135 and 1 was X) (Table 3). Serogroup X has not been isolated from a sterile site (excluding conjunctivitis) in Queensland previously.

The percentage of isolates that were serogroup C is the highest since 1994; it is not significantly higher than 2001 or 1995–1996 ($p=0.1$) but is significantly higher than 1997–2000 inclusive (p 0.02) (Table 3).

There were three cases (11.5% of isolates) caused by serogroup C in children aged less than five years, although there were no cases caused by serogroup C in children aged under 12 months of age. In cases aged 15–19 years of age, 14 (51.9%) of the isolates able to be serogrouped were serogroup C (Figure 3). The proportion of disease due to serogroup C in these key age groups has not altered significantly in the last three years (p 0.2). In 2002, it amounted to a rate of serogroup C meningococcal disease in children aged 1–4 years, of 1.5 cases per 100,000 population compared with 5.3 cases per 100,000 population in the 15–19 age group.

Figure 3. Number of cases of invasive meningococcal disease, Queensland, 2002, by serogroup

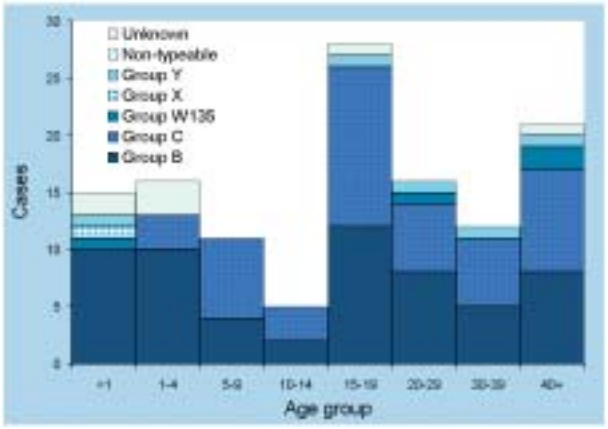


Table 3. Trends in invasive meningococcal disease serogroups, Queensland, 1994 to 2002

Year	Serogroup									Total
	B		C		A	W135	X	Y	Z	
	n	%	n	%	n	n	n	n	n	n
1994	41	55.4	32	43.2				1		74
1995	38	58.4	23	35.4	1	1		2		65
1996	45	59.2	23	30.3		4		3	1	76
1997	47	73.4	13	20.3		4				64
1998	57	71.3	11	13.8		6		6		80
1999	46	68.7	16	23.9		3		2		67
2000	37	77.1	10	20.8		1				48
2001	68	64.2	32	30.2		1		5		106
2002	59	50.4	48	41.0		4	1	5		117

When data were aggregated for the last four years, 1999–2002, 106 of 338 cases (31.4%) were serogroup C. During that time, there have been only two cases of invasive meningococcal disease due to serogroup C in infants under the age of one year. The proportion of disease due to serogroup C was significantly lower in the <1 year (5.1%) and the 1–4 years (15.8%) age brackets than any other age group (range: 32.0 % to 57.1%) ($p<0.05$) except for the 30–39 year age range (31.4%) where small numbers may affect the ability to detect significant differences. Almost half of the serogroup C cases (49 of 106 cases) occurred in persons aged between 15 and 29 years.

In 2002, serotyping and subtyping was performed on 86 isolates. The most common phenotype in 2002 was C:2a:P1.5 which comprised 23.3 per cent of all typed cases but more than a half of serogroup C cases (58.8%) compared with 25 per cent in 2001 ($p=0.01$). This relates to the ET15 strain which occurs among the C:2a:P1.5/P1.5,2 or ET37 lineage rather than to the actual phenotype C:2a:P1.5. Queensland first saw the ET15 strain in 1996 and it has been consistently present since but it was not possible to determine how many of the 2002 isolates were the ET15 strain.

The phenotype C:2a:P1.4, which is relatively new to Queensland, decreased from 16.7 per cent of isolates in 2001 to 11.8 per cent of isolates in 2002. The majority were identical to the Victorian strain (Helen Smith, personal communication).

The phenotypes B:4:P1.4 and B:NT:P1.4 accounted for 31 per cent of the typed serogroup B isolates; this is similar to 2001 (32%). There were three cases of phenotype W135:NT:P1.6. There were no links between these cases.

Outcome

There were four deaths from invasive meningococcal disease in 2002, representing a case fatality of 3.2 per cent. There was one death in each of the under one year, 5–9, 30–39 and over 40 years age brackets. There were two serogroup B (one B:NT:PT NT and the other not able to be typed) and two serogroup C (C:2A:P1.4 and C:2A:PT NT) cases. The case fatality for cases with isolates of serogroup B was 3.4 per cent (2 of 59 cases) while it was 4.2 per cent (2 of 48 cases) for those with serogroup C isolates ($p=1.0$).

In 2002, the case fatality rate was the lowest in the four years of enhanced data collection. However, small numbers hamper the ability to discuss trends or analyse risk factors (Table 4).

Deaths during the four years of enhanced data collection were aggregated by age groups. The overall death rate in the period 1999 to 2002 was 7.5 per cent (31 of 411 cases). There was no significant difference in case fatality rates amongst the age groups ($p=0.5$).

Risk factors for dying of invasive meningococcal disease in 4 year period, 1999 to 2002

Because small numbers of fatal cases each year prevents the identification of significant risk factors for dying, information collected for the last four years has been pooled and analysed.

When data of cases in under 5-year-olds and over 30-year-olds were combined, this group was twice as likely to die from invasive meningococcal disease as those aged between 5 and 29 years in this 4-year period. Of all cases aged under 5 years or over 30 years, 10.2 per cent died compared with 4.9 per cent of 5–29 year olds but this difference was not significant (RR: 2.11; 95% CI: 1.02 – 4.37; $p=0.06$).

Outcomes according to gender and Indigenous status were not statistically significantly different (RR: 1.88; 95% CI: 0.91 – 3.89 and RR: 1.48; 95% CI: 0.48 – 5.54). Fatal outcomes were also not related to geographic location of the case (p 0.5) or to a history of overseas travel (RR: 1.17; 95% CI: 0.17 – 8.04).

Persons who presented with septicaemia alone were not at significant higher risk of dying compared with those who presented with meningitis alone (RR: 4.42; 95% CI: 0.54 – 35.90). However, those who presented with septicaemia with or without other clinical features were 11 times more likely to die than those who did

Table 4. Deaths due to invasive meningococcal disease, 1999 to 2002, by year

Year	Serogroup B			Serogroup C			All serogroups		
	Died	Total	%	Died	Total	%	Died	Total	%
1999	5	46	10.9	6	16	37.5	12	93	12.9
2000	1	37	2.7	1	10	10.0	4	66	6.1
2001	4	68	5.9	5	32	15.6	11	128	8.6
2002	2	59	3.4	2	48	4.2	4	124	3.2
Total	12	210	5.7	14	106	13.2	31	411	7.5

not have septicaemia as one of their presenting features (RR: 11.4; 95% CI: 1.6 – 82.6). Persons who presented with a petechial rash were 10 times more likely to die than those did not have a rash (RR: 10.1; 95% CI: 1.6 – 82.6). This may reflect stage of illness at time of reporting.

Over the four year period, cases due to serogroup C were 2.3 (95% CI: 1.11–4.82) times more likely to die compared with those caused by serogroup B.

General practice management and public health action

In 2002, information on timing of the management of invasive meningococcal disease was available for 80 cases. For these cases, median time delays at points of clinical progress are displayed in Figure 4 and Table 5. The median time taken from onset of illness to hospital admission was 19 hours (range: ½ hour to 6½ days) (Figure 4). The majority of cases were admitted to hospital within one day of the onset of their illness (Table 5); this was similar to 2000[2] (p=0.5) but faster than in 2001[3] (p=0.002). In 2002, the median time for the four fatal cases to be admitted to hospital was not significantly different than for the cases who did not die (p=0.25).

Forty-nine (39.5%) of the 124 cases consulted a general practitioner (GP) about their illness; this included one of the fatal cases. Of these 49 cases, information was available on the suspected diagnosis for 38 of the cases. Almost a half (17 or 44.7%) identified the case may have had invasive meningococcal disease; 15 of these 17 (88%) were referred to the hospital by the GP at the time of consultation. For 21 cases, invasive meningococcal

Figure 4. Median time delays from meningococcal disease onset to notification and response

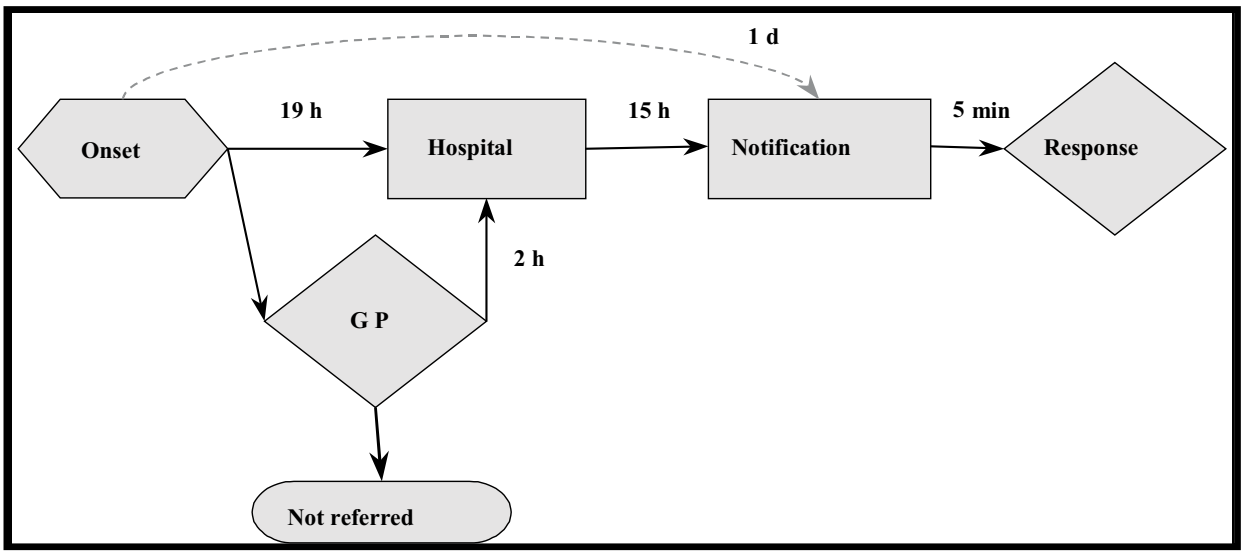


Table 5. Median time delays from meningococcal disease onset to notification and response

Intervals	Onset to hospital admission % (n=80)	Consultation to hospital admission % (n=29)	Hospitalisation to notification of PHU % (n=97)	Onset to notification of PHU % (n=84)	Notification to response by PHU % (n=108)
<½ hour	0.0	6.9	0.0	0.0	80.6
<1 hour	2.5	27.6	2.1	0.0	10.2
<6 hours	6.3	31.0	32.0	0.0	7.4
6–24 hours	62.5	17.2	33.0	32.1	1.9
24–48 hours	15.0	13.8	21.6	35.7	0.0
More than 2 days	13.8	3.4	11.3	32.2	0.0
Total	100	100	100	100	100

disease was not diagnosed at the time of the original consultation, but 18 of these 21 (86%) were referred to hospital; this included one fatal case. Of 41 who were referred by a GP to hospital, information was available on 29 cases. Of these 29, a majority were admitted within six hours of referral from the GP. This is similar to 2001[3] (p=0.7) (Table 5). In 2002, the median time between GP consultation and admission was two hours (range: <½ hour to 2½ days) (Figure 4). This is similar to 2001[3] (p=0.6).

However, in 2002 there was a significant difference in the time taken from GP consultation to hospital admission according to whether or not the GP diagnosed invasive meningococcal disease. The median time between consultation and admission was one hour (range: <½ hour to 21 hours) when this disease was considered and 10½ hours (range: 1¾ hours to 2½ days) when this diagnosis was not considered. This difference was significant (p=0.02).

Six persons (14.7% of those who consulted a GP) were given antibiotics prior to admission; this is a similar proportion to 2001[3] (21%) (p=0.2). Of these six, invasive meningococcal disease was considered in three cases, who were then promptly referred.

The majority of cases (67%) were notified to the relevant public health unit within a day of admission (Table 5). The median time between admission and notification was 15¼ hours (range immediately to 10½ days) (Figure 4). This is similar to 2001[3] (p=0.5).

Sixty-eight per cent of cases were notified to the relevant public health unit within two days of onset of illness (Table 5). The median interval between onset and notification was 1 day 9½ hours (range from 6½ hours to 22 days) (Figure 4). This is not significantly shorter than 2001[3] (p=0.6).

Where information is available, the public health units initiated a response within six hours of notification for the majority (98.2%) of cases (Table 5 and Figure 4).

Discussion

Invasive meningococcal disease is a rare disease in Queensland, with an incidence of 3.4 cases per 100,000 population in 2002. This incidence was similar to 2001.

The completeness of the enhanced surveillance information provided by Public Health Units since its introduction in 1999 has improved, e.g. all cases had their Indigenous status identified in 2002. However, details about clinical presentation and clinical management can be further improved. There are concerns about ambiguity in some questions and inaccurate recording of data at the time of interview,[8] and the enhanced surveillance form has undergone further modification as a result. Improved laboratory methods have an unmeasured influence on the measured incidence of disease. Improved laboratory methods also enable cluster identification.

The epidemiology of the disease was generally consistent with that seen in other years and trends are consistent with overall patterns of disease around Australia.[9] There are some variations to note. The apparent decrease in incidence of invasive meningococcal disease amongst the 1–4 year age group and the concomitant increase in the incidence amongst the 15–19 year age group warrant continued surveillance to determine if this is a sustained change.

The percentage of isolates that were serogroup C has continued to rise and is the highest since 1994; it was statistically greater in 2002 than in the four year period, 1997–2000. The introduction of the meningococcal C vaccination program, particularly for the 15–19 year age group, is therefore timely.

The trend of decreasing case fatality rates over the last 4-year period is encouraging; further surveillance will determine if this downward trend is significant and sustained. Small numbers prevented the identification of any significant risk factors for dying in 2002. In the 4-year period during which enhanced surveillance has been conducted, the factors associated with an increased risk of fatal outcome were presentation with septicaemia, presentation with a rash and infection with serogroup C. Only one of the fatal cases consulted a GP prior to hospital admission, but did not receive antibiotics prior to admission. This suggests that cases with fulminant disease may present directly to hospital. We do not have information on other adverse outcomes to assess the effect of delays in obtaining medical attention.

It is well known that early presentation of invasive meningococcal disease can be variable and may not be severe. Indeed, only 66 per cent of cases notified in 2002 had a rash, emphasising (as in previous years[2,3]) that absence of a rash cannot be considered to exclude the diagnosis of invasive meningococcal disease. The assessment of interval between onset of symptoms and hospital admission is difficult because the definition of onset of symptoms may differ due to this variability of presentation. As in previous years,[1,2,3] septicaemia was the most common presentation; 76 per cent of septicaemic cases had a rash in 2002.

Less than half of the cases consulted a GP prior to hospital admission. Of those who did consult a GP, 41 (84%) were referred by the GP to hospital at the time of consultation. This is an increase from 2001[3] when 51 per cent were referred by the GP to hospital at the time of consultation; although this may indicate improved clinical management, it may depend on the severity of the illness at the time of GP consultation. Severity of presenting illness is not collected in this enhanced surveillance. This enhanced surveillance indicated that a substantial number of patients were referred to hospital for further assessment even though the GP had not apparently made or was not convinced of the diagnosis of invasive meningococcal disease. To reduce ambiguity in seeking this information, the enhanced surveillance form has undergone further revision to clarify the seeking of this information. Diagnostic uncertainty, non-urgency of the case and the proximity of a hospital were explanations for not administering antibiotics prior to admission.[8] Due to the small number of deaths, no conclusions can be drawn about the effects of the small number of cases given antibiotics prior to admission but theoretically, early antibiotic treatment is associated with decreased risk of adverse outcomes. The 2002 data does indicate that diagnosis of invasive meningococcal disease in a patient by the GP does expedite hospital admission. This issue will be reviewed in the analysis of enhanced surveillance data for 2003.

There is clearly a continued need to educate both the community and GPs about this disease to ensure that people seek early medical attention and are provided with early treatment to reduce the likelihood of adverse outcomes associated with this disease. Additional support may be needed to provide algorithms to assist GPs in reaching a greater confidence in diagnosis given the variability of the early clinical presentation of this disease.[8] Although the small number of cases makes it difficult to determine if the reduction in case fatalities has a statistical correlation to more prompt medical attention, it is generally accepted that better outcomes occur when treatment is administered promptly.

In 2002, there was only one cluster of cases, illustrating that invasive meningococcal disease in Queensland remains a largely sporadic disease. A mass vaccination program was mounted as a response to this event incurring considerable costs. Public health services routinely follow up all cases of invasive meningococcal disease in order to ensure that all eligible contacts receive information on the disease and appropriate interventions. The response time after notification of a case continues to improve; there was a response mounted within six hours for over 98 per cent of cases in 2002.

Acknowledgments

All Public Health Medical Officers in Public Health Unit Networks as well as officers of the Communicable Diseases Unit contributed to this document. Data entry was performed by Cristina Chirico. Public Health Nurses in the Public Health Unit Networks also contributed through involvement with case investigation, public health responses and assistance with data collection. Queensland Health Scientific Services conducted the serogrouping, serotyping and serosubtyping. The staff of Queensland Health Pathology Services and the private laboratories are acknowledged for their contribution in the initial laboratory diagnoses across the state and the responsibility for almost all laboratory notifications in a very timely manner to the Public Health Units. General Practitioners and hospital staff together with the cases and their families provided the information.

References

1. Ward J. Enhanced surveillance for meningococcal disease in Queensland in 1999. Queensland Health, 2000. Available from: http://www.health.qld.gov.au/phs/Documents/cphun/6464.pdf

2. Pugh RE. Meningococcal disease in Queensland, 2000. Queensland Health, 2002, Available from: http://www.health.qld.gov.au/phs/Documents/cdu/12776.pdf

3. Pugh RE. Invasive meningococcal disease in Queensland, 2001. Queensland Health, 2002. Available from: http://www.health.qld.gov.au/phs/Documents/cdu/13580.pdf

4. Pugh RE. Invasive meningococcal disease in Queensland, 2002. Queensland Health, 2003. Available from: http://qheps.health.gov.au/phs/Documents/cdu/19219.pdf

5. Communicable Diseases Network Australia. *Guidelines for the early clinical and public health management of meningococcal disease in Australia*. Commonwealth Department of Health and Aged Care, 2001.

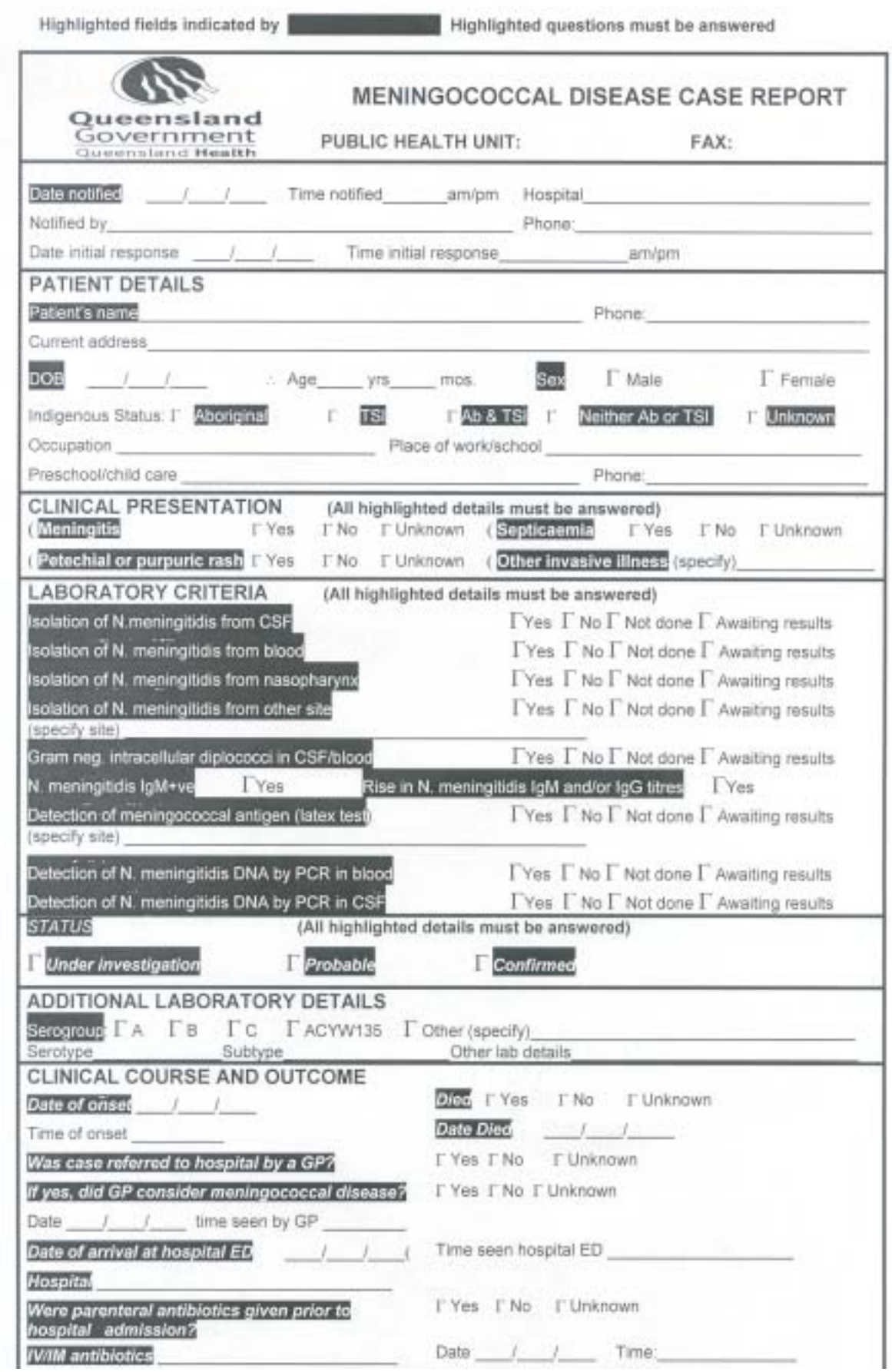
6. Dean AG, Dean JA, Coulombier D, Brendel KA, Smith DC, Burton AH, *et al*. Epi Info, version 6.04b: a word processing, database, and statistics program for epidemiology on microcomputers. Atlanta, Georgia: Centers for Disease Control and Prevention, 1997.

7. StataCorp. Stata Statistical Software: Release 6.0. reference manual extract. College Station, TX: Stata Corporation, 1999.

8. Kari Jarvinen. Influencing general practitioner knowledge, attitudes and practice—first dose antibiotic administration for meningococcal patients. Queensland Health, 2003.

9. Australian Meningococcal Surveillance Programme. Annual report of the Australian Meningococcal Surveillance Programme, 2002. *Commun Dis Intell* 2003;27:196–208.

Appendix



Highlighted fields indicated by [redacted] Highlighted questions must be answered

Queensland Government
Queensland Health

MENINGOCOCCAL DISEASE CASE REPORT

PUBLIC HEALTH UNIT: FAX:

Date notified ___/___/___ Time notified_____am/pm Hospital_____

Notified by_____ Phone:_____

Date initial response ___/___/___ Time initial response_____am/pm

PATIENT DETAILS

Patient's name_____ Phone:_____

Current address_____

DOB ___/___/___ ∴ Age____ yrs____ mos. Sex Γ Male Γ Female

Indigenous Status: Γ Aboriginal Γ TSI Γ Ab & TSI Γ Neither Ab or TSI Γ Unknown

Occupation_____ Place of work/school_____

Preschool/child care_____ Phone:_____

CLINICAL PRESENTATION (All highlighted details must be answered)

(Meningitis Γ Yes Γ No Γ Unknown (Septicaemia Γ Yes Γ No Γ Unknown

(Petechial or purpuric rash Γ Yes Γ No Γ Unknown (Other invasive illness (specify)_____

LABORATORY CRITERIA (All highlighted details must be answered)

Isolation of N.meningitidis from CSF Γ Yes Γ No Γ Not done Γ Awaiting results

Isolation of N. meningitidis from blood Γ Yes Γ No Γ Not done Γ Awaiting results

Isolation of N. meningitidis from nasopharynx Γ Yes Γ No Γ Not done Γ Awaiting results

Isolation of N. meningitidis from other site Γ Yes Γ No Γ Not done Γ Awaiting results

(specify site)_____

Gram neg. intracellular diplococci in CSF/blood Γ Yes Γ No Γ Not done Γ Awaiting results

N. meningitidis IgM+ve Γ Yes Rise in N. meningitidis IgM and/or IgG titres Γ Yes

Detection of meningococcal antigen (latex test) Γ Yes Γ No Γ Not done Γ Awaiting results

(specify site)_____

Detection of N. meningitidis DNA by PCR in blood Γ Yes Γ No Γ Not done Γ Awaiting results

Detection of N. meningitidis DNA by PCR in CSF Γ Yes Γ No Γ Not done Γ Awaiting results

STATUS (All highlighted details must be answered)

Γ Under investigation Γ Probable Γ Confirmed

ADDITIONAL LABORATORY DETAILS

Serogroup Γ A Γ B Γ C Γ ACYW135 Γ Other (specify)_____

Serotype_____ Subtype_____ Other lab details_____

CLINICAL COURSE AND OUTCOME

Date of onset ___/___/___ Died Γ Yes Γ No Γ Unknown

Time of onset_____ Date Died ___/___/___

Was case referred to hospital by a GP? Γ Yes Γ No Γ Unknown

If yes, did GP consider meningococcal disease? Γ Yes Γ No Γ Unknown

Date ___/___/___ time seen by GP_____

Date of arrival at hospital ED ___/___/___(Time seen hospital ED_____

Hospital_____

Were parenteral antibiotics given prior to hospital admission? Γ Yes Γ No Γ Unknown

IV/IM antibiotics_____ Date ___/___/___ Time:_____

Appendix (continued)

Highlighted fields indicated by [redacted] Highlighted questions must be answered

CASE MANAGEMENT

Were blood cultures taken before first dose antibiotics? Γ Yes Γ No Γ Unknown

(Was throat swab taken at the time of first dose? Γ Yes Γ No Γ Unknown

(Antibiotics used in hospital _____

(Chemoprophylaxis given to patient? Γ Not required Γ Yes Γ No Γ Unknown

RISK FACTORS

(Contact with presumptive meningococcal case in 60 days before onset Γ Yes Γ No Γ Unknown

If yes, was prophylaxis offered? Γ Yes Γ No Γ Unknown

If yes, was prophylaxis taken? Γ Yes Γ No Γ Unknown

If yes, specify type of prophylaxis Γ Antibiotic Γ Vaccine

Name of presumptive case _____

Type of contact with presumptive case _____ *(see contact management categories below)*

(Attends child care / preschool / school / university Γ Yes Γ No Γ Unknown

(Returned or arrived from overseas country in past 60 days Γ Yes Γ No Γ Unknown

(Other risk factor for meningococcal disease (specify) _____

OUTBREAK DETAILS (This section must be completed)

Is this case known to be linked to other cases of the same disease? Γ Yes Γ No

Details _____

CONTACTS

Type of contact	Number of contacts identified	Number offered antibiotics	Number offered vaccine	Comments
Household				
Child-care or Preschool				
Close institutional				
Exposed to oral secretions				
Other close contacts (specify)				

COMMENTS

Please Fax To CDU: (07) 3234 0057

Annual report of the Australian National Poliovirus Reference Laboratory, 2002

Bruce R Thorley,[1] Kerri Anne Brussen,[2] Vicki Stambos,[3] Heath Kelly[4]

Abstract

Acute flaccid paralysis is the main clinical manifestation of poliomyelitis. Faecal specimens from cases of acute flaccid paralysis in Australia are referred to the National Poliovirus Reference Laboratory for virus culture to determine if poliovirus is the causative agent. Isolations of poliovirus are tested to determine whether they have characteristics of the Sabin oral polio vaccine virus strains or wild type polioviruses. In 2002, a poliovirus type 3, which tested as Sabin vaccine-like, was isolated from an Australian patient with acute flaccid paralysis. A non-polio enterovirus, Echovirus type 18, was isolated from the faecal specimens of another case of acute flaccid paralysis. In the same period, the laboratory identified 35 Sabin-like polioviruses from 52 referred specimens and isolates from cases without acute flaccid paralysis. Australia is a member nation of the World Health Organization's Western Pacific region that was declared free of endemic wild poliovirus in October 2000. Poliomyelitis remains endemic in three of the WHO regions of the world and wild poliovirus may be re-introduced to Australia. While the number of polio-endemic countries has been reduced to seven, the total number of wild polioviruses identified increased in 2002 compared to 2001 due to a sharp rise in isolations of wild virus from Northern India. Until global eradication of poliomyelitis is achieved, it is essential that a high level of poliovirus vaccination coverage, and surveillance for cases of acute flaccid paralysis, be maintained in Australia. *Commun Dis Intell* 2003;27:352–356.

Keywords: poliovirus, acute flaccid paralysis

Introduction

The Australian National Poliovirus Reference Laboratory at the Victorian Infectious Diseases Reference Laboratory was established in 1994 and has played a major role in Australia's commitment to the World Health Organization's (WHO) program for the global eradication of poliomyelitis. The laboratory is responsible for virological testing of specimens from patients in Australia with acute flaccid paralysis (AFP), the predominant clinical manifestation of poliomyelitis. Diseases such as Guillain-Barré syndrome and transverse myelitis are the most common presentations of AFP in countries free of endemic polio, such as Australia.[1] Members of the enterovirus family, other than poliovirus, can also cause AFP. Non-polio enteroviruses isolated from specimens of Australian AFP cases since 2000 include Echovirus types 11 and 18 and Enterovirus type 71.

The laboratory has worked closely with the AFP clinical surveillance program since its establishment in 1995. Since 2000, the AFP surveillance program has been coordinated at the Victorian Infectious Diseases Reference Laboratory and is conducted in collaboration with the Australian Paediatric Surveillance Unit. The WHO target for notification of AFP cases in children less than 15 years is one per 100,000 population, equivalent to 40 cases for Australia in 2002. A further target nominated by WHO is for two faecal specimens to be referred for laboratory investigation from 80 per cent of the notified AFP cases. The referral of faecal specimens from AFP cases throughout Australia through the clinical surveillance program facilitates the detection of cases of poliomyelitis due to vaccine associated paralytic poliomyelitis (VAPP), circulating vaccine-derived poliovirus (cVDPV) or imported wild-type poliovirus.

1. Head, Poliovirus Reference Laboratory, Carlton South, Victoria
2. Scientist and Co-ordinator AFP surveillance, Victorian Infectious Diseases Reference Laboratory, Carlton South, Victoria
3. Scientist, Victorian Infectious Diseases Reference Laboratory, Carlton South, Victoria
4. Head Epidemiology Division, Victorian Infectious Diseases Reference Laboratory, Carlton South, Victoria

Corresponding author: Dr Bruce R Thorley, Victorian Infectious Diseases Reference Laboratory, Locked Bag 815, Carlton South, VIC 3053. Telephone: +61 3 9342 2607. Facsimile: +61 3 9342 2665. Email: bruce.thorley@mh.org.au

The Australian standard vaccination schedule recommends that the live attenuated Sabin oral polio vaccine (OPV) be administrated to children at 2, 4 and 6 months of age with a booster dose at 4 to 5 years of age. OPV is a live attenuated vaccine and replication of poliovirus takes place in the gut of a recently immunised person. The virus is shed in faecal specimens up to six weeks post-vaccination, and for longer periods from immunocompromised people.[2] Thus, poliovirus may be isolated from clinical specimens of cases other than AFP as an incidental finding during routine laboratory testing.

This annual report provides a summary of the activities of the Australian National Poliovirus Reference Laboratory in 2002 and includes a comparison of AFP surveillance in Australia against the major targets nominated by WHO.

Methods

The methods for AFP surveillance and laboratory testing of faecal specimens and poliovirus isolates were described in detail in the 2001 National Poliovirus Reference Laboratory annual report.[3] In brief, doctors treating AFP patients are requested to collect two faecal specimens, 24 hours apart and within 14 days of the onset of paralysis, and forward them to the National Poliovirus Reference Laboratory. Faecal specimens are extracted with chloroform and inoculated onto continuous cell lines for virus isolation. Polioviruses are tested by enzyme-linked immunosorbent assay (ELISA), nucleic acid probe hybridisation and polymerase chain reaction (PCR) to determine whether they are a strain of wild type virus or the Sabin vaccine. This process is known as intra-typic differentiation. The test results for the poliovirus ELISA are reported as either Sabin-like, non-Sabin-like or double reactive, depending on their reactivity with the respective antisera; double reactive isolates bind the Sabin-like and non-Sabin-like antisera with similar avidity. All polioviruses isolated from Australian AFP patients have portions of the genome sequenced to characterise the isolate more fully.

Poliovirus serology is used only for cases compatible with acute polio infection to test the ability of acute and convalescent serum to neutralise each of the three poliovirus serotypes. The serology test is not able to differentiate between an immune response to a wild or vaccine strain of poliovirus. The patient serum is serially diluted and incubated with a standard dose of each poliovirus serotype to determine the titre of neutralising antibody. For an individual who has not been exposed to poliovirus (wild type or vaccine), a conversion from seronegative to seropositive is regarded as significant. With regard to a person who has been previously exposed to poliovirus, antibodies would be expected to be present in both acute and convalescent sera. To determine if that person has an illness consistent with acute polio infection, a fourfold increase in neutralising antibody titre to any of the three serotypes would be required.[4]

Results

The National Poliovirus Reference Laboratory received a total of 106 specimens and isolates from all sources within Australia for the year 2002.

AFP surveillance

Forty-six cases of AFP in patients of all ages were notified with onset of paralysis in 2002, of which 33 were from children less than 15 years, representing 83 per cent of the WHO notification target (Table 1). Two faecal specimens from six AFP cases and three specimens from a further two cases of children aged

Table 1. AFP surveillance in Australia 2002, compared with WHO indicator targets for children less than 15 years

WHO indicator target for AFP cases of children less than 15 years	Australia's surveillance for AFP cases with onset in 2002	Australia's AFP surveillance rates for 2002
Non-polio AFP case rate of 1 per 100,000 population (40 cases for Australia in 2002).	33 cases of AFP notified. 30 cases classified by the Polio Expert Committee as non-polio AFP.*	AFP notification rate: 0.83 per 100,000 population. Non-polio AFP case rate: 0.75 per 100,000 population.
More than 80% of notified AFP cases with 2 adequate stool samples collected at least 24 hours apart within 14 days of onset of paralysis.	Seven AFP cases with 2 or more specimens per case.	Referral of adequate specimens from AFP cases: 21% of case notifications (7/33).

* Three cases require further information from the referring doctor before final classification.

less than 15 years with onset of symptoms in 2002, were tested at the National Poliovirus Reference Laboratory. Seven cases met the WHO criteria of collection of two or more specimens within 14 days of onset of paralysis representing 21 per cent of notified AFP cases. Two specimens from one case were collected more than 14 days after onset of paralysis and hence did not meet the WHO criteria. Single specimens were referred from five cases with onset in 2002. A further three faecal specimens from a child less than 15 years were referred from an AFP case with onset of paralysis in 2001. Two faecal specimens were referred from five patients 15 years or older and single faecal specimens and a throat swab from a further five cases.

AFP cases

Laboratory test results of specimens from AFP cases in this report includes specimens from patients with symptom onset late in 2001 and 2002. Forty faecal specimens and one throat swab were tested in 2002 from 24 cases of AFP (Table 2).

A poliovirus type 3 (P3) was isolated from a faecal specimen of a fully immunised child with AFP, who had been in contact with a sibling recently immunised with OPV. The virus tested as Sabin vaccine-like (Table 2) and the case was the subject of an extensive clinical and laboratory procedural review as a potential case of VAPP. No significant variation from the Sabin type 3 vaccine strain was identified by sequencing of three subgenomic regions of the isolate. Poliovirus serology determined no significant increase in antibody titre between acute and convalescent serum for P3. The final classification of the case was an acute focal neuropathy and isolation of an incidental Sabin-like P3.

Echovirus type 18 was isolated from both faecal specimens of one case of AFP in a child less than 15 years. No virus was isolated from the specimens of the remaining cases of AFP, from patients of all ages (Table 2).

Specimens and isolates referred for enterovirus typing

Thirty-five polioviruses were identified from specimens and isolates from sources other than cases of AFP (Table 2). The Sabin OPV includes the three serotypes of poliovirus and mixtures of virus types may be identified from the one specimen or isolate. A total of 17 poliovirus type 1 (P1), 14 poliovirus type 2 (P2) and four P3 isolates were identified from the referred enterovirus samples. This included two mixtures of P1 and P2 type viruses identified from two referred samples.

A total of 19 non-polio enteroviruses were identified from the specimens and isolates referred from Victoria and South Australia. The viruses were identified by partial genomic sequencing and confirmed by antisera neutralisation. Table 3 summarises the activities of the laboratory from 1995 to 2002 for specimens and isolates referred from within Australia.

Table 2. Testing of specimens and isolates referred to the Australian National Poliovirus Reference Laboratory for the year 2002

Result	Results of testing from AFP cases		Isolations from referred samples*	Total samples
	< 15 years	15 years		
Poliovirus Sabin-like type 1			15	15
Poliovirus Sabin-like type 1 & 2			2	2
Poliovirus Sabin-like type 2			12	12
Poliovirus Sabin-like type 3	1		4	5
Non-polio enterovirus†	2		19	21
No virus isolated	23	15	11‡	49
Total	26	15	65	106

* Includes polioviruses isolated from recently immunised infants.

† NPEV: non-polio enterovirus. Echovirus type 18 was isolated from both faecal specimens of one AFP case. Testing of the referred NPEVs identified six Echovirus type 6 viruses, two Echovirus type 11, two Coxsackie type A16, two Coxsackie types B2, four Coxsackie types B4, two Coxsackie type B5 and an Enterovirus type 71.

‡ Viruses may not have been isolated from some referred samples due to loss of titre in transit and/or not passaging between different cell lines.

Table 3. Summary of enterovirus testing at the National Poliovirus Reference Laboratory, 1995 to 2002

Year	Poliovirus		Non-polio enterovirus	Non-enterovirus detected or no virus detected	Total samples tested
	Sabin-like	Non-Sabin-like			
1995	190		200	13	403
1996	224		198	9	431
1997	124		76	0	200
1998	52		15	4	71
1999	60	1	9	9	79
2000	45		44	47	136
2001	46	5	33	75	159
2002	36		21	49	106

Poliovirus isolates with incongruent intra-typic differentiation results

Two isolates (one P1 and one P2) from separate patients with clinical conditions other than AFP tested as double reactive by the ELISA in 2002. Both isolates were Sabin-like by nucleic acid probe hybridisation and thus gave an incongruent result for intra-typic differentiation. The VP1 region of the isolates was sequenced and determined to be Sabin-like with 99.6 per cent and 99.8 per cent homology to the Sabin P1 and P2 strains respectively. The first case was from a patient with immune deficiency who had received Sabin vaccine 10 days prior to the onset of symptoms. A second set of faecal specimens was collected six weeks after the first to determine if viral shedding was ongoing. No virus was isolated. The second case was from a suspected cytomegalovirus infection and the poliovirus isolation was regarded as incidental.

Poliovirus serology

Serum specimens from two cases that were compatible with an acute polio infection were referred in 2002. The first was the fully immunised child with AFP, who had been in contact with a sibling recently immunised with OPV, described in the section on AFP.

The second case was from an adult patient with lower limb flaccid paralysis who had no record of polio immunisation or recent travel. Acute and convalescent serum specimens were tested in parallel with detection of pre-existing immunity to all three poliovirus serotypes and no serological evidence of acute poliovirus infection. Faecal specimens for virus culture were not available from this patient.

Regional reference laboratory activities

In addition to the Australian samples, 664 specimens and isolates were referred to the National Poliovirus Reference Laboratory from countries of the Western Pacific region in 2002. This included the retesting of specimens and isolates as part of an ongoing laboratory quality assurance program with 38 samples referred from Mongolia, 29 from Papua New Guinea and 265 from Viet Nam. Seventy-nine specimens and isolates were referred from the Philippines National Poliovirus Laboratory after national immunisation days in response to the cVDPV outbreak in 2001.[5] The Regional Reference Laboratory has not detected a VDPV from specimens from the Philippines since September 2001.

Discussion

The WHO reporting system for detection of poliomyelitis focuses on the surveillance and specimen testing of AFP cases in children less than 15 years. In both 2000 and 2001, Australia achieved the WHO AFP notification target of 1 per 100,000 children less than 15 years.[6,7] The target was not met in 2002, with a notification rate of 0.83, a situation that had been anticipated early in the year.[7] The WHO target for laboratory testing of specimens from AFP cases less than 15 years of age has never been met by Australia.[3,6] While there were no cases of AFP caused by wild, vaccine or vaccine-derived poliovirus in Australia in 2002, the notification and referral of specimens from AFP cases continues to represent an ongoing challenge.

Mutations occur within the viral genome of the Sabin poliovirus as part of the normal replication process. These mutations may result in a loss of attenuation and, in rare circumstances, an increase in neuro-virulence. A neurovirulent poliovirus derived from a vaccine strain can cause AFP in a vaccine recipient

or close contact who has not been previously immunised, or fully immunised, against polio. This is known as VAPP. The isolation of a Sabin P3 from a fully immunised child with AFP whose sibling had recently been immunised was the subject of further investigation by the Polio Expert Committee as a potential case of VAPP. The lack of a significant rise in antibody titre to P3 between acute and convalescent serum, as determined by poliovirus serology, was crucial in the final classification of the case as an acute focal neuropathy with isolation of an incidental poliovirus.

The administration of OPV is not recommended for people diagnosed with an immune deficiency in case of increased poliovirus neurovirulence and long term shedding. The ELISA result of double reactive, for the P1 isolate from the immunocompromised child who had received OPV, was indicative of mutations within the polio capsid. This was confirmed with 0.4 per cent nucleotide sequence variation from the vaccine for the VP1 genomic region and the virus was classified as Sabin-like.

The seven different types of non-polio enteroviruses identified from the referred clinical samples were from two states of Australia: Victoria and South Australia. The viruses may be considered as a representative sample of the non-polio enteroviruses circulating in south-eastern Australia during 2002. Interestingly, three types of non-polio enterovirus identified are known to be capable of causing AFP: Echovirus types 6 and 11 and Enterovirus type 71.[8] Echovirus type 18 was isolated from an AFP patient from Queensland in 2002 but this virus serotype was not amongst those identified in the southern states.

The WHO European region was declared free of indigenous wild poliovirus in September 2002.[9] Three of the six WHO regions are now designated as free of indigenous wild poliovirus: the Americas, Western Pacific and Europe. While only seven countries remain endemic for wild type poliovirus, the increased number of total wild type virus isolations in 2002 compared to 2001,[10,11] and an outbreak of cVDPV on the island of Madagascar[12] is cause for ongoing vigilance for cases of AFP. Until certification of the global eradication of poliomyelitis is declared, Australia needs to maintain high levels of polio vaccination coverage, an AFP notification scheme and virological testing of specimens from AFP cases.

Acknowledgements

We would like to acknowledge Aishah Ibrahim, Ann Turnbull, and Pauline Cardwell for excellent technical assistance. We thank all notifying clinician's and laboratories for forwarding the specimens and isolates that were tested in 2002. The Australian National Poliovirus Reference Laboratory is funded by the Commonwealth Department of Health and Ageing and the Victorian Department of Human Services.

References

1. Morris AM, Elliot EJ, D'Souza RM, Antony J, Kennett M, Longbottom H. Acute flaccid paralysis in Australian children. *J Paediatr Child Health* 2003;39:22–26.
2. Kew OM, Sutter RW, Nottay BK, *et al*. Prolonged replication of a type 1 vaccine-derived poliovirus in an immunodeficient patient. *J Clin Microbiol* 1998;36 :2893–2899.
3. Thorley BR, Brussen KA, Stambos V, Yuen LK, Helly HA. Annual report of the Australian National Poliovirus Reference Laboratory and summary of acute flaccid paralysis surveillance, 2001. *Commun Dis Intell* 2002;26:419–427.
4. World Health Organization. The immunological basis for immunization series. Module 6: Poliomyelitis. WHO/EPI/GEN/93.16.
5. Centers for Disease Control and Prevention. Public health dispatch: acute flaccid paralysis associated with circulating vaccine-derived poliovirus-Philippines. *MMWR Morb Mortal Wkly Rep* 2001;50:874–875.
6. Kelly H, Brussen K, Morris A, Elliot E. Acute flaccid paralysis surveillance in Australia. *Bull World Health Org* 2001;79:1169–1170.
7. Kelly H, Brussen K. Apparent improvement in AFP surveillance in Australia. *Aust N Z J Public Health* 2002;26:281–282.
8. Pallansch MA, Roos RP. Enteroviruses: polioviruses, coxsackieviruses, echoviruses, and newer enteroviruses. In: Knipe DM, Howley PM, eds. *Fields virology*, 4th edn. Philadelphia 2001.
9. World Health Organization. Europe to be certified free of polio. *Bull World Health Org* 2002;80:688.
10. World Health Organization. Progress towards poliomyelitis eradication in India, 2002. *Wkly Epidemiol Rec* 2003;78:66–71.
11. Centers for Disease Control and Prevention. Progress toward global eradication of poliomyelitis, 2002. *MMWR Morb Mortal Wkly Rep* 2003;52:366–369.
12. World Health Organization. Paralytic poliomyelitis in Madagascar, 2002. *Wkly Epidemiol Rec* 2002;77: 241–248.

Estimating immunisation coverage: is the 'third dose assumption' still valid?

Brynley P Hull,[1] Glenda L Lawrence,[1] C Raina MacIntyre,[1] Peter B McIntyre[1]

Abstract

Immunisation coverage is calculated from Australian Childhood Immunisation Register (ACIR) data using the 'third dose assumption'. This assumes that if the third in a series of vaccine doses has been recorded on the ACIR, the previous two doses have been received, whether or not they are recorded. The objectives of this study were to validate the 'third dose assumption', and measure the impact of the assumption on immunisation coverage estimates at 12 months of age. A sample of children born in 1999 and assessed as fully immunised at 12 months of age by applying the 'third dose assumption' were selected from the ACIR. Parents were interviewed by telephone to obtain information about vaccinations not recorded on the ACIR. Based on the survey results, the impact of the 'third-dose assumption' on national coverage estimates at 12 months of age was estimated. Of 219 surveyed children assessed as up-to-date at 12 months of age only by applying the 'third dose assumption', 212 (96.8%) met study criteria of 'definite' immunisation for all unrecorded first and second vaccine doses. Of the remaining seven, six believed all doses had been received, while one confirmed that one dose had been missed. The 'third dose assumption' overestimated coverage by 0.2 per cent, based on criteria for 'definite' immunisation. If the assumption were not used, immunisation coverage at 12 months of age in Australia would have been underestimated by 7 per cent. The 'third dose assumption' is valid and important to use in calculating immunisation coverage from the ACIR. Although ACIR reporting and coverage levels continue to improve, under-reporting of vaccine doses due at two and four months of age persists. The 'third dose assumption' may be applicable to comparable immunisation registries in other countries. *Commun Dis Intell* 2003;27:357–361.

Keywords: immunisation, vaccination

Introduction

The Australian Childhood Immunisation Register (ACIR), managed by the Health Insurance Commission (HIC), is a national population-based register that records immunisations given to children under the age of 7 years.[1] ACIR data are used to estimate and report quarterly immunisation coverage at state and national levels, at the 12 month, 24 month and 6 year milestones. Immunisation coverage is calculated using the cohort method[2] and definitions of coverage based on the Australian Standard Vaccination Schedule.[2,3] The most controversial of the immunisation coverage assessment rules is the 'third dose assumption'. This assumes that if the third dose in a vaccine series is recorded on the ACIR, all previous doses in that series have been given, whether or not they are recorded.[2]

The assumption was considered appropriate when reporting of immunisation coverage from the ACIR first commenced in 1998 because the ACIR is based on the Medicare database and a delay in Medicare registration was likely to affect recording of the first and second vaccine doses due at 2 and 4 months of age. Without the 'third dose assumption', the underestimation of coverage by the ACIR, related to incomplete reporting by providers and delayed Medicare registration, would be substantially greater.[4,5]

Since 1998, incentives to general practitioners to notify vaccinations to the ACIR have been introduced and there has been a significant reduction in delays in Medicare registration.[6] As the ACIR has matured and coverage has increased substantially,[7,8] continued use of the 'third dose assumption' in calculating and reporting immunisation coverage has been questioned. No direct validation of this assumption has been undertaken. This study aimed to assess the validity of the 'third dose assumption' and to estimate its impact on current immunisation coverage at 12 months of age.

1. National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases, Children's Hospital at Westmead and the University of Sydney, New South Wales

Corresponding author: Mr Brynley Hull, National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases, Locked Bag 4001, Westmead NSW 2145. Telephone: +61 2 9845 1256. Facsimile: +61 2 9845 3082. Email: brynleyh@chw.edu.au

Methods

Approval for the study was obtained from the Commonwealth Department of Health and Ageing Ethics Committee.

Study design and population

The study used a cross-sectional survey design. Children were eligible for inclusion if they were born between 1 October and 31 December 1999 and at 4 May 2001 were recorded as fully immunised for vaccines due before 12 months of age only after applying the 'third dose assumption'. That is, one or more of the first or second vaccine doses of diphtheria-tetanus-pertussis (DTP) vaccine, poliomyelitis (polio) vaccine or *Haemophilus influenzae* type b (Hib) vaccine was not recorded. The number of children eligible was approximately 4,500 children of a total three-month birth cohort of approximately 63,000 children. Using the assumption that 90 per cent of eligible children had actually received all first and second doses of DTP, polio and Hib vaccines, the estimated sample required to detect this proportion with 99 per cent confidence and a precision of 5 per cent was calculated to be 226 children.

Recruitment

Based on a previous study using similar methodology,[9] NCIRS anticipated a response rate of approximately 40–60 per cent. The HIC were asked to randomly select from the ACIR, 400 children from the 4,500 eligible children. Information letters were sent to the parents of 394 eligible children to advise them that their child had been selected for the study and that they may be contacted by telephone. Six children were excluded because they were one of a set of twins. Electronic telephone directory searches were conducted to identify numbers corresponding to addresses listed in the ACIR. Up to 10 attempts were made to contact each family at different times of the day.

Data collection

Computer-assisted telephone interviews were conducted in July 2001. Parents were encouraged to read from a provider-completed written vaccination record to answer whether their child had received all first and second doses of DTP, polio and Hib vaccines and the dates each dose had been received.

Data analysis

Data were analysed using SAS version 8[10] and Epi Info version 6.04b.[11]

Assessment of response bias: demographic information and immunisation histories recorded on the ACIR were compared for surveyed children and those for whom contact was attempted but an interview not achieved.

Assessment of immunisation status: information provided by parents was used to determine immunisation status. A child was defined as 'definitely' immunised if the parent provided at least the month and year of vaccination for all six first and second vaccine doses, either from a provider-completed written record or by recalling vaccination dates, at least one of which could be verified from the ACIR (as most children had at least one of the six vaccines recorded on the ACIR). A child was defined as 'possibly' immunised if the parent recalled that the particular vaccine doses had been received but was unable to provide vaccination dates, or none of the dates recalled could be verified from the ACIR. Children were defined as 'under-immunised' if the parent confirmed that the child had not received one or more of the six vaccine doses.

Children who met the study definition of 'definitely' immunised were also assessed to identify the age at which they received the specified vaccines and the type of immunisation provider who gave the vaccines.

Impact of the 'third dose assumption' on coverage at 12 months of age

Immunisation coverage for the entire birth cohort at 12 months of age was re-calculated to correct for the proportion of surveyed children for whom the 'third dose assumption' had been applied inappropriately. Coverage was calculated using the formula: (c–a)+(b*a)

where: *a* was the percentage of the entire birth cohort assessed as fully immunised at 12 months of age due only to the application of the 'third dose assumption' (7.02%), i.e. those missing first or second vaccine doses but recorded as having received all third doses used to assess coverage;

b was the proportion of surveyed children at interview who had received all first and second vaccine doses;

c was the percentage of the birth cohort assessed as fully immunised at 12 months of age from ACIR data (91.18%).

Sensitivity analyses, using more and less stringent definitions of 'immunised' for all first and second vaccine doses, were also conducted in order to assess the assumptions used to define 'definite' immunisation status for the surveyed children.

Results

Response to survey

In all, 225 interviews were completed, a response rate of 57 per cent (Table 1). The majority of those not surveyed were not contactable, presumably because the address recorded on the ACIR was not current. There were no statistically significant differences

between the 225 surveyed and 169 unsurveyed children in gender, rural versus metropolitan residence, or vaccine doses recorded on the ACIR (data not shown).

Evidence of immunisation status of surveyed children

Of the 225 surveyed children, 219 were assessed as fully immunised before 12 months of age, by applying the 'third dose assumption' (i.e. 6 children were up-to-date at 4 May 2001, the date the sample was drawn, but not before their first birthday). The parent of only one of these 219 children confirmed that their child had missed one of the six vaccine doses in question. As shown in Table 2, the 'third dose assumption' appears to have been correctly applied for at least 212 (96.8%) of the 219 children and up to 218 (99.5%) if those defined as 'possibly immunised' are included.

Impact of the 'third dose assumption' on immunisation coverage estimates

Coverage at 12 months of age for the whole birth cohort, using the 'third dose assumption', was assessed by the ACIR as 91.2 per cent.[7] The 'third dose assumption' was applied to 7.02 per cent of the whole birth cohort. If it had not been used, and only those children with all first, second and third doses recorded on the ACIR had been defined as fully immunised at 12 months, coverage would have been 84.2 per cent (Table 3). Based on the 212 surveyed children who met the study criteria of 'definitely' immunised with all first and second vaccine doses, the 'third dose assumption' had been correctly applied for 96.8 per cent (95% CI 94.5–99.1) of the 7.02 per cent of children in the entire birth cohort who were missing first or second doses from their ACIR record. Correcting for inappropriate application of the 'third dose assumption' lowered immunisation coverage at 12 months of age by 0.2 per cent, to 91.0 per cent (Table 3). Sensitivity analyses using more or less stringent study definitions of 'immunised' gave a range of coverage estimates at 12 months of 90.2–91.2 per cent (Table 3).

Immunisation provider of surveyed children

General practitioners (GPs) were the main providers of first and second vaccine doses (Table 4). A higher proportion of surveyed children received these vaccinations from a GP (81%) than was recorded on the ACIR for all vaccinations given to children as at May 2001 (70%). The proportion of surveyed children who usually received vaccinations at hospital clinics

Table 1. Contact and interview rates of the of children selected for the study

	Children selected for study n	%
Total in sample	394*	
Contacted	237	60.2
Not contactable†	157	39.8
Contacted		
Eligible	231	97.5
Ineligible‡	6	2.5
Eligible		
Interviewed	226	97.8
Refused	5	2.2
Interviewed		
Included	225	57.1§
Excluded	1	

* Eligible children sent letters.

† All contact attempts were unsuccessful.

‡ Ineligible to participate in the study as the parent was unavailable during the survey period (n=3) or unable to participate in an English-language interview.

§ Response rate: (number interviewed/total in sample)*100.

|| Excluded: wrong age (ascertained at interview).

Table 2. Parent report of whether six vaccine doses* due at 2 and 4 months of age had been received (n=219)

Immunisation status	Number	%	Cumulative frequency	%
Definitely immunised†	212	96.8	212	96.8
Possibly immunised‡	6	2.7	218	99.5
Under-immunised	1	0.5	219	100.0
Not sure/refused to answer	0	0.0	219	100.0

* The six vaccine doses were the first and second doses of DTP, Hib, and polio vaccines.

† Includes those where at least one recalled vaccination date could be validated from the ACIR.

‡ Includes those where none of the dates provided could be validated from ACIR records.

was similar (3.3% versus 2.9%) and at council clinics, somewhat lower (7.6% versus 18.9%) than recorded for all children in the cohort.

Discussion

This study is the first national, population-based study to attempt to validate the 'third dose assumption' used in calculating immunisation coverage in Australia. The main finding of the study is that the 'third dose assumption' is valid and should continue to be used for estimating coverage at 12 months of age from ACIR data. The level of overestimation caused by using the assumption is negligible (less then 0.5%) compared with the level of underestimation of coverage if it was not used (6–7%). This is particularly important when, despite significant improvements, the ACIR continues to underestimate coverage because of provider under-reporting.[12]

The range of estimates of the impact of the 'third dose assumption' on immunisation coverage at 12 months of age, calculated from survey data, were robust due to the high proportion of survey respondents who read from provider-completed written records. The parent of only one child confirmed that one of the doses in question had been missed. The parents of the six children defined as 'possibly' immunised for all six first and second vaccine doses were certain that all doses had been received. For most of these children, dates were verified from the ACIR for at least three of the vaccine doses. Thus it is likely that most were fully immunised.

A previous study in 1999, in which NCIRS examined changes in the impact of the 'third dose assumption' on coverage estimates, showed that if the 'third dose assumption' was not applied, national and state or territory immunisation coverage estimates fell by 11 per cent, with little change over an 18 month period.[5] The study presented here demonstrates that the reduction in coverage that occurs if the 'third dose assumption' is not applied has reduced (7% versus 11%), but is still significant. The previous study also showed that the impact of the 'third dose assumption' varied by jurisdiction and was more significant in areas where a high proportion of vaccinations were administered by GPs and notified to the ACIR by scannable forms. The present study confirms that GPs are over-represented as vaccination providers

Table 4. Providers from whom the surveyed children* usually received vaccinations

Provider	Number	%
Doctor's surgery	173	81.6
Hospital clinic	7	3.3
Local council	16	7.6
More than one of the above	6	2.8
Overseas	5	2.4
Child health or community clinic	5	2.4
Total	212	

* Includes only those defined as 'definitely immunised' with all first and second vaccine doses.

Table 3. Impact of the 'third dose assumption' on estimates of coverage at 12 months of age for children born between 1 October and 31 December 1999

Evidence	Coverage* % (95% CI)	Difference % (95% CI)
With third dose assumption	91.18	–
Without third dose assumption*	84.16	7.02
Adjusted for 'definite' survey group†	90.96 (90.8–91.1)	0.22 (0.06–0.39)
Adjusted for 'possible' survey group‡	91.15 (91.1–91.2)	0.03 (0.00–0.10)
Adjusted for written record + date§	90.22 (89.9–90.5)	0.96 (0.64–1.28)

* Children defined as up-to-date at 12 months of age only if all first, second and third vaccine doses were recorded in the ACIR.

† Adjusted for the proportion of surveyed children up-to-date at 12 months of age defined as 'definitely' immunised with all first and second vaccine doses.

‡ Adjusted for the proportion of surveyed children who were up-to-date at 12 months of age defined as either 'definitely' or 'possibly' immunised with all first and second vaccine doses.

§ Adjusted to include only children who were up-to-date at 12 months of age defined as 'definitely' immunised where a written record was used and the full date was provided for all the first and second vaccine doses (189/219; 86.3% 95% CI 81.7–90.9).

for children missing first and second doses from their ACIR record (81%) compared with other children in the same birth cohort (70%). This supports the view that non-notification of first and second dose vaccine encounters, while an important issue for all categories of immunisation provider, is more important among GPs.

There were several limitations to the study, although none is likely to substantially alter key results. It is difficult to achieve true random sampling from the ACIR because of both confidentiality requirements and intrinsic limitations of the Medicare database. In this study, disadvantaged or highly mobile families may have been less likely to be contacted and surveyed, and also less likely to be immunised.[13] However, the surveyed and unsurveyed children did not differ significantly in demographic or recorded immunisation histories. ACIR still represents the best available method of obtaining a representative sample of the population.

The study relied on parent's report from provider-completed written immunisation records, with the full date of immunisation accepted as a proxy for confirmed receipt. Parents without written records were asked if they were certain all doses had been received. Our ability to validate parental report within the sample, by comparison with dates for vaccine doses recorded on the ACIR, adds considerable weight to the conclusions.

Conclusions

The 'third dose assumption' is valid and it is appropriate that it be used to calculate official immunisation coverage for children at 12 months of age from the ACIR, in order to minimise the degree to which the ACIR underestimates coverage. We know from a previous study that one of the main contributing factors for underestimation of coverage by the ACIR, and also the need for the 'third dose assumption', is under-reporting of immunisations by providers.[12] This may be best addressed by measures aimed at improving notification of vaccinations to the ACIR through Divisions of General Practice.

Acknowledgments

This study was funded by the Commonwealth Department of Health and Ageing, Canberra. We wish to also acknowledge the contribution to the study of the Health Insurance Commission and the Hunter Valley Research Foundation. The National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases (NCIRS) is supported by The Commonwealth Department of Health and Ageing, The NSW Department of Health and The Children's Hospital at Westmead.

References

1. Hull BP, McIntyre PB, Heath TC, Sayer GP. Measuring immunisation coverage in Australia. A review of the Australian Childhood Immunisation Register. *Australian Family Physician* 1999;28:55–60.
2. O'Brien ED, Sam GA, Mead C. Methodology for measuring Australia's childhood immunisation coverage. *Commun Dis Intell* 1998;22:36–37.
3. National Health and Medical Research Council. *The Australian Immunisation Handbook*, 7th edition. Canberra: Australian Government Publishing Service, 2000.
4. McIntyre PB, Heath TC, O'Brien ED, Hull B. National immunisation coverage—interpreting the first three quarterly reports from the ACIR. *Commun Dis Intell* 1998;22:111–112.
5. Hull BP, McIntyre PB. Immunisation coverage reporting through the Australian Childhood Immunisation Register—an evaluation of the 'third dose assumption'. *Aust N Z J Public Health* 2000;24:17–21.
6. Human Capital Alliance. Evaluation of the Australian Childhood Immunisation Register. Report prepared for the Commonwealth Department of Health and Aged Care. Canberra: April 2000.
7. Department of Health and Ageing. Communicable Diseases Surveillance—additional reports. *Commun Dis Intell* 2001;25:94.
8. Department of Health and Ageing. Communicable Diseases Surveillance—additional reports. *Commun Dis Intell* 2000;24:324.
9. National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases. Measles Control Campaign 1998. Evaluation report. Canberra: Department of Health and Ageing, 1999. Available from: http//immunise.health.gov.au/metadata/measeval.htm
10. SAS version 8 (computer software). Win98. Cary, NC: SAS Institute Inc., 1999.
11. Dean AG, Dean JA, Coulombier D, *et al*. Epi Info version 6: a word processing, database and statistics program for epidemiology on microcomputers. Atlanta, Georgia, USA: Centers for Disease Control and Prevention, 1994.
12. Hull, BP, Lawrence GL, MacIntyre CR, McIntyre PB. Immunisation Coverage: Australia 2001. 2002. Canberra, Commonwealth Department of Health and Ageing. Available from: http://immunise.health.gov.au/report.pdf
13. Bond L, Nolan T, Lester R. Home vaccination for children behind in their immunisation schedule: a randomised controlled trial. *Med J Aust* 1998;168: 487–490.

Invasive pneumococcal disease among children in Victoria

Min Liu,[1,2] Ross Andrews,[2,3] Joanne Stylianopoulos,[4] Catherine Ferreira,[2] Geoff Hogg,[4] Nyree Pyper[2]

Abstract

This study analysed notification data from the first year of enhanced surveillance of invasive pneumococcal disease (IPD) in Victoria (1 July 2001 – 30 June 2002), with a focus on risk factors for infection and vaccination status among children under five years of age. Overall, there were 397 notifications (8.2 per 100,000 population), 131 (33%) were children under five years of age. The highest notification rates were among those aged less than two years (72.6 per 100,000 population). Among children aged less than five years: bacteraemia without a primary focus of infection was the most common clinical presentation (64%); 89 per cent were hospitalised with the median length of stay being three days; four children (3%) died. There were 107 cases of a known serotype, 92% (n=98) were either in or closely related to those included in the 7-valent conjugate pneumococcal vaccine (7vPCV). Most cases (98%) were not eligible for free 7vPCV under the currently funded program in Victoria. Only one child had been vaccinated. The results from the first year of enhanced IPD surveillance in Victoria suggest consideration should be given to extending the publicly funded program to include all children under two years of age. *Commun Dis Intell* 2003;27:362–366.

Keywords: invasive pneumococcal disease; enhanced surveillance; risk factors; vaccine; serotype; children

Introduction

Streptococcus pneumoniae causes morbidity and mortality in both developing and developed countries, predominantly among young children and the aged.[1] Invasive pneumococcal disease (IPD), that is where *S. pneumoniae* is isolated from a normally sterile site, usually presents as pneumonia, meningitis or bacteraemia (without a primary focus of infection). *S. pneumonia*e has gradually become more resistant to penicillin and other antibiotics.[2]

Victoria is participating in a national program of enhanced IPD surveillance under the auspices of the Communicable Diseases Network Australia (CDNA).[3] Since May 2001, all medical practitioners and laboratories in Victoria have been required to notify the Department of Human Services (DHS) of all IPD diagnoses pursuant to the Health (Infectious Diseases) Regulations 2001.

A 7vPCV (Prevenar™, Wyeth-Lederle Vaccines) has been licensed and approved for use among children six weeks to nine years of age in Australia,[4] but public funding for the vaccine in Victoria is only available to Indigenous children under two years of age or children under five years of age with one of the following medical risk factors:[5]

- impaired immunity;
  - congenital immune deficiency including symptomatic IgG subclass or isolated IgA deficiency;
  - disease associated with immunosuppressive therapy or radiation therapy;
  - compromised splenic function due to sickle haemoglobinopathies or congenital or acquired asplenia;
  - HIV infection;
  - renal failure or relapsing or persistent nephrotic syndrome;
- anatomical abnormalities;
  - cardiac disease associated with cyanosis or cardiac failure;
  - proven or presumptive cerebrospinal fluid leak.

This article describes the epidemiology of IPD in Victoria based on the first 12 months of notification data, with a focus on risk factors for infection and vaccination status of children under five years of age.

1. Public Heath Training Scheme, Department of Human Services, Victoria
2. Communicable Diseases Section, Department of Human Services, Victoria
3. National Centre for Epidemiology and Population Health, Australian National University, Canberra
4. Microbiological Diagnostic Unit, Public Health Laboratory, University of Melbourne, Victoria

Corresponding author: Dr Min Liu, 589 Collins Street, Melbourne, Victoria 3000. Telephone: +61 3 9616 1506. Facsimile: +61 3 9616 1500. Email: min.liu@dhs.vic.gov.au

Methods

A case of IPD was defined as a clinical condition where *S. pneumoniae* was isolated from blood, cerebrospinal fluid or other normally sterile site or detected by nucleic acid testing, e.g. polymerase chain reaction, in a normally sterile site.

All notifications of IPD received by DHS from 1 July 2001 to 30 June 2002 were included. The treating practitioner of each notified case was contacted by telephone or facsimile to confirm clinical details, risk factors for infection and vaccination status as a component of a national program of enhanced IPD surveillance.[3] The primary diagnostic laboratory was encouraged to forward cultures from normally sterile sites to the Microbiological Diagnostic Unit, Public Health Laboratory, Melbourne University, for serotyping.

Risk factor data for notifications related to children under five years of age included: immunocompromising conditions (e.g. HIV/AIDS, organ transplant, multiple myeloma, asplenia, chronic drug therapy); chronic illness (e.g. chronic respiratory, heart, liver or renal disease, diabetes); prematurity (<37 weeks gestation); low birth weight (<2,500 g); congenital or chromosomal abnormality; cigarette smoker in the household. More than one risk factor could be reported. Cases were classified according to the identified risk factors as: immunocompromised; any other identified risk factor; no identified risk factor; or as unspecified (if no records were available). Immunocompromised cases who also had other risk factors were classified as immunocompromised.

For all children under five years of age, vaccination status was checked against the Australian Childhood Immunisation Register (ACIR). In order to be considered vaccinated or partially vaccinated, a pneumococcal vaccine must have been given at least two weeks prior to illness onset. The Australian Bureau of Statistics Estimated Residential Population for Victoria, as at 30 June 2001, was used as the source for denominator data when calculating notification rates.

Results

All ages

From 1 July 2001 to 30 June 2002, DHS received 397 notifications of IPD, ranging from 18 cases in February 2002 to a peak of 56 cases in August 2001. There were 213 notifications for males (56%) and 184 females (44%). The notification rate was 8.2 cases per 100,000 population. Thirty-three per cent of the notifications (n=131) were for children under five years of age. Age-specific rate notification rates were highest among those aged less than five years (42.1 per 100,000 population) and those aged 85 years or more (35.6 per 100,000 population) (Figure). For the younger age group, rates were highest among children aged less than two years (72.6 per 100,000 population). There were 22 deaths due to IPD (6%), the highest case fatality rate was among those aged 65 years or more (10%, 12 deaths).

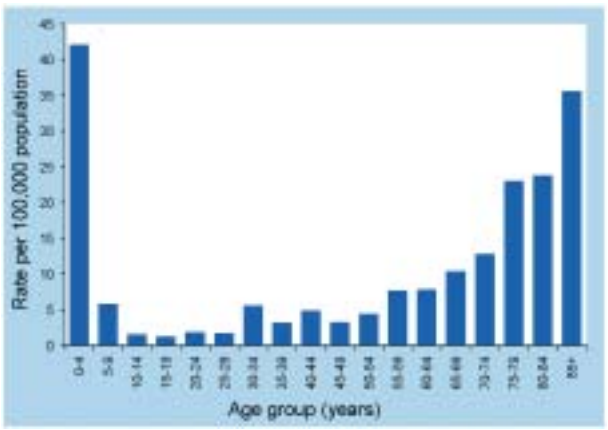
Four notifications (1%) were Aboriginal persons (aged from 39–46 years), 325 (82%) were not Aboriginal or Torres Strait Islander persons whilst Indigenous status was not specified for the remaining 68 cases (17%).

Children under five years of age

Of the 131 notifications among children aged less than five years, 84 (64%) had bacteraemia without a primary focus of infection, 27 (21%) presented with pneumonia and 13 (10%) with meningitis (one child presented with pneumonia and meningitis). The foci of infection were not specified for the remaining eight cases (6%). One hundred and seventeen cases were hospitalised (89%), seven (5%) were not hospitalised whilst hospitalisation status was not established for the remaining seven (5%). The median length of stay for hospitalised cases was three days (range 0–86 days) and the interquartile range was 2–3 days.

Four deaths were reported among children aged less than five years (3% case fatality rate). A 17-month-old child with serotype 18C had bacteraemia without primary focus. The second fatality was an infant aged two months who had serotype 19A identified from a post mortem lung culture. The cause of death was confirmed as bilateral broncho-pneumonia by the Coroner and the Chief Pathologist. The third fatality was a two-year-old child who presented with meningitis and had serotype 19F identified from cerebrospinal fluid. The fourth fatality was a 15-month-old child with a positive blood culture and clinical meningitis features for whom the serotype was unknown. Of the three deaths due to known serotypes, two were a type contained in the 7vPCV. No risk factor information was obtained for the child

Figure. Age-specific notification rate of invasive pneumococcal disease, Victoria, 1 July 2001 to 30 June 2002



diagnosed post mortem, while none of the other children were immunocompromised or identified as having any other risk factor.

Serotypes

Serotypes were identified for 107 cases (82%), one isolate was unable to be typed (1%) and cultures were not forwarded for serotyping for the remaining 23 cases (18%). Of the 107 with a known serotype, 95 (89%) were serotypes contained in the 7vPCV, while another 3 (3%) were serotype 6A for which the vaccine is likely to confer protection since it is closely related to a serotype contained within the 7vPCV.[6] Eight of the nine remaining cases were caused by serotypes contained in the 23 valent polysaccharide pneumococcal vaccine (7F, 11A, 15B and 19A) but only one of these was old enough (>2 years) to have received that vaccine (Table 1).[7]

Vaccination status and risk factors

One child, who had biliary atresia and was awaiting a liver transplant, had recurrent bacteraemia within the study period (both episodes were serotype 14). The first episode occurred at 10 months of age, the child received a first dose of 7vPCV five days prior to illness onset so was not expected to have developed an immune response within that time. The second episode occurred at age 11.5 months and by that time, the child had received two doses at least two weeks prior to illness onset (the second dose of 7vPCV was given 12 days after the first).

Three cases (2%) were in a risk group eligible for the free vaccine in Victoria, all were immunocompromised. One of these was infected with a serotype not contained in the 7vPCV—the child, aged four months, had received a bone marrow transplant and had serotype 11A isolated from a blood culture. The other two children were both infected with serotypes contained in the 7vPCV (14 and 18C)—one child, aged three years, was receiving treatment for leukaemia while the other child, aged four years, had acute lymphatic lymphoma. All three children had bacteraemia without a primary focus of infection.

Twenty-six children (20%) had a risk factor for IPD other than those for which the vaccine is currently funded, 89 (68%) had no identified risk factor, and there was insufficient information available to enable

Table 1. Vaccine and non-vaccine serotypes of invasive pneumococcal disease identified among children aged less than 5 years, Victoria, 1 July 2001 to 30 June 2002

Vaccine	Serotype	Age (years)					Total		Cumulative
		<1	1	2	3	4	n	%	%
7vPCV	14	12	13	7	3	4	39	36	36
	6B	7	9	1	1		18	17	53
	18C	2	5	3	2	1	13	12	65
	19F		5	3		2	10	9	75
	4		3	1	2	1	7	7	81
	23F	3		1	1		5	5	86
	9V	1				2	3	3	89
Related*	6A	1	1	1			3	3	92
Subtotal		26	36	17	9	10	98	92	92
23vPPV	19A	2	3				5	5	96
	11A	1					1	1	97
	15B	1					1	1	98
	7F					1	1	1	99
Neither	18B		1				1	1	100
Total		30	40	17	9	11	107	100	100
Others		12	8	0	3	2	25		N/A

7vPCV refers to serotypes contained in the 7 valent conjugate pneumococcal vaccine.

* Serotype 6A is not contained in the 7vPCV but is closely related to Serotype 6B.

23vPPV refers to serotypes contained in the 23 valent polysaccharide pneumococcal vaccine but not in the 7vPCV.

Other includes one isolate for a child aged <1 year that was not typable and 24 isolates that were not forwarded for serotyping.

N/A Not applicable with respect to proportions of vaccine and non-vaccine serotypes.

identification of any risk factors for the remaining 12 children (9%) (Table 2). Information on smoking in the household was poorly reported with 67 per cent (n=88) recorded as unknown or not stated, even so this was the most prevalent risk factor reported (10 children, 8% of 130). It is likely that more cases with this risk factor would have been identified if interviews had also been conducted with the parent/guardian. Chronic illness and gestation related risk factors were more completely reported with the proportions unknown or not stated ranging from 30–34 per cent. The congenital or chromosomal abnormalities identified were: Arnold-Chiari syndrome; anomalous pulmonary venous drainage; biliary atresia; cardiac murmur/pulmonary stenosis; Down's syndrome; Hirschsprung's disease; infantile osteopetrosis and translocation of chromosome 3&6.

Discussion

IPD first became notifiable in Victoria on 15 May 2001. This is the first report including a full 12 months data since that time and includes the information collected through enhanced surveillance in Victoria. This report has focussed on children less than five years of age because this is a group with high rates of disease and includes a subgroup for which the 7vPCV is publicly funded.[5]

Other jurisdictions, such as metropolitan New South Wales and the United States of America have reported rates approaching, or in excess of, 100 cases per 100,000 children under two years of age.[8,9] In Victoria, the notification rate for children aged less than five years (42.1 cases per 100,000 population) was slightly lower than the national rate reported recently (47.3 cases per 100,000 population).[3] For children less than two years of age, the notification rate (72.6 cases per 100,000 population) represented a 23 per cent increase on data collated prior to IPD becoming a notifiable condition in Victoria.[10] However, it is likely that the true disease burden remains under-reported. Failure to test or failure to test prior to commencement of antibiotics are factors that have been identified as contributing to under-reporting.[11] Failure to notify all diagnosed cases to DHS could also be a factor given that this was the first year the condition was notifiable.

Even though the notification rate was highest in children under two years of age and serotyping showed that 92 per cent of cases in this age group were of a type included in/or closely related to those in the 7vPCV, only one child had been vaccinated. Of all the cases detected in children under five years of age, only three (2%) were eligible for free vaccine under the current program.

Table 2. Risk factors of invasive pneumococcal disease identified among children aged less than 5 years, Victoria, 1 July 2001 to 30 June 2002

Risk factor	Age (years)					Total*	
	<1	1	2	3	4	n	%
Immunocompromised	1	0	0	1	1	3	2
Any other identified risk factor (see below)	10	7	2	5	2	26	20
No identified risk factor	25	37	14	6	7	89	68
Unspecified	4	4	1	0	3	12	9
Total	40	48	17	12	13	130	100
Any other identified risk factor including:	10	7	2	5	2	26	20
Chronic illness	2	3	1	2	1	9	7
Premature birth	2	2	2	0	1	7	5
Low birth weight	1	1	2	1	0	5	4
Congenital or chromosomal abnormality	5	2	1	0	0	8	6
Smoker in household	5	2	0	2	1	10	8

* Total refers to children (n=130) not notifications (one child had two episodes during study period)

† More than one risk factor could be identified for each notified case

The 7vPCV is currently funded for those groups in Australia at highest risk of pneumococcal disease: Indigenous children to the age of two years and non-Indigenous children to the age of five years in specified risk groups.[4] Our data showed that, within Victoria, the disease burden was predominantly among children outside the funded risk groups (98%). Whilst it is acknowledged that risk factor information collated through the enhanced surveillance may be incomplete, it is not believed that the information collected from treating practitioners is likely to substantially under-estimate the proportion of children eligible for the 7vPCV under the currently funded program.

The 7vPCV contains serotypes that most frequently cause invasive antibiotic-resistant disease.[12] Both the efficacy and cost-effectiveness of the vaccine have shown that it has the potential to have a significant public health impact on the incidence of IPD.[13,14] Assuming 92 per cent of all cases in children were caused by serotypes contained in the 7vPCV, then, given vaccine efficacy of 94 per cent, we could expect that a universal vaccination program in Victoria could prevent 86 per cent of invasive pneumococcal disease in children old enough to complete the primary course.

In the United States of America, conjugate pneumococcal vaccine has been recommended for all children under two years of age.[15] A recent report on invasive pneumococcal disease in north Queensland, an area with a much higher proportion of Indigenous children than Victoria, suggested that there may be a case for extending the publicly funded 7vPCV program to include all non-indigenous children under two years of age.[16] The results from the first year of enhanced surveillance in Victoria support this view.

Acknowledgements

We wish to thank staff at the Department of Human Services, the Microbiological Diagnostic Unit, Public Health Laboratory, the University of Melbourne, primary diagnostic laboratories, medical practitioners and hospitals throughout Victoria who contributed to the surveillance. In particular, we wish to acknowledge Kerry-Ann O'Grady, Joanna Gaston and Megan Counahan, DHS, for data management and comments on the manuscript. The National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases (NCIRS) provided funding to support a pilot program of enhanced IPD surveillance, additional funding was also provided by the Commonwealth Department of Health and Ageing during the first year of the program. NCIRS also provided a PhD scholarship for Ross Andrews. The Commonwealth Department of Health and Ageing also supported Laboratory Typing.

References

1. Forrest JM, McIntyre PB, Burgess MA. Pneumococcal disease in Australia. *Commun Dis Intell* 2000;24:89-92.
2. Musher DM. *Streptococcus pneumoniae*. In: Mandell GL, Douglas RG and Bennett JE, eds. *Principles and practice of infectious diseases*. 4th edn. Philadelphia: Churchill Livingstone, 2000:1811–1826.
3. Roche P, Krause K for the Enhanced Pneumococcal Surveillance Group of the Pneumococcal Working Party of the Communicable Diseases Network Australia. Invasive pneumococcal disease in Australia, 2001. *Commun Dis Intell* 2002;26:505–519.
4. National Health and Medical Research Council Health Advisory Committee. National Childhood Pneumococcal Vaccination Program: recommendations of the Australian Technical Advisory Group on Immunisation for a childhood pneumococcal vaccination program. National Health and Medical Research Council; October 2001
5. Victorian Government Department of Human Services, Public Health Division. Childhood pneumococcal disease immunisation information. Department of Human Services; May 2002 (0210202).
6. Fedson DS, Musher DM, Eskola J. Pneumococcal vaccine. In: Plotkin SA, Orenstein WA, eds. *Vaccines*. 3rd edn. Philadelphia: WB Saunders, 1999:553–607.
7. National Health and Medical Research Council. The *Australian Immunisation Handbook*. 7th edn. Canberra: Australian Government Publishing Service, 2000:183–187.
8. McIntyre PB, Gilmour RE, Gilbert GL, Kakakios AM, Mellis CM. Epidemiology of invasive pneumococcal disease in urban New South Wales, 1997–1999. *Med J Aust* 2000;173:S22–S26.
9. Centers for Disease Control and Prevention. Prevention of pneumococcal disease: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR Morb Mortal Wkly Rep* 1997;46:1–24.
10. Hogg GG, Strachan JE, Lester RA. Invasive pneumococcal disease in the population of Victoria. *Med J Aust* 2000;173:S32–S35.
11. Fedson DS, Scott JA, Scott G. The burden of pneumococcal disease among adults in developed and developing countries: what is and is not known. *Vaccine* 1999;17:S11–S18.
12. Poland GA. The prevention of pneumococcal disease by vaccines: promises and challenges. [Review] *Infect Dis Clin North Am* 2001;15:97–122.
13. Peters TR, Edwards KM. The pneumococcal protein conjugate vaccines. *J Paediatr* 2000;137:416–420.
14. Lieu TA, Ray GT, Black SB, Butler JC, Klein JO, Breiman RF, *et al*. Projected cost-effectiveness of pneumococcal conjugate vaccination of healthy infants and young children. *JAMA* 2000;283:1460–1468.
15. Centres for Disease Control and Prevention. Preventing pneumococcal disease among infants and young children: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR Morb Mortal Wkly Rep* 2000;49(RR–9):1–38.
16. Hills SL, Hanna JN and Murphy D. Invasive pneumococcal disease in North Queensland, 2001. *Commun Dis Intell* 2002;26:520–524.

Sentinel Chicken Surveillance Program in Australia, July 2002 to June 2003

Annette K Broom
Discipline of Microbiology, School of Biomedical and Chemical Sciences, University of Western Australia

Abstract

Detection of flavivirus seroconversions in sentinel chicken flocks located throughout Australia is used to provide an early warning of increased levels of Murray Valley encephalitis (MVE) and Kunjin (KUN) virus activity in the region. During the 2002–2003 season low levels of flavivirus activity were detected in northern Australia compared to previous years. MVE and KUN virus activity was detected in the Kimberley and Pilbara regions of Western Australia and the Northern Territory but not in north Queensland, New South Wales or Victoria. This is similar to the previous season. There were no reported cases of disease caused by either virus. *Commun Dis Intell* 2003;27:367–369.

Keywords: encephalitis, flavivirus, Kunjin, Murray Valley encephalitis

Introduction

The Sentinel Chicken Surveillance Program is used to provide an early warning of increased flavivirus activity in Australia. The main viruses of concern are Murray Valley encephalitis (MVE) and Kunjin (KUN) viruses. MVE virus causes the disease Murray Valley encephalitis (formerly known as Australian encephalitis), a potentially fatal disease in humans. Encephalitis is less frequent in cases of Kunjin virus infection and these encephalitis cases have a lower rate of severe sequelae. These viruses are enzootic in the Kimberley region of Western Australia and in the Top End of the Northern Territory and possibly in Far North Queensland (Western Cape and Gulf country). They are epizootic in the Pilbara, Gascoyne and Midwest regions of Western Australia, central Australia and in western and central Queensland. MVE virus is also responsible for occasional severe epidemics of encephalitis in south-eastern Australia, the most recent occurring in 1974.

In the northern areas of Australia MVE and KUN virus activity varies depending on the extent and location of wet season rainfall and flooding in the region. MVE and KUN virus activity is monitored in Australia by detecting seroconversions in sentinel chicken flocks.[1] Since 1974, a number of sentinel chicken flocks have been established in five Australian States to provide an early warning of increased MVE and KUN virus activity. These programs are funded by the State health departments and each state has a contingency plan, which will be implemented if one or more chickens in a flock seroconverts to one of these viruses. From 1992 to 2001 the results of the state sentinel chicken programs were reported bimonthly in *Communicable Diseases Intelligence* (*CDI*). From 2002 onwards, important results were posted on the Communicable Diseases Australia website by each state and this report is a brief summary of the results obtained from each State program during the 2002–2003 season.

Currently, 31 flocks are maintained in the north of Western Australia, eight in the Northern Territory, six in New South Wales, 10 in Victoria and two in northern Queensland. The flocks in Western Australia and the Northern Territory were sampled and tested all year round but those in New South Wales and Victoria were tested only in the summer months, during the main MVE risk season. The Queensland flocks were tested weekly from January to June. All flock locations were presented earlier in *CDI*.[2] Additional details of the Australian sentinel chicken surveillance program has also been presented earlier in *CDI*.[1]

Summary of recent flavivirus activity in Australia

MVE and KUN virus activity is detected in Western Australia and the Northern Territory in most years. Activity in other areas is less regular. Record rainfall was recorded in the north of Australia during the 1999–2000 wet season and cases of Murray Valley encephalitis were reported from the Northern Territory, central Australia and Western Australia. Above average rainfall was recorded in central Australia in 2000–2001 and cases were again

Corresponding author: Dr Annette Broom, Senior Research Officer, Disciple of Microbiology, School of Biomedical and Chemical Sciences, University of Western Australia,35 Stirling Highway, CRAWLEY WA 6009. Telephone +61 8 9346 2213. Facsimile: +61 8 9346 2912. Email: abroom@cyllene.uwa.edu.au

reported in the region. A single case was also reported from central Queensland. In 2000–2001 MVE activity was detected in New South Wales for the first time since 1974 but no cases were reported. Kunjin virus activity was also detected in New South Wales and Victoria in 2000–2001.

MVE and KUN virus activity was low in 2001–2002 with activity recorded only in Western Australia and the Northern Territory. Kunjin virus activity was reported from Western Australia, Northern Territory and northern Queensland.

Flavivirus activity in 2002–2003

Western Australia

Serum samples from the Western Australian sentinel chicken flocks are tested by the Arbovirus Surveillance and Research Laboratory at the University of Western Australia in Perth.

MVE activity was detected from July to September in the Kimberley and Pilbara regions in 2002, but this was a continuation of the previous season's activity. A localised warning was issued by the Mosquito-Borne Disease Control section at the Western Australia Department of Health (WADOH) for the Pilbara region in September.

Although there was above average summer rainfall (December to February) in most areas of the Kimberley in 2002–2003, flavivirus activity was considerably lower than last year and began later than usual in Western Australia. Antibodies to either MVE or KUN virus were only detected in a total of six chickens in the Kimberley region. There was only one seroconversion reported from Paraburdoo in the Pilbara region in May 2003. No human cases were reported.

MVE activity was first detected in February 2003 at Fitzroy Crossing in the West Kimberley and seroconversions to both MVE and KUN viruses were detected later in April and May at two sites (Kununurra and Kalumburu) in the north-east Kimberley. The WADOH issued a health warning to residents and visitors to the Kimberley in early March. An additional health warning was sent out to the Kalumburu community in May.

MVE activity was only detected at one site (Paraburdoo) in the Pilbara in May. In response to this, a health warning was issued in June 2003 by WADOH, to residents and visitors to the Pilbara region. No activity was detected further south or east in the Gascoyne, Murchison, Midwest, Goldfields and Wheatbelt regions in 2003.

Northern Territory

MVE activity is usually initiated later in the Northern Territory than in Western Australia. The flocks were bled monthly by veterinary officers of the Department of Business Industry and Resource Development and volunteers, and the serum samples were tested by staff of the Arbovirus Surveillance and Research Laboratory in Perth.

Flavivirus activity during the 2002–2003 wet season was lower in the Northern Territory than in the previous season. Kunjin virus activity was detected in August 2002 in the Darwin area, but this was probably a continuation of the previous season's activity (P Whelan, personal communication).

The first MVE seroconversion for this season was detected in April 2003 at Gove. MVE activity was also detected in the Darwin rural area in June. Media warnings were issued by the Northern Territory Department of Health and Community Services in early May from Maningrida to Groote Eylandt and late June for the general Top End.

KUN activity was detected at Katherine in May, at Gove from April to June, and at Tennant Creek in June. A media warning of the increase in KUN activity in the Northern Territory was issued in late May for Maningrida to Groote Eylandt.

No cases of disease caused by MVE or KUN virus were recorded in the Northern Territory during the 2002–2003 season. The lack of MVE activity in Alice Springs is thought to be partly due to an extensive insecticide application and drainage measures in Ilparpa swamp on the outskirts of Alice Springs, that were carried out in early 2002, and the below average summer rainfall for 2002–2003. The lack of MVE activity in the Alice Springs region was in accord with the predictions based on accumulated summer rainfall, with less than 100 mm of summer rain in Alice Springs this year, despite heavy November 2002 rain.[3]

North Queensland

The two sites in Queensland were monitored weekly for six months (January to June) and samples were tested by staff at Queensland Health Scientific Services. No flavivirus activity was detected.

New South Wales and Victoria

Samples from sentinel chicken flocks were tested weekly for flavivirus antibodies in New South Wales (Westmead Hospital) from December to April and in Victoria (Veterinary Research Institute) from October to March. In the 2002-2003 season no MVE or KUN virus activity was detected in this region.

Acknowledgements

The Sentinel Chicken Programs in each state are funded by the State health departments.

I thank Mr PI Whelan, Medical Entomology Branch, Department of Health and Community Services, Darwin for his advice on this report.

The following people have contributed to the Australian sentinel chicken program and I thank them for their help with this report. I apologise if I have missed anyone.

Mr J Azoulas, Veterinary Research Institute, Victoria; Dr D Dwyer, Virology Department, Westmead Hospital, New South Wales; Ms S Harrington, Mosquito-Borne Disease Control Branch, Western Australian Department of Health; Ms L Hueston, Virology Department, Westmead Hospital, New South Wales; Dr Cheryl Johansen, Arbovirus Surveillance and Research Laboratory, University of Western Australia, Ms Nina Kurucz, Medical Entomology Branch, Department of Health and Community Services, Darwin; Dr MD Lindsay, Mosquito-borne Disease Control Branch, Western Australian Department of Health; Ms Alyssa Pyke, Public Health Virology Laboratory, Queensland Health Scientific Services; Prof. JS Mackenzie, Department of Microbiology, University of Queensland; Dr L Melville, Berrimah Agricultural Research Centre, Darwin; Dr SA Ritchie, Cairns Tropical Public Health Unit, Queensland; Dr DW Smith, Division of Health Sciences, Western Australian Centre for Pathology and Research, Western Australia.

The following laboratories were responsible for testing sentinel chicken sera:

Arbovirus Surveillance and Research Laboratory, Discipline of Microbiology, University of Western Australia.

Public Health Virology Laboratory, Queensland Health Scientific Services

Virology Department, Westmead Hospital, New South Wales

Veterinary Research Institute, Victoria

References

1. Spencer JD, Azoulas J, Broom AK, Buick TD, Currie B, Daniels PW, *et al*. Murray Valley encephalitis virus surveillance and control initiatives in Australia. *Commun Dis Intell* 2001;25:33–47.
2. Sentinel Chicken Surveillance Program. *Commun Dis Intell* 2003;27:125–129.
3. Whelan PI, Jacups SP, Melville L, Broom A, Currie BJ, Krause VL, *et al*. Rainfall and vector mosquito numbers as risk indicators for mosquito-borne disease in Central Australia. *Commun Dis Intell* 2003;27:110–116.

Communicable Diseases Australia website has moved

The Communicable Diseases Australia website now has a new look and new structure. The site has been redeveloped to improve its functionality and for better navigation.

The previous static Annual diseases data pages for the National Notifiable Diseases Surveillance System have been replaced by a dynamic system that extracts data directly from a database according to selected options. These options now also include rates for selected diseases.

Other changes are: separate navigation pages by topic: (Communicable Diseases Network Australia; publications; quarantine; national surveillance; and other links); and a navigation page for all published annual reports.

As notified earlier, the site has also moved to a new address: http://www.cda.gov.au/index.htm. Since the launch of the redeveloped site the old longer address (http://www.health.gov.au/cdi/) is no longer available. Other sub pages have also moved but can be found from the home page. Please update your bookmarks.

We would appreciate any feedback or comments on the new site to help us continue to improve the site. Please send your comments by email to: cdi.editor@health.gov.au

Gonorrhoea, chlamydia and syphilis incidence in the Kimberley

Donna B Mak,[1,2] Lewis J Marshall[3]

Abstract

The Kimberley region in far-north Western Australia has some of the highest reported incidences of sexually transmitted infections (STIs) in the nation. This report documents the region's incidence rates of gonorrhoea and syphilis from 1997 to 2001 and of chlamydia from 1993 to 2001. Chlamydia rates have been increasing since 1993 when genital chlamydia became a notifiable disease. By contrast, gonorrhoea rates remained stable from 1997 to 2001. Syphilis rates, which plateaued between 1996 and 2000 following a steep decrease in the previous decade, rose in 2001 in association with a regional syphilis outbreak. Factors important in interpreting changes in STI rates over time include the increased accuracy of more recent census data, the introduction of new and more sensitive diagnostic techniques and the influence of health workforce numbers and skills on STI diagnosis. *Commun Dis Intell* 2003;27:370–372.

Keywords: chlamydia, gonorrhoea, sexually transmissible diseases, syphilis

Introduction

The Kimberley region in far-north Western Australia has some of the highest reported incidences of sexually transmitted infections (STIs) in the nation.[1] This sparsely populated region has a resident population of 32,000, one half of whom are Indigenous. Access to, and delivery of, primary health care, and in particular STI prevention and management, is often challenging in this remote region, with its poor roads, flooding, high staff turnover and cross-cultural issues.

A previous publication documented gonorrhoea and syphilis incidence in the Kimberley from 1987 to 1996.[2] Since then, new diagnostic techniques (such as nucleic acid testing and self obtained lower vaginal swabs for gonorrhoea and chlamydia) have become widely available in the region, laboratory notification of gonorrhoea and chlamydia was introduced in Western Australia, and the region's periodic syphilis screening program was evaluated, modified and subsequently ceased.[3,4,5,6,7]

This report aims to document incidence rates in the Kimberley, of gonorrhoea and syphilis from 1997 to 2001 and of chlamydia from 1993 to 2001.

Methods

Population data from the Australian Bureau of Statistics' 1996 and 2001 census collections were obtained from the Epidemiology Branch of the Health Department of Western Australia.

The number of reports of gonorrhoea and chlamydia were obtained from laboratory and doctors' notifications to the Kimberley Public Health Unit. The number of reports of syphilis were obtained from the Kimberley Public Health Unit's syphilis database and doctors' notifications. Early syphilis was defined as an infection with clinical features of primary, secondary or congenital syphilis or syphilis of less than two year's duration as evidenced by the patient's serological history. All other new cases of syphilis were classified as late or unknown onset. Duplicate notifications were removed from the database before analysis.

Results

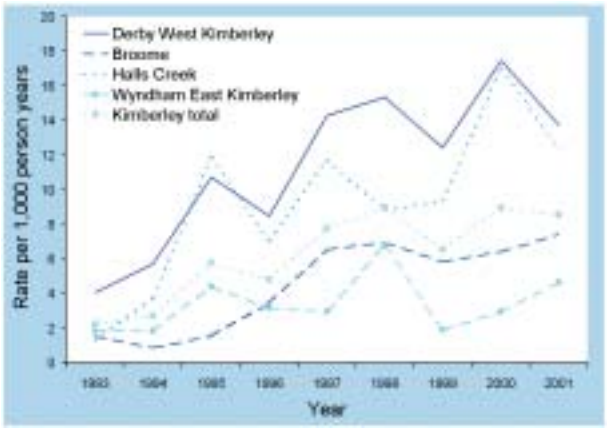
Incidence rates are shown in Figures 1, 2, 3, 4 and 5.

Since genital chlamydia became a notifiable disease in 1993, chlamydia rates in all Kimberley Shires have been increasing in both males and females (Figures 1 and 2). By contrast, total Kimberley gonorrhoea rates remained stable from 1997 to 2001 and the decrease in male gonorrhoea rates observed between the

1. Public Health Medical Officer, Department of Health Western Australia, (formerly Kimberley Public Health Unit,) Derby, Western Australia
2. Adjunct Research Fellow, School of Population Health, University of Western Australia, Nedlands, Western Australia
3. Sexual Health Physician and Head of Department, Infectious Diseases Department, Fremantle Hospital, Fremantle, Western Australia

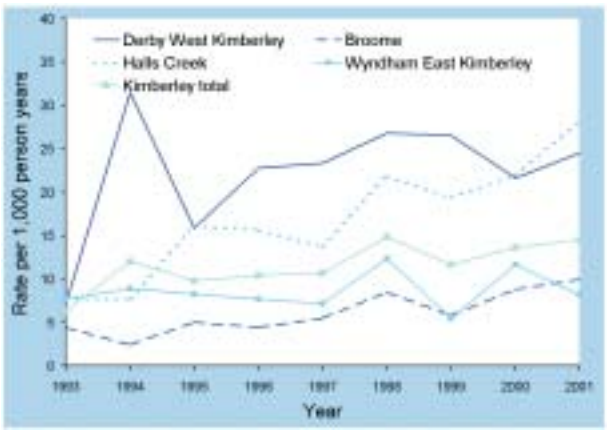
Corresponding author: Dr Donna Mak, 189 Royal Street, East Perth WA 6009. Telephone: +61 8 6389 2223.
Email: makho@bigpond.com

Figure 1. Incidence rates per 1,000 person years, of chlamydia in males in the Kimberley, 1993 to 2001, by shire



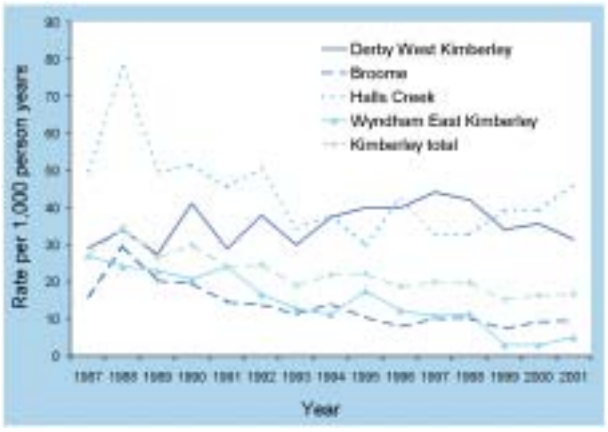
Nucleic acid testing was introduced in mid-1995

Figure 2. Incidence rates per 1,000 person years, of chlamydia in females in the Kimberley, 1993 to 2001, by shire



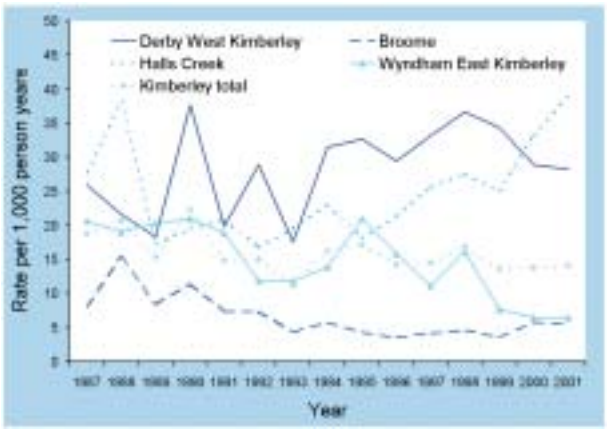
Nucleic acid testing was introduced in mid-1995

Figure 3. Incidence rates per 1,000 person years, of gonorrhoea in males in the Kimberley, 1987 to 2001, by shire



Nucleic acid testing was introduced in mid-1996

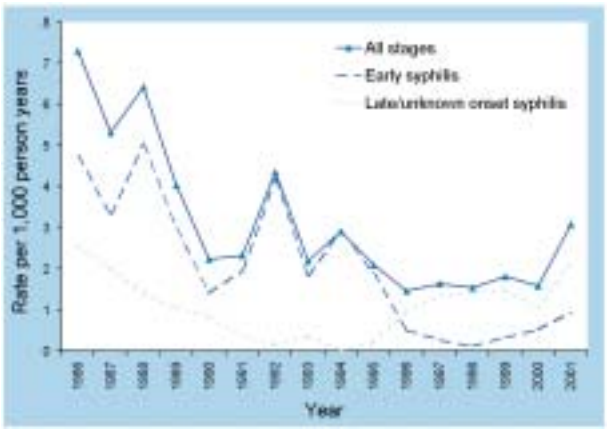
Figure 4. Incidence rates per 1,000 person years, of gonorrhoea in females in the Kimberley, 1987 to 2001, by shire



Nucleic acid testing was introduced in mid-1996

mid-1980s and the mid-1990s has plateaued (Figures 3 and 4). However, there were significant local variations, with male and female gonorrhoea rates in the Halls Creek Shire increasing, whereas in both males and females in the Shire of Wyndham East Kimberley there was a sustained decrease between 1998 and 2001. The decrease in syphilis rates observed between the mid-1980s and the mid-1990s plateaued in the late-1990s. Syphilis rates increased in 2001 in a regional syphilis outbreak that probably started in August 2000.[8] This outbreak has continued to the present (2003). The first case of congenital syphilis in the Kimberley since 1989 was reported in 2001.[8]

Figure 5. Incidence rates per 1,000 person years, of syphilis in the Kimberley, 1986 to 2001, by stage



Discussion

The Kimberley Public Health Unit has received both doctors' and laboratory notifications of notifiable STIs since 1986. This contrasts with other parts of Western Australia, where laboratory notification was introduced in 2000. In the first year following this change, there was an increase in STI notifications from all regions of Western Australia except the Kimberley (Dr Sandra Thompson, Medical Coordinator, Sexual Health Program Health Department of Western Australia, personal communication). Therefore this change in the notification process is not thought to be significant for the Kimberley region.

Population data from the Australian Bureau of Statistics were used in these calculations, even though they probably underestimate the Kimberley population and, in particular, the Kimberley Aboriginal population.[9] The degree of underestimation is likely to have been greater in earlier than in more recent years.[9] This needs to be remembered when interpreting changes in rates over time.

Another factor than needs to be remembered is that nucleic acid testing for gonorrhoea and chlamydia was introduced to, and became available throughout, the Kimberley (at no cost to the patient or health care provider) in mid-1995 and mid-1996, respectively. Prior to this, gonorrhoea and chlamydia may have been under-diagnosed because previous diagnostic tests (gonorrhoea culture and chlamydia enzyme-linked immunosorbent assay) were far less sensitive than nucleic acid tests. Self obtained lower vaginal swabs for gonorrhoea and chlamydia were piloted in the Kimberley in 2000 and became widely available in 2001. This could be expected to result in increased testing and diagnosis of STIs in women, particularly in areas without female health staff able to perform vaginal examinations.

Diagnosis of STIs, especially in more remote areas, is very dependent, not just on the presence or absence of health staff, but also on the skills and personalities of individual staff members. For example, part of the increase in gonorrhoea incidence in the Halls Creek Shire between 1998 and 2001 is likely to have been caused by the presence of a few individuals who had the necessary clinical and public health skills required to effectively manage patients with STIs and who were also trusted by people living in the area. In the Wyndham East Kimberley Shire there was a decrease in gonorrhoea incidence between 1998 and 1999 which was maintained over the next two years. Due to the relative stability of health staff, and the collaboration between health, education and youth work professionals in sexual health education that has occurred since the late-1990s in this Shire, the observed decrease in gonorrhoea rates is probably due to a real decrease in disease incidence rather than a decrease in diagnosis due to poor access to health services.

Gonorrhoea, chlamydia and syphilis rates in the Kimberley, while far higher than those in other parts of Western Australia, are comparable with those reported from the Northern Territory.[1,10,11] With the increasing numbers of residents in, and visitors to, the Kimberley it is crucial that adequate resources be allocated to STI surveillance, control and prevention to limit the spread of STIs and HIV. Timely diagnosis and treatment is essential to minimise permanent consequences of STIs, e.g. infertility, congenital syphilis. The current outbreak of syphilis, a disease which only recently was thought to be under control in the Kimberley, is a salutary reminder of how easily and quickly STIs can spread throughout remote Australia.[8]

References

1. Lin M, Roche P, Spencer J, Milton A, Wright P, Witteveen D, *et al*. Australia's notifiable diseases status, 2000. Annual report of the National Notifiable Diseases Surveillance System *Commun Dis Intell* 2002;26:118–203. [Erratum in: *Commun Dis Intell* 2002;26:374].
2. Mak D, Platt E, Marshall L. Gonorrhoea and syphilis in the Kimberley region. *Aust N Z J Public Health* 1998;22:167–169.
3. Health Department of Western Australia. *Guidelines for managing sexually transmitted diseases*. Sydney: Australasian Medical Publishing Company, 1997.
4. Health Department of Western Australia. *Guidelines for managing sexually transmitted infections: a guide for primary health care providers.* Perth: Public Health Division of the Health Department of Western Australia, 2001.
5. Garrow SC, Smith DW, Harnett GB. The diagnosis of chlamydia, gonorrhoea, and trichomonas infections by self obtained low vaginal swabs, in remote northern Australian clinical practice. *Sex Trans Infect* 2002;78:278–281.
6. Mak DB, Holman CD. Age at first episode of venereal syphilis in an aboriginal population: an application of survival analysis. *Aust N Z J Public Health* 1998;22:704–708.
7. Mak DB, Holman CD. A decision to end a periodic syphilis-screening program in the Kimberley region. *Commun Dis Intell* 2000;24:386–390.
8. Mak D. An outbreak of syphilis in the Kimberley. Australasian Sexual Health Conference, 29 May – 1 June 2002, Perth, Australia.
9. Australian Bureau of Statistics. Statistics on the Indigenous Peoples of Australia. In *Year Book Australia, 1994*. ABS Catalogue No. 1301.0.
10. Northern Territory AIDS/STD Program surveillance update 2001, Department of Health and Community Services; 2 (1).
11. Northern Territory AIDS/STD Program surveillance update 2001, Department of Health and Community Services; 2 (2).

An assessment of the Roche Amplicor® *Chlamydia trachomatis/Neisseria gonorrhoeae* multiplex PCR assay in routine diagnostic use on a variety of specimen types

David E Leslie, Franca Azzato, Norbert Ryan, Janet Fyfe
Victorian Infectious Diseases Reference Laboratory

Abstract

The Roche Cobas Amplicor® *Chlamydia trachomatis/Neisseria gonorrhoeae* polymerase chain reaction (PCR) assay can simultaneously detect both *C. trachomatis* and *N. gonorrhoeae*, and has been cleared by United States Food and Drug Administration (FDA) for the testing of endocervical and urethral swabs and urine specimens. The Amplicor *N. gonorrhoeae* PCR target sequence is known to be present in some strains of commensal *Neisseria* species, including *N. cinerea* and *N. subflava*, necessitating the use of a second PCR assay to confirm positive results. This study analyses the performance of the assay on 7,007 unselected specimens submitted to the laboratory for the PCR diagnosis of *N. gonorrhoeae* and *C. trachomatis;* compares the PCR assay with culture for the detection of *N. gonorrhoeae*; examines the performance of the assay with specimens from different body sites; and briefly compares two confirmatory PCR assays. Confirmation rates for an initial Amplicor *N. gonorrhoeae* positive result varied widely by specimen type, ranging from 86.2 per cent for penile/urethral swabs to 5.6 per cent for oropharyngeal swabs, indicating all positive Amplicor *N. gonorrhoeae* results should be confirmed by a second method to maintain adequate specificity. Overall there was 98.1 per cent agreement between the confirmed PCR assay and culture, with confirmed PCR showing a sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of 81.7 per cent, 99.5 per cent, 92.7 per cent and 98.5 per cent respectively, compared with *N. gonorrhoeae* culture. When confirmed *C. trachomatis/N. gonorrhoeae* PCR assay performance was analysed against culture using only FDA-cleared specimens (553 penile/urethral swabs, urines and cervical/vaginal swabs), sensitivity, specificity, PPV and NPV and percent agreement were 96.7 per cent, 99.8 per cent, 98.9 per cent, 99.4 per cent and 99.3 per cent respectively. No significant differences were found between the two confirmatory PCR assays used during the study period. Limitations of Amplicor for the detection of *N. gonorrhoeae* and the appropriate use of combined *C. trachomatis/N. gonorrhoeae* PCR in a routine diagnostic setting are discussed. *Commun Dis Intell* 2003;27:373–379.

Keywords: Chlamydia trachomatis, Neisseria gonorrhoeae

Background

Many diagnostic laboratories now routinely use nucleic acid amplification (NAA) assays to detect a variety of pathogenic organisms. The automated Roche Cobas Amplicor® *Chlamydia trachomatis/Neisseria gonorrhoeae* (CT/NG) PCR assay has become popular due to its ability to detect both *C. trachomatis* and *N. gonorrhoeae* simultaneously from a variety of easily collected specimen types. This allows self-collection of specimens and is less sensitive to specimen transport and storage than traditional culture methods for *N. gonorrhoeae*.[1,2] The assay has been given 510(k) listing by the United States Food and Drug Administration (FDA) for the testing of urine, endocervical and urethral swabs, but has not been fully validated or cleared for testing of specimens from other body sites.[3]

For *C. trachomatis*, there are significant advantages of NAA assays over the technically difficult and expensive culture methods and the assay can handle a much greater range of specimens than the once widely used direct immunofluorescence kits. The sensitivity of the Amplicor assay for both *C. trachomatis* and *N. gonorrhoeae* compared with

Corresponding author: Dr David Leslie, Medical Microbiologist, Victorian Infectious Diseases Reference Laboratory, Melbourne Health Network, Locked Bag 815, Carlton South, Victoria 3053. Telephone: +61 3 9342 2600. Facsimile: +61 3 9342 2666. Email david.leslie@mh.org.au

traditional methods has been demonstrated in a number of studies. Specificity for the detection of *C. trachomatis* in female genital specimens has been estimated at over 99 per cent.[4,5,6]

Recently, major problems with the specificity of the assay for detection of *N. gonorrhoeae* have been documented.[7,8,9] The Amplicor assay targets a sequence in the cytosine DNA methyltransferase gene of *N. gonorrhoeae*, however similar sequences are now known to be present in some strains of the commensal *Neisseria* species, *N. cinerea* and *N. subflava*, and possibly *N. sicca, N. lactamica* and *N. flavescens*.[7,8,9] Commensal *Neisseria* species are almost ubiquitous in the human oro-pharynx, but may also be present in the genital tracts, possibly transiently, of some healthy people.[10]

To circumvent this problem, it has been common practice to use a second polymerase chain reaction (PCR) assay targeting a different site within *N. gonorrhoeae* to confirm all initial *N. gonorrhoeae* positive results obtained by the Amplicor CT/NG assay. Two main targets have been used for the supplementary test; initially Roche released a *N. gonorrhoeae* 16S rRNA gene detection kit, however this was withdrawn for unspecified reasons in May 2001. Subsequently, various laboratories have developed other in-house methods.[7,11,12] At the Victorian Infectious Diseases Reference Laboratory (VIDRL) an in-house method was developed based on a LightCycler real-time PCR assay for detection of the cppB gene of *N. gonorrhoeae*, which is present in multiple copies in the cryptic plasmid of *N. gonorrhoeae* or as a single genomic copy in a few atypical strains.

The purpose of this study is to examine the performance of the Amplicor assay on a variety of specimen types, and to assist with the formulation of appropriate testing strategies using this assay.

All test procedures involving the detection of *N. gonorrhoeae* were analysed over a 20 month period, from 1 January 2001 to 31 August 2002. Test procedures analysed included the Roche Amplicor CT/NG assay, and culture procedures for detection of *N. gonorrhoeae* from genital, oropharyngeal, and other specimens.

Methods

Specimens

VIDRL is a tertiary referral public health laboratory and specimens were referred from all parts of the State of Victoria. In addition to referrals from other pathology laboratories, VIDRL provides primary pathology services to a number of inner Melbourne specialist clinics with high caseloads of men who have sex with men (MSM) and HIV-infected patients. This patient population is predominantly male and has very high rates of sexually transmitted and bloodborne viral infections (STI/BBVI) compared with the rates in general population. All specimens included in the study were submitted to VIDRL for diagnostic purposes; any specimens known to derive from screening or prevalence studies were excluded. First void urine specimens and swabs were either collected by medical staff or self-collected under instruction. A few unusual specimens such as intra-uterine devices, or pleural or peritoneal fluids were handled by the laboratory in a similar way to the swabs and urine specimens. Requests for *C. trachomatis* PCR only (*N. gonorrhoeae* PCR not requested) over the test period have been excluded from analysis. One thousand and thirty-eight requests for *N. gonorrhoeae* PCR with *C. trachomatis* PCR not requested were included in the study.

Cobas Amplicor® *C. trachomatis/N. gonorrhoeae* PCR assay

The details of the assay have been previously described.[13] Urine and genital swabs were processed and run on the automated Cobas instrument according to the manufacturer's instructions. Swabs from other sites were processed as for genital specimens. Swabs submitted in charcoal Amies transport medium were tested by culture and PCR, and dry swabs were tested by PCR only. An internal amplification control was included for each specimen. The criteria used for determination of a positive result were those supplied with the assay. Extracts of urine and swabs showing inhibition on initial testing were diluted, 1:2 and 1:4 respectively, for retesting. Following Amplicor testing, extracted PCR specimens were stored at –20ºC for further testing as necessary.

N. gonorrhoeae 16S rRNA confirmatory assay

Confirmatory testing of Amplicor *C. trachomatis/ N. gonorrhoeae* positive results was initially performed using a 16S rRNA assay (developed by Roche Diagnostic systems) which targets the *N. gonorrhoeae* 16S rRNA gene sequence described by Rossau, *et al*.[14] This assay used the manual Amplicor format. Use of this assay for confirmatory purposes ceased on 31 August 2001.

N. gonorrhoeae LightCycler cppB PCR assay

This assay was introduced in August 2001 following the announcement by Roche that the company would not continue to supply the *N. gonorrhoeae* 16S rRNA gene confirmatory PCR assay. The basic method for the LightCycler cppB assay for *N. gonorrhoeae* has been previously published.[15] It was optimised at VIDRL in conjunction with Gippsland Pathology Service and Roche Diagnostics Australia. Specimens already processed for the Amplicor assay were further purified using DNA extraction columns (High-Pure Purification kit, Roche Diagnostics, Australia) before the specimen was run in the cppB PCR assay. All

extracted DNA specimens were stored at –20ºC if a delay in processing was expected. This new test was run in parallel with the 16S rRNA gene assay for one month on 75 samples, of which 36 per cent were positive, but no discordant results were detected.

N. gonorrhoeae culture

Swabs submitted for culture in charcoal Amies transport medium were usually transported to the laboratory at ambient temperature on the same day of collection. Swabs were plated out on New York City Agar and Chocolate or Horse-blood agar (depending on site) and incubated at 37ºC in five per cent CO_2. The plates were read daily for up to four days. Presumptive positive *N. gonorrhoeae* isolates were identified by typical colonial and Gram-stain morphology, oxidase and superoxol reactions. Carbohydrate utilisation and other biochemical testing was determined using API NH kits (Biomerieux, Lyon France) according to the manufacturer's instructions. Any *N. gonorrhoeae* isolates identified were referred to the Victorian state *N. gonorrhoeae* reference laboratory (Microbiological Diagnostic Unit, University of Melbourne, Parkville, Victoria) for confirmation and antimicrobial susceptibility testing.

Data extraction

All data relating to procedures that detect *N. gonorrhoeae* and *C. trachomatis* for the period 1 January 2001 to 31 August 2002 were downloaded from the Medipath Laboratory Information system (LRS Software Pty Ltd, Traralgon Victoria) into MS Excel spreadsheets. The data were checked for errors and non-diagnostic testing excluded from further analysis.

Statistical analysis

Categorical variables were compared using a Chi-squared analysis.

Results

N. gonorrhoeae

Overall, 7,007 specimens from 4,324 patents were tested by PCR and 4,016 specimens from 2,305 patients were tested by culture. The test and patient numbers by test type and sex are shown in Tables 1 and 2. Overall, there were more than three times as many men as women tested. When test figures were combined, culture showed a crude positive rate of 5.3 per cent compared with PCR at 3.3 per cent. Some patients had multiple episodes of infection and/or infection at multiple sites.

Specialist clinics diagnose a high proportion of the gonorrhoea cases in Victoria. Of the 214 specimens positive by culture and 229 positive by PCR, only 2 and 22 specimens respectively, were referred from sources other than inner Melbourne clinics with a known high MSM patient load.

Only five specimens from three women were found to be positive for *N. gonorrhoeae* over the period. Of the three women with gonorrhoea, one specimen was referred via a private pathology service, while the other two women, both with positive vaginal and throat swabs, were referred from a specialist STI clinic.

Table 1. Tests for the detection of *Neisseria gonorrhoeae,* 1 January 2001 to 31 August 2002

Test method	Requests				Positive tests			% +ve
	n	M	F	U*	n	M	F	
PCR	7,007	5,338	1,666	3	229	224	5	3.3
Culture	4,016	3,128	888	0	214	214	0	5.3
Total tests	11,023	8,466	2,554	3	443	438	5	4.0

* Sex unknown; n = Total number tested; +ve = positive; –ve = negative.

Table 2. Patient numbers tested for *Neisseria gonorrhoeae,* 1 January 2001 to 31 August 2002

Test method	Number of patients tested				Positive patients†			+ve %
	n	M	F	U*	n	M	F	
PCR	4,324	3,242	1,079	3	197	194	3	4.6
Culture	2,305	1,774	531	0	186	186	0	8.1
Total	5,085	3,826	1,256	3	275	272	3	5.4

* Sex unknown.

† Patients may have one or more positive results during the study period.

The initial Amplicor positive rate and subsequent *N. gonorrhoeae* confirmation rate are examined by specimen type and site in Table 3. The rate of confirmation varied significantly with specimen types ($p<10^{-7}$), with penile/urethral swabs confirmed as positive in 86.2 per cent of tests, compared with oropharyngeal swab confirmation rates of 5.6 per cent. Ano-rectal swabs confirmed positive in 20 per cent of cases. The confirmation rate of cervico-vaginal specimens (5.7%) was low, however this may be a reflection of the low rates of gonorrhoea in women (3 out of 1,256 patients tested, 0.24%) in our patient population compared with the male patients (272 out of 1,256 patients tested, 7.1%).

C. trachomatis

Results for *C. trachomatis* detection by Amplicor PCR are shown in Table 4. Of note is the rate of detection of *C. trachomatis* in ano-rectal specimens (8%), a site that was difficult to examine by *C. trachomatis* culture or direct immunofluorescence prior to the availability of PCR testing. Carriage of *C. trachomatis* at oropharyngeal sites is relatively uncommon in comparison (2.3%). Of those tests positive for *N. gonorrhoeae* by PCR (n=229), 26 (including one vaginal swab) were also simultaneously positive for *C. trachomatis*. *Chlamydia trachomatis* PCR was not requested on 15 specimens positive for *N. gonorrhoeae*.

Table 3. Amplicor CT/NG *N. gonorrhoeae* PCR detection and confirmation rate by site

Specimen type	n	All Amplicor CT/NG initial +ve	Amplicor CT/NG +ve/ confirmatory assay +ve	Amplicor CT/NG +ve/ confirmatory assay –ve	Amplicor CT/NG inhibited (No result)	Amplicor CT/NG –ve	Amplicor CT/NG initial +ve confirmed %	Specimens confirmed positive %
Urine	4,490	164	105	59	1	4,325	64.0	2.3
Penile/urethral swab	302	65	56	9	0	237	86.2	18.5
Ano-rectal swab	1,030	200	40	160	3	827	20.0	3.9
Cervical/ vaginal swab	441	35	2	33	2	404	5.7	0.5
Oropharyngeal swab	716	447	25	422	0	269	5.6	3.5
Other site*	28	2	1	1	0	26	50.0	3.6
Total	7,007	913	229	684	6	6,088	25.1	3.3

* Includes eye, iud, body fluids, and site not stated.

Table 4. Amplicor CT/NG *C. trachomatis* PCR detection rates by site and sex

Specimen type	Total* n	Amplicor +ve total	Amplicor –ve total	Positive (all) %	Male n	+ve male specimens	male specimens +ve %	Female n	+ve female specimens	Female specimens +ve %
Urine	3,521	184	3,337	5.2	2,733	145	5.3	787	39	5.0
Penile/urethral swab	286	32	254	11.2	278	32	11.5	8	0	0.0
Ano-rectal swab	1,028	82	946	8.0	1,010	81	8.0	18	1	5.6
Cervical/ vaginal swab	401	14	387	3.5	–	–	–	401	14	3.5
Oropharyngeal swab	708	16	692	2.3	602	16	2.7	106	0	0.0
Other†	25	2	23	8.0	19	2	10.5	6	0	0.0
Total	5,969	330	5,639	5.5	4,642	276	5.9	1,326	54	3.9

* CT PCR was not requested on 1,038 specimens. sex not determined for one negative urine specimen.

† Includes eye, iud, body fluids, and site not stated.

Correlation of *Neisseria gonorrhoeae* PCR and culture results

Culture was performed in parallel on 1,234 specimens tested by PCR. Results by specimen type are shown in Table 5. Of the 17 specimens culture positive but negative by PCR, 12 were initially positive by Amplicor PCR but failed to confirm on the secondary PCR. Overall, there was 98.1 per cent agreement between the confirmed PCR assay and culture, with confirmed PCR showing a sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of 81.7 per cent, 99.5 per cent, 92.7 per cent and 98.5 per cent respectively compared with *N. gonorrhoeae* culture.

In 146 cases, VIDRL received a urine specimen for PCR testing and a urethral swab for culture collected from the same patient on the same day. There was again excellent correlation between the two methods (99.3% agreement), with only one culture positive, Amplicor positive, but cppB PCR negative discrepant result. This gave confirmed PCR a sensitivity, specificity, PPV and NPV of 97.5 per cent, 100 per cent, 100 per cent and 99.1 per cent respectively, compared with culture.

When confirmed CT/NG PCR assay performance was analysed against culture using only FDA-listed specimens (553 penile/urethral swabs, urines and cervical/vaginal swabs), sensitivity, specificity, PPV and NPV and per cent agreement were 96.7 per cent, 99.8 per cent, 98.9 per cent, 99.4 per cent and 99.3 per cent respectively.

This compares with figures of 65.1 per cent, 99.4 per cent, 84.8, 98.1 and 97.6 per cent respectively, for non-FDA listed specimens (827 ano-rectal, oropharyngeal and other specimen types).

Confirmation assay performance

In order to assess if there were differences in performance between the two confirmatory assays used during the study period, the confirmation rates of initial Amplicor positive results were examined for the period of use of each assay. In August 2001, both methods were used in parallel, but only the results from the earlier 16S rRNA assay were used in this analysis (Table 6.) The proportion of specimens tested from sites for which the Amplicor assay has FDA approval was similar for both the 16S rRNA assay (28.6%), and the cppB assay (26.8%). Overall, no significant differences between the confirmation methods were noted (p=0.65). It should be noted that the detection limits for *N. gonorrhoeae* from clinical specimens has not been fully established for either confirmatory assay.

Table 6. *Neisseria gonorrhoeae* PCR confirmation rates by method

	Amplicor CT/NG +ve/ confirmatory assay +ve	Amplicor CT/NG +ve/ confirmatory assay –ve	Total*
16S rRNA	71	223	294
cppB	158	461	619
Total	229	684	913

Table 5. Correlation between culture and PCR results by site

Specimen type	n	Culture +ve, PCR +ve	PCR +ve, culture –ve	Culture +ve PCR –ve	Culture +ve PCR –ve initial Amplicor CT/NG result		PCR –ve Culture –ve
					–ve	+ve*	
Penile/urethral swab	216	48	1	2	1	1	165
Ano-rectal swab	491	22	1	13	3	10	455
Cervical/vaginal swab	191	0	0	0	0	0	191
Oropharyngeal swab	328	5	4	2	1	1	317
Other†	8	1	0	0	0	0	7
Total identical specimens	1,234	76	6	17	5	12	1,135
Paired urine PCR/ urethral swab culture	146	39	0	1	0	1	106

* Initial Amplicor CT/NG positive result that failed to confirm on supplementary assay.

† Includes eye, iud, body fluids, and site not stated.

Discussion

In this study culture displayed both higher sensitivity and higher crude positive rate than PCR for the detection of *N. gonorrhoeae* in contrast to previously published studies using the Amplicor assay and a confirmatory *N. gonorrhoeae* PCR.[4] However, it should be noted that confirmed PCR performed well in comparison with culture on genital specimens listed for testing in the CT/NG assay by the FDA.

There are likely to be a combination of factors influencing these findings. The apparent lower sensitivity of confirmed PCR compared with culture on paired specimens may be due to lower sensitivity of the confirmatory assays for the detection of low numbers of organisms. This is suggested by the fact that 13 of 18 identical or related specimens that were culture positive but confirmatory assay negative, were positive on the initial Amplicor PCR. The lower sensitivity of various confirmatory assays compared with Amplicor has been previously reported by a number of authors.[15,17] It has been noted that some rare *N. gonorrhoeae* strains lack multiple copies of the cppB gene, effectively reducing the sensitivity of the cppB gene PCR assay.[16]

Competitive inhibition in the multiplex PCR assay due to reagent limitation has been suggested as a reason for false-negative CT/NG PCR results, especially in specimens positive for both *C. trachomatis* and *N. gonorrhoeae*.[17] This prompted a review of the raw data printouts from the five *C. trachomatis/ N. gonorrhoeae* PCR–negative, culture-positive specimens, however, partial assay inhibition was identified as a potential problem in only one case.

The effect of specimen transport, the transport media used and the storage and handling of extracted specimens following analysis on the Cobas machine may also play a part and deserves further investigation.[11]

The low confirmation rate of cervico/vaginal specimens (5.7%) is probably a reflection of the low rates of gonorrhoea in women in our patient catchment compared with that seen in the MSM population. These findings are similar to those of Diemert, *et al* who studied the use of the Amplicor and 16S rRNA confirmatory assay in a Canadian population with a low prevalence of gonorrhoea in women.[12]

The confirmation rates for ano-rectal initial Amplicor positives was 20 per cent, with a positive rate of 3.9 per cent of specimens tested. Interestingly, the CT/NG assay revealed a rate of *C. trachomatis* carriage of 8 per cent in ano-rectal specimens; a site not traditionally associated with *C. trachomatis* infection. For this reason, we believe testing for *Neisseria gonorrhoeae* at this site by PCR should be considered in sexually active MSM populations despite the low *N. gonorrhoeae* PCR confirmation rate.

The overall higher detection rate seen with gonorrhoea culture may reflect a sampling bias by doctors working in clinics with high caseloads of symptomatic patients. In this scenario, culture is often requested in the expectation of obtaining a positive result with subsequent drug susceptibility details. A sampling bias is also suggested by the higher overall *N. gonorrhoeae* PCR detection rates noted for urethral swabs (18.5%) as compared with urine specimens submitted (2.3%) (Table 3). However, paired urine PCR and urethral swab culture results from the same, predominantly male patients showed a high degree of concordance (Table 5).

Although not subjected to a rigorous parallel comparison, the two different confirmatory assays appear to have little difference in performance when confirmation rates were compared. A recent study by Palmer, *et al*[9] identified an unusual British proline-arginine- and uracil-requiring *N. gonorrhoeae* auxotype that failed to be detected by a cppB PCR, but to the best of our knowledge, strains of this type are rare in Australia. The authors also found that no single PCR target was completely sensitive or specific for *N. gonorrhoeae* and that given the promiscuous genetic recombination that occurs within the genus,[18] any positive PCR results obtained on extra-genital specimens should be confirmed by an assay that uses a different genetic target.[9]

We believe the above data can assist in optimising the use of the available diagnostic tests for *Neisseria gonorrhoeae* and *C. trachomatis*, and that the testing strategy adopted by the laboratory should be appropriate to the patient population tested.

In a highly sexually active MSM population we believe it is appropriate to test both ano-rectal swabs and either a urine specimen or urethral swab by CT/NG PCR. We would recommend against routinely testing throat swabs by CT/NG PCR. Culture is more appropriate at this site, and will also detect other pathogens such as *Streptococcus pyogenes* that are commonly isolated in this population (data not shown). Although *C. trachomatis* may be carried at this site, it is relatively uncommon and many clinicians automatically treat for non-gonococcal STIs whenever a diagnosis of gonorrhoea is presumed or proven.

Our data on specimens from women is more limited due to the much lower rates of gonorrhoea in the study population, and the lack of data on parallel testing of urine with other types of female genital specimens. However, other authors have found either endocervical swabs, self-collected vaginal swabs or tampon specimens to be superior to urine specimens for the detection of both *C. trachomatis* and *N. gonorrhoeae* in the CT/NG assay.[1, 8,19] We found little evidence of extra-genital *C. trachomatis* infection in women in our study population, but found *N. gonorrhoeae* in throat swabs of two women who

also had a positive vaginal swab for *N. gonorrhoeae*. This implies that the CT/NG PCR need not be used routinely for testing of extra-genital sites in women, however, PCR testing of ano-rectal swabs in women with a history of exposure or symptoms would seem reasonable. As in the male population, culture is a more appropriate testing procedure for throat swabs.

It should be noted that the current Australian Medicare Benefits schedule will not fund more than one CT/NG PCR assay per patient episode. In a recent study by Donovan, *et al* in Sydney, the impact of this policy was considered as having a negative effect on STI diagnosis and control.[20] This leaves laboratories and clinicians working in practices with high rates of STIs with an ongoing testing dilemma.

Acknowledgments

The authors would like to thank Elise Walker, Roche Diagnostics Australia, and Neville Pattle, Gippsland Pathology Service for their assistance with test development, and Heath Kelly, VIDRL for assistance with statistical analysis.

References

1. Garrow SC, DW Smith, GB Harnett. The diagnosis of chlamydia, gonorrhoea, and trichomonas infections by self obtained low vaginal swabs, in remote northern Australian clinical practice. *Sex Transm Infect* 2002;78:278–281.
2. Tabrizi SN, Paterson B, Fairley CK, Bowden FJ, Garland SM. A self-administered technique for the detection of sexually transmitted diseases in remote communities. *J Infect Dis* 1997;176:289–292.
3. Johnson RE, Newhall WJ, Papp JR, Knapp JS, Black CM, Gift TL, *et al.* Screening tests to detect *Chlamydia trachomatis* and *Neisseria gonorrhoeae* infections – 2002. *MMWR Recomm Rep* 2002;51:1–38.
4. Martin DH, Cammarata C, Van Der Pol B, Jones RB, Quinn TC, Gaydos CA, *et al*. Multicenter evaluation of AMPLICOR and automated COBAS AMPLICOR CT/NG for *Neisseria gonorrhoeae. J Clin Microbiol* 2000;38:3544–3549.
5. Livengood CH 3rd, Wrenn JW. Evaluation of COBAS AMPLICOR (Roche): accuracy in detection of *Chlamydia trachomatis* and *Neisseria gonorrhoeae* by coamplification of endocervical specimens. *J Clin Microbiol* 2001;39:2928–2932.
6. Gaydos CA, Crotchfelt KA, Shah N, Tennant M, Quinn TC, Gaydos JC, *et al.* Evaluation of dry and wet transported intravaginal swabs in detection of *Chlamydia trachomatis* and *Neisseria gonorrhoeae* infections in female soldiers by PCR. *J Clin Microbiol* 2002;40:758–761.
7. Farrell DJ. Evaluation of AMPLICOR *Neisseria gonorrhoeae* PCR using cppB nested PCR and 16S rRNA PCR. *J Clin Microbiol* 1999;37:386–390.
8. Van Der Pol B, Martin DH, Schachter J, Quinn TC, Gaydos CA, Jones RB, *et al.* Enhancing the specificity of the COBAS AMPLICOR CT/NG test for *Neisseria gonorrhoeae* by retesting specimens with equivocal results. *J Clin Microbiol* 2001;39:3092–3098.
9. Palmer HM, Mallinson H, Wood RL, Herring AJ. Evaluation of the specificities of five DNA amplification methods for the detection of *Neisseria gonorrhoeae. J Clin Microbiol* 2003;41:835–837.
10. Knapp JS, Hook EW 3rd. Prevalence and persistence of *Neisseria cinerea* and other *Neisseria* spp. in adults. *J Clin Microbiol* 1988;26:896–900.
11. Van Dyck E, Smet H, Van Damme L, Laga M. Evaluation of the Roche *Neisseria gonorrhoeae* 16S rRNA PCR for confirmation of AMPLICOR PCR-positive samples and comparison of its diagnostic performance according to storage conditions and preparation of endocervical specimens. *J Clin Microbiol* 2001;39:2280–2282.
12. Diemert DJ, Libman MD, Lebel P. Confirmation by 16S rRNA PCR of the COBAS AMPLICOR CT/NG test for diagnosis of *Neisseria gonorrhoeae* Infection in a low-prevalence population. *J Clin Microbiol* 2002;40:4056–4059.
13. Bassiri M, Mardh PA, Domeika M. Multiplex AMPLICOR PCR screening for *Chlamydia trachomatis* and *Neisseria gonorrhoeae* in women attending non-sexually transmitted disease clinics. The European Chlamydia Epidemiology Group. *J Clin Microbiol* 1997;35:2556–2560.
14. Rossau R, Heyndrickx L, Van Heuverswyn H. Nucleotide sequence of a 16S ribosomal RNA gene from *Neisseria gonorrhoeae. Nucleic Acids Res* 1988;16:6227.
15. Whiley DM, LeCornec GM, Mackay IM, Siebert DJ, Sloots TP. A real-time PCR assay for the detection of *Neisseria gonorrhoeae* by LightCycler. *Diagn Microbiol Infect Dis* 2002;42:85–89.
16. Hagblom P, Korch C, Jonsson AB, Normark S. Intragenic variation by site-specific recombination in the cryptic plasmid of *Neisseria gonorrhoeae. J Bacteriol* 1986;167:231–237.
17. Hamilton MS, Otto M, Nickell A, Abel D, Ballam Y, Schremmer R. High frequency of competitive inhibition in the Roche Cobas AMPLICOR multiplex PCR for *Chlamydia trachomatis* and *Neisseria gonorrhoeae*. *J Clin Microbiol* 2002;40:4393.
18. Kroll JS, Wilks KE, Farrant JL, Langford PR. Natural genetic exchange between *Haemophilus* and *Neisseria*: intergeneric transfer of chromosomal genes between major human pathogens. *Proc Natl Acad Sci U S A* 1998;95:12381–12385.
19. Tabrizi SN, Paterson BA, Fairley CK, Bowden FJ, Garland SM. Comparison of tampon and urine as self-administered methods of specimen collection in the detection of *Chlamydia trachomatis, Neisseria gonorrhoeae* and *Trichomonas vaginalis* in women. *Int J STD AIDS* 1998;9:347–349.
20. Donovan B, Knight V, McNulty AM, Wynne-Markham V, Kidd MR. *Gonorrhoea* screening in general practice: perceived barriers and strategies to improve screening rates. *Med J Aust* 2001;175:412–414.

An outbreak of *Campylobacter jejuni* infection among conference delegates

Jane C A Raupach,[1] Rebecca L Hundy[2]

Abstract

***Campylobacter* infection is one of the most commonly reported foodborne diseases in Australia however, reported *Campylobacter* outbreaks are rare. This report describes such an outbreak among delegates attending a 10 day international academic meeting in South Australia during May 2001. A retrospective cohort study of the 29 delegates who attended the conference was conducted. A questionnaire was sent by email with a response rate of 93 per cent. Ten cases (onset of diarrhoea while attending the conference) were identified. Two were culture positive for *Campylobacter jejuni*. There was a significant association between the illness and eating a number of food items from two restaurants however, environmental investigation of the two venues did not identify a definitive source for the outbreak. This investigation demonstrates the usefulness of email in the distribution of questionnaires among specific cohorts. *Commun Dis Intell* 2003;27:380–383.**

Keywords: campylobacteriosis, Campylobacter jejuni, *disease outbreak*

Introduction

Campylobacter infection is one of the most commonly reported foodborne diseases in Australia and overseas. The majority of cases are reported to be sporadic, with outbreaks rarely detected.[1,2,3] Factors contributing to the relative infrequency of *Campylobacter* outbreaks have been discussed elsewhere and include the nature of the organism and its epidemiology, lack of follow-up of *campylobacter* infections and lack of detailed strain characterisation.[4] Reported outbreaks have been associated with a point source such as contaminated drinking water, raw milk and chicken.[5–11] This article describes the epidemiological, microbiological and environmental investigation of an outbreak of *Campylobacter jejuni* among delegates attending an international meeting in South Australia during May 2001.

Methods

On 18 May 2001, the Communicable Disease Control Branch of the South Australian Department of Human Services received notification of several cases of gastrointestinal illness among delegates attending an international academic meeting at a large hotel in metropolitan Adelaide. Thirty delegates attended the meeting between 9 and 18 May 2001. Of these, 29 delegates (13 international and 16 interstate visitors) were staying at the hotel. The 13 international delegates were from 10 different countries on five continents (Australia, Asia, North America, Africa and Europe).

Hypothesis-generating interviews were conducted with seven known cases, prior to their departure on the evening of 18 May. Cases were also requested to provide a faecal specimen for testing, prior to their departure. From the hypothesis-generating interviews seven different premises were identified where cases had consumed food at the meeting and prior to illness onset (between 9 and 13 May). Frequency of attendance at these premises indicated that apart from the conference hotel, only three venues were common amongst all seven cases interviewed. These were a bakery, a regional restaurant and a metropolitan Chinese restaurant. On 12 May a group of delegates attended a day tour of local wineries. During the winery tour, morning tea was provided at a bakery and lunch (with a choice of kangaroo fillet or baked chicken fillet) was provided at a regional restaurant. On the evening of 12 May most delegates from the winery tour shared an evening banquet meal of 11 dishes at a Chinese restaurant in metropolitan Adelaide.

1. Medical Epidemiologist, Communicable Disease Control Branch, Department of Human Services, South Australia
2. Master of Applied Epidemiology Scholar, National Centre for Epidemiology and Population Health, Australian National University, Canberra, Australian Capital Territory

Corresponding author: Dr Jane Raupach, Medical Epidemiologist, Communicable Disease Control Branch, Department of Human Services, PO Box 6, Rundle Mall SA 5000. Telephone: +61 8 8226 7248. Facsimile: +61 8 8226 7187.
Email: jane.raupach@dhs.sa.gov.au

A retrospective cohort study was undertaken using email to distribute the questionnaires. The cohort was defined as persons who attended the conference between 9 and 18 May with a date of arrival between 9 May and 13 May. One delegate did not arrive until 14 May and so was excluded from the cohort. A case was defined as a person who had onset of diarrhoea while attending the conference between 9 and 18 May. A cohort study was selected because the conference delegates represented a well-defined population, and contact details for all individuals including phone numbers and email addresses were readily available.

A questionnaire was developed and included items about attendance at the winery tour, the Chinese restaurant, and exposure to menu foods at these venues. The questionnaire was sent to 27 delegates from 10 different countries by email as a word attachment. Respondents were asked to return the questionnaire either by fax or email and a reminder email was sent after five days. Two other delegates were interviewed in person: an overseas resident who was hospitalised in South Australia and a local South Australian resident. Data were entered and analysed using Epi Info Version 6.0 statistical software.

A search of the South Australian Notifiable Diseases Database was conducted for additional *Campylobacter jejuni* cases that were potentially related to the same source but not associated with the meeting delegates. This search aimed to identify notified cases that indicated eating at a Chinese restaurant or at a winery prior to their illness.

Results

Cohort study

Twenty-seven responses to the questionnaire were received with a final response rate of 93 per cent. Fifteen (56%) of the 27 responses were returned via email, 10 (37%) were returned via fax and two (7%) were face to face interviews. The median age of respondents was 46 years (range 29–72 years) and 23 (85%) were male.

Ten cases were identified among the cohort of 29 delegates. The median age of cases was 50 years (range 37–72 years) and 9 (90%) cases were male. Onset of nine cases occurred over a three day period between 13 and 15 May (Figure). A further case had an onset of 17 May 2001. Other symptoms, apart from diarrhoea, included abdominal pain (seven cases), fever/chills (four cases), headache (four cases), nausea (four cases) and vomiting (one case). Duration of the illness (where known) ranged from one to seven days, with a mean of four days. One case was hospitalised for six days.

Thirteen respondents had attended the winery tour and 11 respondents had attended the Chinese restaurant. All 11 had also attended the winery tour. Risk ratio (RR) for attendance at the Chinese banquet was 13.1 (95% confidence interval (CI) 1.9–89.1) and for the winery tour was 9.7 (95% CI 1.4–66.3). Attack rates among those attending the Chinese restaurant and those attending the winery tour were 81 per cent and 69 per cent respectively (Table).

Dishes at the Chinese restaurant with the highest risk ratios (RR) were: spring rolls, fried chicken and fried rice, RR = 13.1 (95% CI 1.9–89.1) with an attack rate of 82 per cent, followed by sizzling prawns, smoked duck, and vegetable dishes with RR of 6.8 (95% CI 1.8–25.9) and an attack rate of 80 per cent. Two respondents noted that the sizzling prawns were undercooked and another observed that the smoked duck was pink.

For food on the winery tour, the highest risk ratio was for the kangaroo, RR = 11.3 (95%CI 1.1.7–76.9) followed by vegetables, RR = 9.7 (95%CI 1.4–66.3). The attack rates for the kangaroo and vegetables were 75 per cent and 69 per cent respectively. No delegate reported eating chicken breast on the winery tour. The risk ratio for one other restaurant was lower and not statistically significant. A further restaurant was attended by all cases on 10 May but the attack rate was much lower (48%).

No additional *Campylobacter jejuni* cases linked to a winery or Chinese restaurant were identified through a search of the South Australian Notifiable Diseases Database between January and March 2001.

Microbiological investigation

Faecal specimens were obtained from three cases. Two were positive for *Campylobacter jejuni* on culture and of these, one specimen also showed large numbers of *Blastocystis hominis* on microscopy.

Figure. Cases of diarrhoeal illness among conference delegates, Adelaide, 9 to 13 May 2001, by date and time of onset

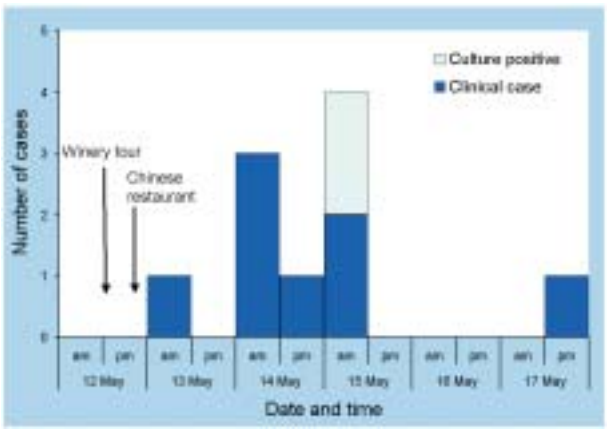


Table. Attendance at the winery and Chinese restaurant, and exposure to specific foods eaten, by attack rates and relative risk

Exposure	Exposed		Attack rate (% exposed)	Not exposed		Attack rate (% not exposed)	Relative risk	95% confidence Interval
	Ill	Total		Ill	Total			
Attended winery tour	9	13	69.0	1	14	7.1	9.7	1.4–66.3
Bee sting (morning tea)	8	11	73.0	2	16	13.0	5.8	1.5–22.4
Kangaroo fillet	9	12	75.0	1	15	6.7	11.3	1.7–76.9
Vegetables	9	13	69.0	1	14	7.1	9.7	1.4–66.3
Date pudding	6	8	75.0	4	19	21.0	3.6	1.4–9.3
Water	6	9	67.0	4	18	22.0	3.0	1.1–8.0
Cream	3	4	75.0	7	23	30.0	2.5	1.1–5.7
Caramel sauce	5	8	62.5	5	19	26.0	2.4	0.9–6.0
Chicken	0	1	0.0	10	26	38.0	0.0	undefined
Attended Chinese restaurant	9	11	82.0	1	16	6.3	13.1	1.9–89.1
Spring rolls	9	11	82.0	1	16	6.3	13.1	1.9–89.1
Chicken	9	11	82.0	1	16	6.3	13.1	1.9–89.1
Fried rice	9	11	82.0	1	16	6.3	13.1	1.9–89.1
Sizzling prawns	8	10	80.0	2	17	12.0	6.8	1.8–25.9
Smoked duck	8	10	80.0	2	17	12.0	6.8	1.8–25.9
Vegetables	8	10	80.0	2	17	12.0	6.8	1.8–25.9
Dim sim	7	9	78.0	3	18	17.0	4.7	1.6–13.9
Satay beef	7	9	78.0	3	18	17.0	4.7	1.6–13.9
Seafood soup	7	9	78.0	3	18	17.0	4.7	1.6–13.9
Sweet and sour sauce	7	9	78.0	3	18	17.0	4.7	1.6–13.9
Beef with lemon grass	6	8	75.0	4	19	21.0	3.6	1.4–9.3
Fried ice cream	6	8	75.0	4	19	21.0	3.6	1.4–9.3

Environmental investigation

An environmental investigation of the Chinese restaurant was conducted by the local environmental health officer. Problems with food handling were detected. A mop and bucket were stored in the hand basin and there was no hand towel or soap. Frozen meats were thawed in the sink overnight and foods including meat were kept uncovered on the cool room floor. All food on the banquet menu at the Chinese restaurant was prepared in the wok. Environmental investigation of the winery restaurant did not identify any problems with food handling or storage. No food or other microbiological specimens were obtained from either of the premises.

Discussion

Only a small number of *Campylobacter* outbreaks have been recognised in South Australia over the past 5 years and most reports of *Campylobacter* infection in South Australia appear sporadic. In 2000, 1,883 notifications of *Campylobacter* infection were received but only nine notifications were attributed to a single outbreak. This outbreak was associated with the consumption of raw milk purchased from a dairy.[12]

Chicken and other poultry are common vehicles for *Campylobacter* and are often associated with infection in humans.[4,13] Recognised outbreaks are frequently related to the handling and consumption of chicken and to cross contamination and poor food handling practices.[1,11,14] Other *Campylobacter* outbreaks have been associated with the consumption of cucumber, tuna salad, gravy, and pineapple, all consumed on commercial premises. All of these are unusual vehicles for *Campylobacter* and all of these outbreaks were attributed to cross contamination or poor food handling practices in the kitchen.[2,15,16]

In this outbreak of *Campylobacter jejuni* among people attending an international academic meeting in Adelaide, a definitive source could not be determined. The most likely source was one of the banquet dishes served at the Chinese restaurant, in view of the high risk ratios combined with high attack

rates for several banquet food items. Delegates eating at the restaurant noted that undercooked meat was served and a subsequent environmental inspection revealed inadequate food handling practices. The highest risk ratios were for the chicken dish, as well as spring rolls and fried rice at the Chinese restaurant. As poultry are a natural reservoir for *Campylobacter jejuni*, chicken or duck may have been a possible source. In addition, cross contamination of several banquet dishes may have occurred. Another possible source was the kangaroo meat served on the winery tour. However environmental inspection of the winery restaurant did not identify any inadequacies.

The protozoan *Blastocystis hominis* was detected on faecal microscopy from a culture positive *Campylobacter* case, who was a resident of northern Australia. While *Blastocystis hominis* may occasionally cause gastrointestinal symptoms, it has limited pathogenicity and is common in asymptomatic patients.[17] The presence of *Blastocystis hominis* in the faeces of a patient with gastrointestinal symptoms does not necessarily signify that it is the cause. It is considered unlikely that *Blastocystis hominis* contributed to this outbreak.

A limitation of the investigation was the high level of exposure by cases to a limited menu of food items. This resulted in a number of food items with similar and high relative risks for illness. While a quantitative (dose-response) analysis can sometimes be helpful in these circumstances, it could not be used in this investigation.

Finally this investigation was conducted using email as the main method for distribution of questionnaires. This method was chosen as a feasible means of contacting a group of professional people, who were from three continents with varying time zones, over a short period. The response rate of 93 per cent indicated a high level of acceptance of survey administration by email among a cohort of delegates attending an international academic conference.

Acknowledgements

We are grateful to Dr Robert Hall of the Communicable Disease Control Branch, Department of Human Services, South Australia for providing valuable advice and to Drs Scott Cameron and Mary Beers of the National Centre for Epidemiology and Population Health National Centre for helpful comments on earlier drafts.

References

1. Pebody RG, Ryan MJ, Wall PG. Outbreaks of *Campylobacter* infection: rare events for a common pathogen. *Commun Dis Rep CDR Rev* 1997;7:R33–R37.
2. Kirk M, Waddell R, Dalton C, Creaser A, Rose N. A prolonged outbreak of *Campylobacter* infection at a training facility. *Commun Dis Intell* 1997;21:57–61.
3. Crerar SK, Dalton CB, Longbottom HM, Kraa E. Foodborne disease: current trends and future surveillance needs in Australia. *Med J Aust* 1996;165:672–675.
4. Frost JA, Gillespie IA, O'Brien SJ. Public health implications of *Campylobacter* outbreaks in England and Wales, 1995–99: epidemiological and microbiological investigations. *Epidemiol Infect* 2002,128:111–118.
5. Maurer AM, Sturchler D. A waterborne outbreak of small round structured virus, *Campylobacter* and *Shigella* co-infections in La Neuveville, Switzerland, 1998. *Epidemiol Infect* 2000;125:325–332.
6. Merritt A, Miles R, Bates J. An outbreak of *Campylobacter enteritis* on an island resort, north Queensland. *Commun Dis Intell* 1999;23:215–219.
7. Miettinen IT, Zacheus O, von Bonsdorff CH, Vartiainen T. Waterborne epidemics in Finland in 1998–1999. *Water Sci Technol* 2001;43:67–71.
8. Evans MR, Roberts RJ, Ribeiro CD, Gardner D, Kembrey D. A milk-borne *Campylobacter* outbreak following an educational farm visit. *Epidemiol Infect* 1996;117:457–462.
9. Kalman M, Szollosi E, Czermann B, Zimanyi M, Szekeres S. Milkborne *Campylobacter* infection in Hungary. *J Food Prot* 2000;63:1426–1429.
10. Pearson AD, Greenwood MH, Donaldson J, Healing TD, Jones DM, Shahmat M, *et al*. Continuous source outbreak of campylobacteriosis traced to chicken. *J Food Prot* 2000;63:309–314.
11. Evans MR, Lane W, Frost JA, Nylen G. A *Campylobacter* outbreak associated with stir-fried food. *Epidemiol Infect* 1998;121:275–279.
12. Communicable Disease Control Branch, Department of Human Services, South Australia. Unpublished data. 2001.
13. Studahl A, Andersson Y. Risk factors for indigenous *Campylobacter* infections: a Swedish case-control study. *Epidemiol Infect* 2000;125:269–275.
14. Gent RN, Telford DR, Syed Q. An outbreak of *Campylobacter* food poisoning at a university campus. *Commun Dis Public Health* 1999;2:39–42.
15. Roels TH, Wickus B, Bostrom HH, Kazmierczak JJ, Nicholson MA, Kurzynski TA, *et al*. A foodborne outbreak of *Campylobacter jejuni* (O:33) infection associated with a tuna salad: a rare strain in an unusual vehicle. *Epidemiol Infect* 1998;121:281–287.
16. Olsen SJ, Hansen GR, Bartlett L, Fitzgerald C, Sonder A, Manjrekar R, *et al*. An outbreak of *Campylobacter jejuni* infections associated with food handler contamination: the use of pulsed-field gel electrophoresis. *J Infect Dis* 2001;183:164–167.
17. Stenzel DJ, Boreham PF. Blastocystis hominis revisited. *Clin Microbiol Rev* 1996;9:563–584.

Dengue in north Queensland, 2002

Jeffrey N Hanna,[1] Scott A Ritchie,[1] Susan L Hills[2,3] Alyssa T Pyke,[4] Brian L Montgomery,[1] Ann R Richards,[1] John P Piispanen[2]

Abstract

In 2002 three separate outbreaks of dengue were detected in north Queensland, including the first documented outbreak of dengue 4 in Australia. Molecular analyses identified Thailand and Indonesia as the likely origin of two of the outbreaks. Investigations during 2002 also included a suspected dengue outbreak in the Torres Strait which proved to be a false alarm, and a number of imported cases of dengue in north Queensland. *Commun Dis Intell* 2003;27:384–389.

Keywords: Aedes aegypti*, dengue, disease outbreak, north Queensland*

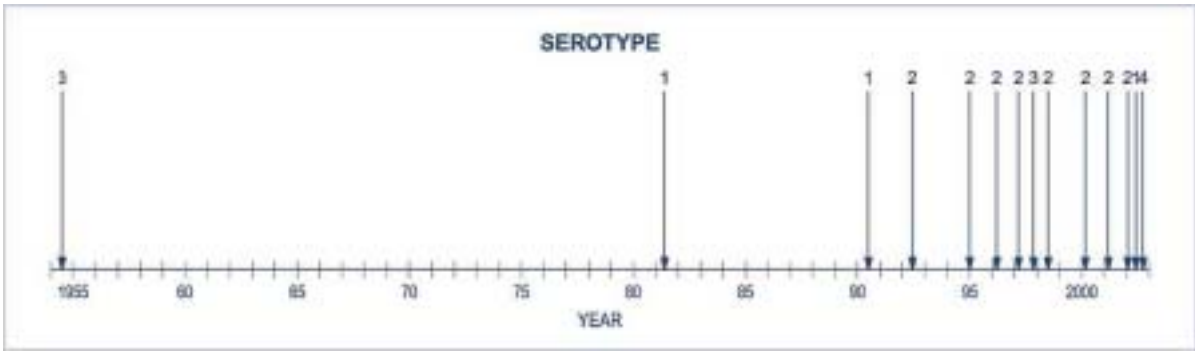
Introduction

Because the principal vector of dengue, the mosquito *Aedes aegypti*, occurs throughout much of north Queensland, the region is susceptible to outbreaks of the disease. Indeed, in keeping with global trends,[1] the frequency of outbreaks in north Queensland has increased markedly over the past decade (Figure 1). This report documents the dengue activity that occurred in the region in 2002, with brief descriptions of the responses that were undertaken.

Methods

The laboratory methods and control measures have been described elsewhere.[3,4] Briefly, an outbreak is defined by the recognition of a single confirmed locally-acquired case of dengue in north Queensland. A case was confirmed by either virus isolation, or polymerase chain reaction (PCR), or by haemagglutination inhibition assay (HAI). Any person with a compatible illness and a dengue IgM positive result by enzyme immunoassay (EIA) was also considered to be a confirmed case, provided there was an epidemiological link to another confirmed case.

Figure 1. Dengue outbreaks in north Queensland over the past 50 years



The serotype involved in each outbreak is shown above each arrow.

Reproduced and modified with the kind permission of the Medical Journal of Australia.[2]

1. Tropical Public Health Unit Network, Queensland Health, Cairns, Queensland
2. Tropical Public Health Unit Network, Queensland Health, Aitkenvale, Queensland
3. Senior Project Officer, Australian International Health Institute (University of Melbourne) and Children's Vaccine Program at PATH, Hanoi, Vietnam
4. Public Health Virology, Queensland Health Scientific Services, Coopers Plains, Queensland

Corresponding author: Dr J Hanna, Tropical Public Health Unit, PO Box 1103, CAIRNS QLD 4870. Telephone: +61 7 4050 3604. Facsimile: +61 7 4031 1440. Jeffrey_hanna@health.qld.gov.au

Nucleotide sequencing and phylogenetic analyses were performed on sequence information of a 189 nucleotide region, and a 1,045 nucleotide region, of the envelope (E) genes of the dengue 2 and dengue 4 viruses respectively. Phylogenetic trees were constructed using modifications of EclustalW,[5] DnaDist[6] and the neighbour-joining method.[7] Trees were rooted using a dengue 1 virus sequence[8] and drawn using TreeView software[9] with bootstrap analyses of 1,000 replicates.

Premises within 200 m of each case's home or workplace were surveyed for breeding sites of *Ae. aegypti* and, where necessary, either elimination of breeding sites or larviciding was implemented. Particular attention was paid to locate cryptic breeding sites such as roof gutters.[10] Breteau Indices (the number of containers breeding *Ae. aegypti* per 100 premises) were calculated; an Index of 5 is considered the hypothetical lower limit, whereas an Index over 50 is considered high-risk for dengue transmission.[3]

Interior spraying with residual adulticides was undertaken, with consent, in premises within 100 m of each case.[11] Particular attention was paid to possible 'dissemination' premises: those that may act as sources for the rapid dispersal of dengue throughout a community.[3]

Results

Outbreaks

Kuranda dengue 2 outbreak

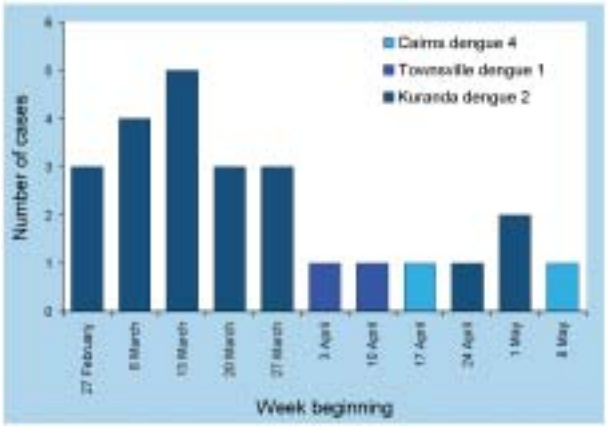
In early March 2002, the Tropical Public Health Unit (TPHU) was notified of an adult male resident of Kuranda, a rainforest village 20 km north-west of Cairns, with a dengue IgM and IgG positive EIA. The patient had not recently travelled away from Kuranda, and he did not have a typical dengue clinical illness. Because the TPHU had followed up several false-positive dengue IgM results around that time, it was decided to await confirmatory tests before implementing mosquito control measures. Although further tests did not confirm the diagnosis in the index case, an adult female resident of Kuranda also with a dengue IgM and IgG positive EIA was subsequently notified to the TPHU in mid-March. This patient also had not travelled, but she had a dengue-compatible illness, and worked in a local hotel where several other staff had a similar illness.

At this point it was considered that there was almost certainly an outbreak of dengue in Kuranda. This concern was heightened when mosquito surveys at the hotel revealed intense *Ae. aegypti* breeding, particularly in long pot plant boxes along the walls of the open-plan establishment. Larviciding (using s-methoprene pellets) and interior spraying (using the synthetic pyrethroid lambda-cyhalothrin) were undertaken at the hotel. Dengue was eventually confirmed in four other hotel staff, with dengue 2 being identified by PCR and/or isolation in two of the cases.

The mosquito surveillance and control measures were extended beyond the hotel. Local residents were informed by mail of the probable situation and of personal mosquito precautions and measures to reduce *Ae. aegypti* breeding in the home and at the place of work. These activities, together with media reporting of the outbreak, led to the recognition of other suspect cases in, and nearby, Kuranda.

Altogether there were 21 confirmed cases of dengue, with dengue 2 being identified in three, in the outbreak that lasted for 10 weeks (Figure 2). Eighteen of the cases occurred in the first five weeks; all of these were either staff or patrons of the hotel (8 cases), or people who either worked or lived close to the hotel (10 cases). There were no cases recognised over the next three weeks, but then the remaining three cases, all associated with the same residence in a street not far from the hotel, occurred in weeks nine and ten. A total of 172 premises were surveyed for mosquitoes in Kuranda, 14 (8%) of which had *Ae. aegypti* breeding in containers on site (Breteau Index = 11).

Figure 2. Epidemic curve of dengue outbreaks in north Queensland, 2002

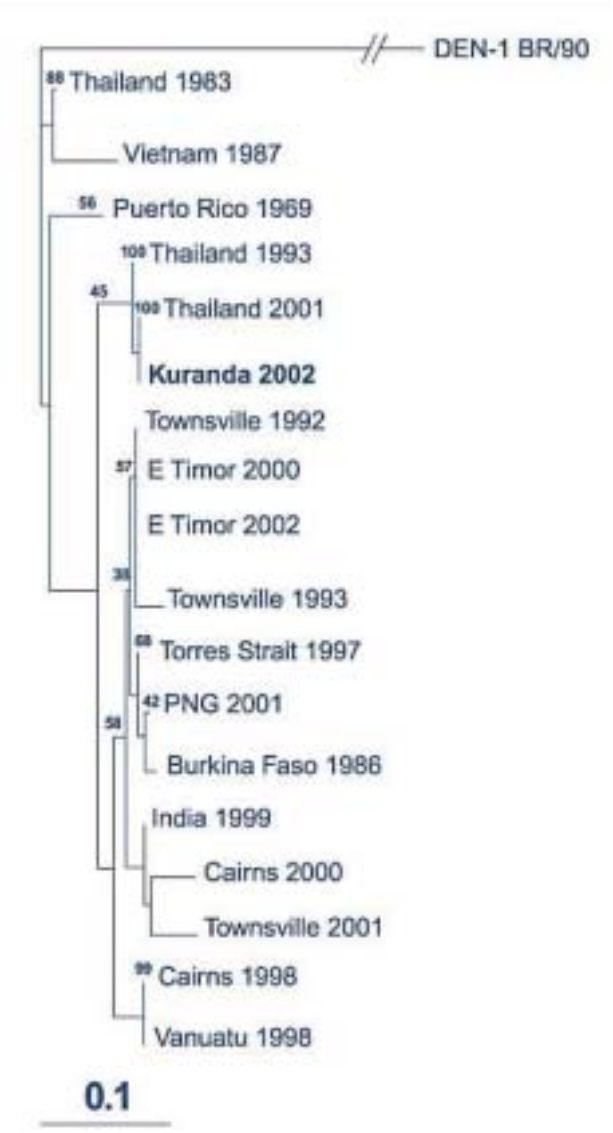


Because there had been a recent importation of dengue 2 from East Timor into north Queensland (Table), there was initial speculation that the Kuranda outbreak may have been initiated by a traveller recently arrived from that country. However, the molecular analysis of the dengue virus E gene indicated that this was very unlikely, and that it was much more probable that the dengue 2 virus had been imported from Thailand (Figure 3).

Townsville dengue 1 outbreak

In mid-April 2002, the TPHU was notified of an adult male, who lived on acreage approximately 40 km south of Townsville, with a dengue IgM and IgG positive EIA. He had had a typical, but mild, dengue-like illness, and had not recently travelled either overseas or to Kuranda. He had made a single afternoon trip to Townsville during his exposure period when he had visited a residential address in the suburb of Railway Estate. A week later dengue was confirmed by HAI, with dengue 1 being implicated as the infecting virus. Further enquiries revealed that an adult female who resided at the address in Railway Estate had had a mild febrile illness with rash in early April. Her illness was subsequently confirmed as dengue.

Figure 3. Phylogenetic relationships of the Kuranda 2002 dengue 2 virus isolate to other selected dengue 2 viruses, predicted from a 189 nucleotide region of the envelope (E) gene



The trees were rooted using a dengue 1 (DEN–1 BR/90) virus sequence (8) as an outgroup; the scale indicates the number of nucleotide substitutions per site and horizontal branch lengths are proportional genetic distance. The number above the branches indicates bootstrap confidence levels for 1,000 replicates.

Recognition of the outbreak was of particular concern as it was in Railway Estate that an outbreak of dengue 2 in Townsville commenced in 1992.[12] There were, therefore, many residents previously infected with dengue 2 virus who had a potentially increased risk of severe dengue should they acquire a second infection with a different serotype.[1] Case surveillance was enhanced through alerts to local general practitioners, notification of laboratories and media announcements; mosquito surveys and control measures were undertaken over a large area. One hundred and thirty-two premises, many of which were unscreened residences, were inspected in Railway Estate and *Ae. aegypti* breeding was found in 13 premises (Breteau Index = 10).

No further cases of dengue fever were identified, and the source of the outbreak remains unknown. No PCR-product or dengue virus was obtained, so molecular analysis was not possible. However, a large outbreak of dengue 1 was occurring in the South Pacific at the time,[13] suggesting that the virus may have been imported from an island nation in the region. Although there was an importation of dengue 1 into Townsville in April (Table), that case did not appear to have any connection with Railway Estate.

Cairns dengue 4 outbreak

In mid-May 2002, the TPHU was notified by Queensland Health Scientific Services (QHSS) that dengue 4 virus had been identified by both PCR and virus isolation in serum from an adult female resident of Smithfield, a northern suburb of Cairns. She had had a clinically compatible illness, but had not travelled away from Cairns in the recent past. Her partner had had a similar illness three weeks previously, about three weeks after returning from Indonesia. This travel history was thought not to be relevant, as the incubation period for dengue is usually less than 10 days.[1]

Since the male partner had consulted a general practitioner at the time of his illness and some blood tests had been done, residual serum was retrieved and forwarded to QHSS. Dengue 4 virus was detected by both PCR and virus isolation. A total of 52 premises were surveyed in Smithfield; 27 (52%) had *Ae. aegypti* breeding in containers on site (Breteau Index = 52). Despite the relatively high Breteau Index, no further cases were recognised in this outbreak.

Molecular analysis of the E gene of the dengue 4 viruses indicated that they were most closely related to other recent isolates acquired in Indonesia in 1998 and in East Timor in 2000 (Figure 4).

Figure 4. Phylogenetic relationships of the two Cairns 2002 dengue 4 virus isolates to other selected dengue 4 viruses, predicted from a 1045 nucleotide region of the E gene

The trees were rooted using a dengue 1 (DEN–1 BR/90) virus sequence (8) as an outgroup; the scale indicates the number of nucleotide substitutions per site and horizontal branch lengths are proportional genetic distance. The number above the branches indicates bootstrap confidence levels for 1,000 replicates.

A false alarm

In mid-June 2002, the TPHU was notified of a strongly reactive dengue IgM positive EIA result in the serum from a 16-year-old resident of Mer, an outer island in the Torres Strait. The youth had had a compatible illness and he had not recently travelled away from the island.

For several reasons it was decided to mount an immediate response to this EIA result before waiting for confirmation of the diagnosis. Mer was the epicentre of a large outbreak of dengue 2 in the Torres Strait in 1996–97,[2] and a mosquito survey earlier in 2002 had revealed intense *Ae. aegypti* breeding (Breteau Index = 205) on the island.[14] Furthermore, this island receives many visitors from Papua New Guinea, and a large number of visitors from other islands and the Australian mainland had visited the island for the Mabo Day celebration in early June (when the youth was acutely unwell).

The response required chartering an aircraft to fly vector-control personnel and equipment, to the island from Cairns. However, 13 days after the initial notification, QHSS reported that the serum sample from the youth was flavivirus IgM negative by EIA, and subsequently the HAI results were also reported as negative.

Importations of dengue into north Queensland

There were seven recognised importations of dengue into north Queensland in 2002 (Table). Six of these were in the first half of the year; they did not appear to be connected with the outbreaks in any way. Nevertheless, they all required the same public health follow-up, and mosquito surveys and control measures, as did each locally-acquired case. The average duration of viraemia in the imported cases, prior to the implementation of the public health responses,[15] was 6 days.

Discussion

This report describes dengue surveillance and control activities in north Queensland in 2002. This was the first year ever in which three separate outbreaks of dengue were recognised; indeed the occurrence of even two outbreaks in the same year is most unusual (Figure 2). The first documented outbreak of dengue 4 in Australia occurred in 2002. Although the outbreaks were small, they nevertheless required a huge investment in terms of persons, time and money to investigate and bring them under control.

The outbreaks demonstrated the limitations inherent in recognising dengue: the inadequacies in the commercially available dengue IgM diagnostic tests and the delays in notification of cases. The dengue IgM tests, although useful for screening purposes, not infrequently give incorrect results.[16] Therefore, any dengue IgM positive result reported by a

Table. Importations of dengue into north Queensland, 2002

Age, sex of patient	Imported from	Imported to, month	Notified by doctor at initial consultation	Delay between consultation & notification	Viraemic days in north Qld	Serotype
39 yrs, M	East Timor	Townsville, March	Yes	0 days	3	2
59 yrs, M	East Timor	Cairns, March	Yes	0 days	4	?
19 yrs, M	Papua New Guinea	Cairns, April	No	6 days	10	1
60 yrs, F	Vanuatu	Townsville, April	Yes	0 days	5	?
58 yrs, M	Vanuatu	Townsville, April	No	3 days	11	1
22 yrs, F	Thailand	Cairns & Pt Douglas, May	Yes	0 days	3	1
61 yrs, F	Philippines	Edmonton, November	No	1 day	7	3

laboratory in north Queensland must be confirmed by the QHSS reference laboratory before it can be accepted as being correct. False-positive results, as occurred with the 16-year-old resident of Mer, may arise from cross-reactivity with other flaviviruses, other infections (such as malaria and leptospirosis), and in chronic clinical disorders, especially if rheumatoid factor is present.[16]

All three index cases were notified by diagnostic laboratories rather than by the medical practitioners who undertook the initial consultations. This inevitably contributed to delays in implementing public health responses to the outbreaks. The Table, however, indicates that there is much more prompt notification of imported cases, indicating that practitioners are eliciting a travel history and are considering dengue in the differential diagnosis. Despite prompt notification, the seven imported cases were viraemic in north Queensland for a total of approximately six weeks.

The molecular analyses were extraordinarily useful in identifying the origin of the dengue viruses. The E gene sequence of the Kuranda dengue 2 virus was shown to be virtually identical to that of a dengue 2 virus acquired in Thailand in 2001. The dengue 4 virus was shown to have the greatest sequence similarity with a dengue 4 virus acquired in Indonesia in 1998, revealing the likely origin of the Smithfield outbreak.

The outbreaks have also demonstrated the importance of the strategic approach to dengue prevention and control that has evolved in north Queensland over the past decade. Fundamental to this approach is a dedicated team of vector control personnel, the Dengue Action Response Team, who use interior spraying of premises as an important control strategy. In all three outbreaks, no further local transmission occurred beyond the initial focus of transmission, and only three cases (12% of the total) were acquired after mosquito control measures were begun.[11] This strategic approach to dengue prevention and control has been described in the Dengue Fever Management Plan for north Queensland 2000–2005.[17]

Acknowledgements

Many people assisted with the responses to dengue in north Queensland in 2002. We particularly wish to thank Jan Humphreys, Judith Northill, Teck Chuan, Peter Foley and the Dengue Action Response Team (Alistair Hart, Sharron Long and Ian Walsh)

References

1. Gibbons RV, Vaughan DW. Dengue: an escalating problem. [Review] *BMJ* 2002;324:1563–1566.
2. Hanna JN, Ritchie SA, Merritt AD, van den Hurk AF, Phillips DA, Serafin IL, *et al*. Two contiguous outbreaks of dengue type 2 in north Queensland. *Med J Aust* 1998;168:221–225.
3. Hanna JN, Ritchie SA, Phillips DA, Serafin IL, Hills SL, van den Hurk AF, *et al*. An epidemic of dengue 3 in Far North Queensland, 1997–1999. *Med J Aust* 2001;174:178–182.
4. Warrilow D, Northill JA, Pyke A, Smith GA. Single rapid TaqMan fluorogenic probe based PCR assay that detects all four serotypes. *J Med Virol* 2002;66:524–528.
5. GcG Wisconsin Package, Version 8. Madison, Wis: Genetics Computer Group, 1994.
6. Felenstein J. PHYLIP (Phylogeny Inference Package, version 3.572c). Seattle, WA: Department of Genetics, University of Washington, 1995.
7. Saitou N, Nei M. The neighbour-joining method: a new method for reconstructing phylogenetic trees. *Mol Biol Evol* 1987;4:406–425.
8. dos Santos CN, Rocha CF, Cordeiro M, Fragoso SP, Rey F, Deubel V, *et al*. Genome analysis of dengue-1 virus isolated between 1990 and 2001 in Brazil reveals a remarkable conservation of the structural proteins but amino acid differences in the non-structural proteins. *Virus Res* 2002;90:197–205.

9. Page RD. TreeView: an application to display phylogenetic trees on personal computers. *Comput Appl Biosci* 1996;12:357–358.

10. Montgomery BL, Ritchie SA. Roof gutters: a key container for *Aedes aegypti* and *Ochlerotatus notoscriptus* (Diptera: Culicidae) in Australia. *Am J Trop Med Hyg* 2002;67:244–246.

11. Ritchie SA, Hanna JN, Hills SL, Piispanen JP, McBride WJH, Pyke A, *et al.* Dengue control in north Queensland, Australia: enhancement by early case recognition and interior spraying. *Dengue Bull* 2002;26:7–13.

12. Streatfield R, Sinclair D, Bielby G, Sheridan J, Pearce M, Phillips D, *et al.* Dengue serotype 2 epidemic, Townsville, 1992–93. *Commun Dis Intell* 1993;17:330–332.

13. Lepers C. DEN–1 outbreak in the Pacific – update as of 17 January 2003. Inform'ACTION 2002; (no. 13): 12–13.

14. Ritchie S, Montgomery B, Walsh I. Production of mosquitoes in rainwater tanks and wells on Yorke Island, Torres Strait: preliminary study. *Environ Health* 2002;2:13–18.

15. Malcolm RL, Hanna JN, Phillips DA. The timeliness of notification of clinically suspected cases of dengue imported into north Queensland. *Aust N Z J Public Health* 1999;23:414–417.

16. Hanna J, Morgan A. Diagnostic tests for dengue: a quick review. Tropical Public Health Unit *Communicable Diseases Control Newsletter* 2003:4.

17. Queensland Health. Dengue Fever Management Plan for North Queensland 2000–2005 (internal document). Cairns: Tropical Public Health Unit, 2000.

An outbreak of *Salmonella* Typhimurium phage type 99 linked to contaminated bakery piping bags

Ingrid G Tribe,[1] Sharon Hart,[1] David Ferrall,[2] Rod Givney[1]

In October 2002, the Communicable Disease Control Branch investigated an outbreak of *Salmonella* Typhimurium phage type 99. Cases (13 male, 9 female, age range: 2 to 83 years) were residents of metropolitan Adelaide. Of these, 20 cases were available for interview. Hypothesis generating interviews sought demographic, illness, food purchasing practices, food consumption, social activities and animal contact information for the 7-day period prior to the onset of symptoms. Seven cases were hospitalised, and one case died. There were two secondary cases.

Hypothesis generating interviews identified three distinct groupings. The first consisted of six community cases reporting consumption of sweet bakery items. Of these, five had eaten cream-filled buns or cakes. These items were all traced back to the point of manufacture identified as bakery A.

The second grouping consisted of six cases that had attended a self-catered birthday party. A cohort study was initiated using a telephone administered structured questionnaire. In total, 53 (93%) of 57 party attendees were interviewed. Of these, 22 (42%) experienced an onset of gastrointestinal illness within three days of attending the party. Of the ill party attendees, 15 (68%) reported fever, 20 (91%) abdominal pain, 20 (91%) diarrhoea, 3 (14%) bloody diarrhoea, 13 (59%) nausea and 8 (36%) vomiting. Three party attendees reported gastrointestinal illness prior to attending the party, however, none were involved in subsequent food preparation or food handling practices.

The analytical study revealed males were 8 (RR=8.48, 95%CI 2.19-32.84) times more likely to have experienced illness after attending the party. Univariate analyses identified pork (RR=2.41, 95%CI 1.11-5.24) and cream puffs (RR=3.73, 95%CI 2.11-6.59) as statistically significant risk factors for illness. Thirteen

1. Communicable Disease Control Branch, Department of Human Services, South Australia

2. Environmental Health Officer, City of Charles Sturt

Corresponding author: Ms Ingrid Tribe, Communicable Disease Control Branch, Department of Human Services, GPO Box 6, Rundle Mall, South Australia. Telephone: +61 8 8226 7177. Facsimile: +61 8 8226 7187. Email: ingrid.tribe@dhs.sa.gov.au

assorted desserts from a variety of sources were served at the party. Of these, 10 dozen small individual cakes had been purchased the previous day from a local bakery. After purchase, the cakes were stored un-refrigerated until required the following evening. Included in the purchase, was a selection of cream filled cakes. The risk ratio for small individual cream-filled cakes was 3.02 (95%CI 1.39-6.57). These cakes were traced back to the point of manufacture, bakery A.

The third grouping consisted of four cases that reported no apparent links to the consumption of sweet bakery products.

An environmental investigation was conducted. There were two reports of gastrointestinal illness in bakery employees. Both employees reported involvement in the production of cream filled bakery products. Moreover, both employees reported eating sweet bakery items produced by bakery A. Stool specimens provided by both employees yielded *Salmonella* Typhimurium phage type 99.

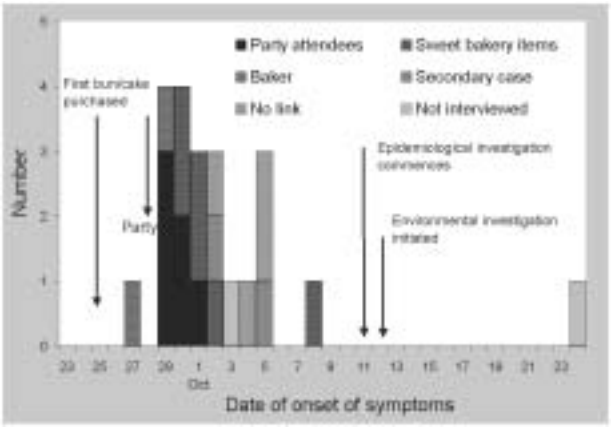
In total, 111 environmental swabs and food samples were collected from bakery A. Of these, a composite sample of six piping bags yielded *Salmonella* Typhimurium phage type 99. Initially, unrecognised cross-contamination of piping bags from staff, ingredients or environmental sources was considered. Of particular importance, the environmental investigation focussed on inadequate procedures for cleaning and sanitising piping bags. Subsequent questioning of staff directly involved in food production procedures identified that non-disposable piping bags were being used to pipe both raw meat for sausage rolls and cream for sweet bakery items.

The epidemiological and microbiological investigations identified an association between human infection with *Salmonella* Typhimurium phage type 99 and the consumption of bakery items from bakery A.

This outbreak illustrates the dangers of using non-disposable piping bags for multiple purposes. To minimise cross-contamination, separate piping bags for raw meat and cream processes were introduced. In addition, correct procedures for cleaning and sanitising non-disposable piping bags were instituted. A Food Industry Bulletin highlighting correct procedures for maintaining piping bags was issued.

Clearly, temperature abuse of cream products by some customers may have increased the likelihood of human illness. Nonetheless, *Salmonellae* are an undesirable contaminant in any commercial food product that is sold ready-to-eat. Procedures should be in place in all commercial bakeries to minimise the risk of infection to members of the public.

Figure. Epidemic curve illustrating an outbreak of *Salmonella* Typhimurium phage type 99, 27 September to 24 October 2002



BEACH – Bettering the Evaluation and Care of Health:

a continuous national study of general practice activity

General practice is recognised as the first port of call for most patients in the Australian healthcare system with GPs performing a gatekeeper role. There are more than 17,000 vocationally registered general practitioners in Australia and about 1,500 registrars currently training[1] or one GP per 974 persons. Almost all of us (82%) attend a GP at least once during any given year. GPs provide by far the majority of the 100 million non-specialist services to the population that are paid by Medicare,[1] at an average rate of 5.4 per person.[2]

In 1998, little was known about the problems managed and treatments provided by general practitioners. Over the previous quarter century only one major study of general practice clinical activity had been undertaken. This was the Australian Morbidity and Treatment Survey (AMTS), conducted in 1990–91.[3]

The methods applied in the AMTS and those used in Bettering the Evaluation and Care of Health (BEACH) program are similar, though BEACH collects more detailed information about pharmacological management, and tests and investigations ordered or undertaken. The methods were developed over two decades, in the Department of General Practice at the University of Sydney and were continued by the Family Medicine Research Centre (FMRC) when it was formed in the nineties.

In 1997 the Australian Institute of Health and Welfare (AIHW), recognised the need to include in their reports of the health of the community, data about what happens in general practice. As the FMRC was recognised for its work in this area, the AIHW and the University of Sydney formed the GP Statistics and Classification Unit (GPSCU) as a collaborating unit of the Institute. Its duties are to fill the (then) void in data pertaining to general practice and to continue to develop and promote classifications in primary care.

The Director of the Centre is A/Professor Helena Britt, and the Medical Director is Dr Graeme Miller. BEACH is managed by a multi-disciplinary team including graduates and post-graduates of medicine (general practice), epidemiology, statistics, psychology, health information management and information technology.

The BEACH program, a continuous study of general practice activity, began in April 1998 and is now in its sixth year. It fills the first of the GPSCU's objectives. BEACH is endorsed by the Royal Australian College of General Practitioners (RACGP) and the Australian Medical Association (AMA).

BEACH aims:

- to provide a reliable and valid data collection process for general practice which is responsive to the ever-changing needs of information users;
- to establish an ongoing database of GP–patient encounter information; and
- to assess patient risk factors and health states and the relationship these factors have with health service activity.

Funding

The BEACH program is currently funded by:

- the Commonwealth Department of Health & Ageing;
- AstraZeneca (Australia);
- Roche Products Pty Ltd;
- Janssen-Cilag Pty Ltd; and
- Merck Sharp & Dohme (Australia) Pty Ltd.

Management

The program is overseen by the BEACH Advisory Board which is made up of representatives of the GPSCU and the AIHW, a representative of each of the funding organisations, and of the RACGP, the AMA, the Australian Divisions of General Practice, the Australian College of Rural and Remote Medicine and the Consumers Health Forum.

The activities of the GPSCU are overseen by a Management Committee made up of two representatives of the University of Sydney and two representatives from the AIHW, with an independent Chair (currently Emeritus Professor Charles Bridges-Webb).

BEACH methods

In any year, each of a random sample of approximately 1,000 GPs completes details about 100 consecutive patient encounters on structured paper encounter forms and provides information about themselves and their practice. The source population includes all GPs who claimed a minimum of 375 general practice A1 Medicare items in the most recently available 3-month Health Insurance Commission data period. This equates with 1,500 Medicare claims a year and ensures inclusion of the majority of part-time GPs while excluding those who are not in private practice but claim for a few consultations a year. The General Practice Branch of the Commonwealth Department of Health and Ageing draws a sample on a regular basis. GPs are rewarded

for participation by provision of Quality Assurance points required for their professional recognition.

The characteristics of the final sample of GPs are compared with those of GPs who decline to participate, and with those of the source population. Post-stratification weighting adjusts for a consistent under-representation of young GPs, the majority of whom are registrars who are not required to follow the quality assurance program. Weights are also applied to each GP's 100 encounters according to how 'busy' they were in the previous quarter and statistical techniques adjust for the cluster effect of the sampling design.

BEACH includes three interrelated data collections: encounter data, GP characteristics, and patient health status.

Encounter data

- Patient data include: date of birth, sex and postcode of residence. Tick boxes are provided for status as health care card holder, Veterans' Affairs card holder, non-English-speaking background, an Aboriginal person (self-identification) and Torres Strait Islander (self-identification). Space is provided for up to three patient reasons for encounter.
- Encounter data include: date of consultation, type of consultation (direct, indirect), Medicare/Veterans' Affairs item number (where applicable), specified other payment source.
- Morbidity data: at each encounter the GP can record up to four diagnoses/problems managed and their status to the patient (new/old)
- Pharmacological management of each problem includes medications prescribed, over-the-counter medications advised and other medications supplied by the GP. Details comprise brand name, form (where required), strength, regimen, status (new medication for this problem, this patient) and number of repeats.
- Non-pharmacological management of each problem includes counselling, procedures, new referrals, and pathology and imaging ordered.

GP characteristics

- Data elements include age and sex, years in general practice, number of GP sessions worked per week, number of GPs working in the practice (to generate a measure of practice size), postcode of major practice address (to provide state and rural/metropolitan classification), country of graduation, postgraduate general practice training and RACGP Fellowship status.

Supplementary analysis of nominated data (SAND)

Many sub-sample studies are conducted throughout each year. These cover a wide range of topics and usually rely on the GP asking the patient and using their own knowledge of the patient to complete questions relating to the prevalence or incidence of a selected disease, current management and (sometimes) some previous history. Several investigate the extent of vaccine coverage for, or the incidence of, selected infectious disease.

These sub-studies do not depend on what is, or is not, managed at the current encounter as the data are patient rather than encounter based. Sample size is usually about 3,000 patients. These subjects are summarised in abstract form and published on the web at the time the annual BEACH report is released (in early December each year). The reports are available from: http://www.fmrc.org.au/publications/ (BEACH – SAND Abstracts)

BEACH is the result of over 20 years methodological work undertaken in the Department of General Practice (and later the FMRC) since 1978. The validity and reliability of each step in the process has been tested over the years. The reliability of the methods is further demonstrated by the consistency of results over the first five years of the program, for areas in which you would not expect change, together with the ability of the process to identify changes where they would be anticipated (e.g. when a new medication is released on the Pharmaceutical Benefits Scheme).

Data are currently available regarding 512,100 encounters from 5,121 GPs. These include data on the management of 743,625 problems. Problems are classified according to the International Classification of Primary Care–2nd edition (ICPC–2), a product of the World Organization of Family Doctors (Wonca).[4] The ICPC is used in over 45 countries as the standard for data classification in primary care.

The ICPC has a bi-axial structure, with 17 chapters on one axis (each with an alphabetic code) and seven components on the other (numeric codes). Chapters are based on body systems, with additional chapters for psychological and social problems. Component 1 includes symptoms and complaints. Component 7 covers diagnoses. These are independent in each chapter and both can be used for patient reasons for encounter (the subjective reasons given by the patient for the visit) or for problems managed (as described by the GP).

Components 2 to 6 cover the process of care and are common throughout all chapters. The processes of care, including referrals, non-pharmacological treatments and orders for pathology and imaging, are classified in these process components of ICPC–2.

Component 2 (diagnostic screening and prevention) is also often applied in describing the problem managed (e.g. immunisation, check-up).

In Component 7, there are five sub-groups of diseases, one of which is infections. Infections account for 15.1 per cent of all problems managed in general

practice, being managed at a rate of more than 20 infections per 100 encounters. This extrapolates to about 20 million contacts with infectious diseases in general practice across the country per year. GPs manage a broad range of infectious diseases. The most commonly managed are:

- upper respiratory tract infection (managed at a rate of 6.2 contacts per 100 encounters, extrapolated estimate 6.2 million consultations p.a. in general practice in Australia);
- acute bronchitis/bronchiolitis (2.7 contacts per 100 encounters, estimated 2.7 million consultations p.a.);
- urinary respiratory tract infection (1.6 contacts per 100 encounters, extrapolated 1.6 million consultations p.a.);
- unspecified viral illness (1.5 contacts per 100 encounters or 1.5 million consultations p.a.);
- acute sinusitis (1.4 contacts per 100 encounters, 1.4 million consultations p.a.);
- acute otitis media (1.3 contacts per 100 encounters, 1.3 million consultations p.a.);
- gastroenteritis, presumed infectious (1.1 contacts per 100 encounters or 1.1 million consultations p.a.).

Infectious diseases less frequently managed in general practice include:

- pelvic inflammatory disease (managed at a rate of 67.7 contacts per 100,000 encounters) 67,700 consultations per year;
- Ross River virus infection (19.3 contacts per 100,000 encounters) 19,300 consultations per year;
- tuberculosis (12.0 contacts per 100,000 encounters) 12,000 consultations per year;

and vaccine preventable diseases such as:

- chickenpox (160.7 contacts per 100,000 encounters) 160,700 consultations per year;
- hepatitis C (119.0 contacts per 100,000 encounters) 119,000 consultations per year;
- whooping cough (27.0 contacts per 100,000 encounters) 27,000 consultations per year nationally.

Data are also available regarding immunisations and vaccinations given by GPs, including childhood immunisations, influenza vaccines, malaria prophylaxis and others.

The BEACH encounter data cannot be used to estimate incidence as the encounters include both new cases and follow-up consultations for a problem. They also cannot be used to estimate prevalence of disease as patients may have multiple encounters involving the management of the problem. What they do provide is an estimate of the proportion of the general practice clinical workload taken up by a specific morbidity, and detailed data pertaining to the management of any selected problem dealt with by GPs.

However, the SAND sub-studies can often provide an estimate of incidence or prevalence (depending on the topic under study) within the patients who attend general practice.

The results of the BEACH program are published annually by the AIHW-University of Sydney. These, and other more specific reports are available through AusInfo or can be downloaded from the AIHW website – www.fmrc.org.au/publications (go to Books-General Practice Serries and select the book you want).

There are many secondary analyses conducted on the BEACH data, for researchers, government and industry. The GPSCU is not funded to provide secondary analytical services so some charges have to be made. These vary from full commercial rates to academic rates. Please contact A/Professor Helena Britt to discuss possible secondary analysis of a specific topic.

Further information

A/Professor Helena Britt
Director
AIHW GP Statistics and Classification Unit
University of Sydney
Acacia House
Westmead Hospital
WESTMEAD NSW 2145
Telephone: +61 2 9845 8150
Facsimile: + 61 2 9845 8155
Email: helenab@med.usyd.edu.au
URL: http://www.fmrc.org.au

References

1. Commonwealth Department of Health and Aged Care. General practice in Australia: 2000. Canberra: Department of Health and Aged Care, 2000.
2. Australian Institute of Health and Welfare. Australia's health 2000: the seventh biennial health report of the Australian Institute of Health and Welfare. Canberra: Australian Institute of Health and Welfare, 2000.
3. Bridges-Webb C, Britt H, Miles DA, Neary S, Charles J, Traynor V. Morbidity and treatment in general practice in Australia 1990–1991. *Med J Aust* 1992;157 Suppl:S1–S56.
4. Classification Committee of the World Organization of Family Doctors (WICC). ICPC–2: International Classification of Primary Care. 2 ed. Oxford: Oxford University Press, 1998.

Letter to the Editor

Human infestation with birds mites in Wollongong

The recent article by Charles R Watson, *Human infestation with bird mites in Wollongong,*[1] may lead to confusion and inappropriate diagnoses in relation to the particular mites actually or potentially involved.

The author states in the Abstract that, 'If bird mite infestation is not correctly diagnosed, families who attempt to repeatedly treat it as if it were lice or scabies may incur considerable expense until the source of infestation is eliminated.' This statement is indeed correct, however, the author failed to diagnose the bird mite species in his infestation, stating that the mite was 'most probably from the genus *Ornithonyssus*.' Fortunately in this circumstance, the mite problem was readily apparent and easily controlled. However, often this is not the case and identification to the species level is critical to ensure that the above scenario of possible inappropriate treatment does not occur. For example, at least two mites from the genus *Ornithonyssus, O. bursa* (the 'tropical fowl mite', but often called the 'starling mite') and *O. bacoti* (the 'tropical rat mite', or simply the 'rat mite') bite humans[2] and can occur in Australian homes, yet their habits and ecology are very different and the misidentification (or non-identification) of the species can lead to incorrect treatments and failure to control the pest. To base an identification and to provide control advice on the basis of an assumption is clearly scientifically inappropriate. Another bird mite, *O. sylviarum* (the 'northern fowl mite'), also occurs in parts of Australia in association with commensal birds (e.g. starlings, mynahs, pigeons) and, although not particularly different from *O. bursa* in its impact on humans, it likewise must be distinguished from the rodent-associated *O. bacoti* for appropriate management of the infestation.

The author mentions that '…bird mite infestation…[is a] relatively uncommon cause of bites in humans', although he notes that many pharmacists in the area of Wollongong are aware of bird mites causing a problem. In fact, bird mites are a commonly treated pest in many Australian cities. Indeed, *O. bursa* is the second most commonly submitted specimen to the Institute of Clinical Pathology and Medical Research Department of Medical Entomology, the only National Association of Testing Authorities accredited laboratory for the identification of arthropods of medical importance in Australia. During the past five years, our Department received over 150 separate samples containing *O. bursa*, and the clinical notes with the specimens usually indicated that bites on humans were involved. This is likely to be the 'tip of the iceberg' with respect to overall activity of this mite. Specimens of *O. bacoti* are less frequently submitted, but their distinction from *O. bursa* is important in order to advise on treatment and prevention.

Also in the article, it is stated '…fumigation of the roof cavity and adjacent rooms would be recommended in order to eradicate the source of infestation.' Fumigation involves using pesticides that are volatile in nature and produce poisonous gases toxic to arthropods. In the past, chemicals such as dichlorvos have been used in roof cavities for this purpose but fumigants are no longer registered for the control of bird mites.[3] The correct recommendation is for the expert use of surface sprays or dusts for the control of bird mites in roof cavities and on walls, and a variety of products are currently registered.

The author indicated that treatment was with Lyclear, a permethrin based cream. This is confusing, as it is not clear if he meant that the bites were treated with Lyclear, or was he suggesting that the bird mites need to be treated on the skin, despite the fact that they do not persist on or burrow into the skin? Alternatively, is the author suggesting the use of Permethrin as a toxicant to provide a 'barrier' and further prevent bites? If it is the latter, than the product should be advocated as a preventative and not a 'treatment'. Either way, the immediate removal of the bird nesting material and the prevention of access to roosting spaces, and then the surface treatment of the immediate and surrounding area with an approved insecticide, should be the main strategy employed to control the mite. Applying either a toxicant (e.g. permethrin) or a repellent (such as DEET) is rarely required and not usually recommended. Humans should never be treated with insecticides as the contact between the mite and human is purely temporary and incidental, and the infestation is self-limiting once the source of the mites has been found and eliminated.

The listing of the most common bird mites in Australia is not strictly correct. The most common is *O. bursa*, whereas *O. sylviarum* is not nearly as common. To avoid confusion, reference should always be to the species name as different authors quote different common names. Another species, *Dermanyssus gallinae* (the chicken mite), is also relatively similar in appearance and, although most commonly associated with domestic chickens, it can be associated with commensal birds and occasionally attacks humans from this source.

The family name for *Ornithonyssus* is stated in the article as 'Gamasidae', this is an old name and the current family name is now Macronyssidae.[4]

It is stated that bird mites have eight legs, however it should be noted that the youngest developmental stage, larval mites, have only six legs and can thus be mistaken for small insects rather than mites, and this may cause confusion to those not familiar with their life cycle. Larvae however, are rarely collected except from the nesting material and do not feed.

The author mentions body lice as a possible differential diagnosis for bites, however body lice are rare in Australian communities other than in homeless, displaced or vagrant persons, and the lice or their eggs usually can be readily found in the clothing of infested individuals. Other mites, associated with live or stored animal or plant material are more likely to be diagnostic confounders.

The author is justified in raising the issue of bird mites causing urticarial problems for humans in Australia, as they are a commonly encountered arthropod pest, particularly during the spring/summer months. However, misidentification of this group is also common, as mite taxonomy is extremely complex. To suggest that they can be 'recognised with the aid of an identification key and a low power microscope' is a gross over-simplification. There are numerous species associated with other vertebrate hosts that have been reported attacking humans, and these are in related mite families and many are morphologically almost identical to *Ornithonyssus* species; hence specialist entomologists should be used to confirm any putative identification. Additionally, 'misidentification' of the cause of urticarial complaints, in situations with or without obvious commensal bird or rodent association, is an issue that can lead to inappropriate and ineffective management advice.

Stephen Doggett, (Senior Hospital Scientist)
Merilyn Geary (Senior Technical Officer)
Department of Medical Entomology
ICPMR, Westmead Hospital Westmead NSW 2145

References

1. Watson CR. Human infestation with bird mites in Wollongong. *Commun Dis Intell* 2003;27:259–261.
2. Baker EW, Evans TM, Gould DJ, Hull WB, Keegan HL. A manual of parasitic mites of medical or economic importance. 1956. National Pest Control Association, New York.
3. Australian Pesticides & Veterinary Medicines Authority website. Available from: http://www.apvma.gov.au/. Assessed 11 July 2003.
4. Halliday RB. Mites of Australia. A checklist and bibliography. Monographs on Invertebrate Taxonomy, Vol. 5. CSIRO, Australia, 1998.

Errata

National atypical mycobacteria survey, 2000

There was an error in the Discussions section of the article *National atypical mycobacteria survey, 2000* published in the last issue of *Communicable Diseases Intelligence* (*Commun Dis Intell* 2003;27:180–189).

The second paragraph on page 188 should read:

'The most common isolate from lymphatic tissue was MAC, (48/60 = 80%). Not all MAC are fully identified to species level, so complete data for *M. avium* and *M. intracellulare* are unavailable. Where data were available there were twice as many (lymphatic) *M. intracellulare* isolations as *M. avium* (Table 5). *M. avium* accounted for 23 per cent of pulmonary and 57 per cent of lymphatic MAIS disease in 1988, somewhat different (36%, 30% respectively) for MAC disease seen in 2000.'

Communicable Diseases Surveillance – Tables 2 and 3, 2nd quarter 2002 (*Commun Dis Intell* 2002;26:479-483.)

The data shown in the above tables were for the first quarter 2002. The correct data are shown in the tables opposite. Since the data was re-analysed nearly one year later, the totals do not agree with the numbers discussed in the 'Highlights' section for this quarter.

Communicable Diseases Surveillance – Table 3, 4th quarter 2002 (*Commun Dis Intell* 2003;27:141-142.)

The rates per 100,000 for the 4th quarter 2002 were incorrect. The correct data are reproduced in this issue.

The editorial staff regrets these errors and apologises for the confusion.

Table 2. Notifications of diseases received by State and Territory health authorities in the period 1 April to 30 June 2002, by date of notification*

Disease	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Total 2nd quarter 2002[1]	Total 1st quarter 2002[1]	Total 2nd quarter 2001[1]	Last 5 years mean 2nd quarter	Year to date 2002	Last 5 years YTD mean	Ratio†
Bloodborne diseases															
Hepatitis B (incident)	0	21	9	21	2	4	51	12	120	83	94	76	203	148	1.6
Hepatitis B (unspecified)	19	886	NN	187	67	1	501	92	1,753	1,444	1,497	1,906	3,197	3,633	0.9
Hepatitis C (incident)	3	39	NN	NN	13	5	24	33	117	79	63	79	196	141	1.5
Hepatitis C (unspecified)	51	1,629	43	651	157	88	1,016	270	3,905	3,400	3,889	4,970	7,305	9,107	0.8
Hepatitis D	0	3	0	0	0	0	3	0	6	2	6	4	8	7	1.6
Hepatitis E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Hepatitis (NEC)	0	0	0	0	0	0	0	0	0	0	0	2	0	7	0.0
Gastrointestinal diseases															
Botulism	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0.0
Campylobacterosis[2]	96	NN	55	874	455	100	1,137	485	3,202	3,696	3,629	2,825	6,898	5,877	1.1
Cryptosporidiosis	9	86	40	283	42	9	89	60	618	2,094	385	n/a	2,712	N/A	N/A
Haemolytic uraemic syndrome	0	3	0	0	0	0	0	0	3	2	0	2	5	7	1.9
Hepatitis A	1	37	9	19	5	0	5	6	82	137	115	489	219	1,201	0.2
Hepatitis E	0	3	0	1	0	0	2	0	6	1	2	9	7	3	0.7
Listeriosis	0	2	0	9	0	1	6	2	20	14	8	15	34	34	1.4
Salmonellosis	19	507	91	655	162	35	360	175	2,004	2,765	1,550	1,640	4,769	4,065	1.2
Shigellosis	0	18	22	25	8	0	21	34	128	136	122	160	264	344	0.8
SLTEC,VTEC[3]	0	0	0	1	8	0	2	1	12	16	6	5	28	15	2.3
Typhoid	1	2	0	3	0	0	3	1	10	29	10	15	39	42	0.7
Quarantinable diseases															
Cholera	0	0	0	0	0	0	0	0	0	1	0	1	1	3	0.0
Plague	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Rabies	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Viral haemorrhagic fever	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Yellow fever	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Table 2. Notifications of diseases received by State and Territory health authorities in the period 1 April to 30 June 2002, by date of notification* (continued)

Disease	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Total 2nd quarter 2002[1]	Total 1st quarter 2002[1]	Total 2nd quarter 2001[1]	Last 5 years mean 2nd quarter	Year to date 2002	Last 5 years YTD mean	Ratio†
Sexually transmissible infections															
Chlamydial infection	124	1,388	383	1,601	504	125	1,295	737	6,157	5,410	4,294	3,268	11,567	6,018	1.9
Donovanosis	0	0	3	1	NN	0	0	0	4	8	8	5	12	16	0.8
Gonococcal infection[4]	0	391	400	214	68	0	230	369	1,672	1,479	1,392	1,482	3,151	2,747	1.1
Syphilis[5]	5	161	112	103	11	1	114	57	564	257	264	437	821	841	1.3
Vaccine preventable infections															
Diphtheria	0	0	0	0	0	0	0	0	0	0	0	0	0		0.0
Haemophilus influenzae type b	0	5	1	1	0	0	1	3	11	10	14	11	21	21	1.0
Influenza‡	7	211	1	124	136	1	183	72	735	107	24	N/A	842	N/A	N/A
Measles	0	2	0	1	0	0	4	0	7	6	12	77	13	174	0.1
Mumps	0	9	1	2	3	0	1	3	19	16	30	54	35	90	0.4
Pertussis	13	449	6	330	105	3	225	47	1,178	1,625	1,284	1,120	2,803	2,388	1.1
Pneumococcal disease‡	9	229	15	102	61	26	101	44	587	242	326	N/A	829	N/A	N/A
Poliomyelitis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Rubella[6]	2	4	0	41	0	0	4	0	51	53	40	151	104	482	0.3
Tetanus	0	0	0	0	0	0	0	0	0	0	0	1	0	3	0.0
Vectorborne diseases															
Arbovirus infection NEC	0	6	0	1	0	0	0	0	7	7	14	14	14	41	0.5
Barmah Forest virus infection	0	203	5	130	0	0	11	11	360	251	446	189	611	451	1.9
Dengue	0	20	8	25	3	0	1	8	65	73	50	46	138	140	1.4
Japanese encephalitis	0	0	0	0	0	0	0	0	0	0	0	N/A	0	N/A	N/A
Kunjin virus infection	0	0	0	0	0	0	0	0	0	0	0	N/A	0	N/A	N/A
Malaria	2	20	6	56	7	5	12	8	116	142	148	196	258	459	0.6
Murray Valley encephalitis	0	0	0	0	0	0	0	0	0	3	0	N/A	3	N/A	N/A
Ross River virus infection	0	96	12	337	11	63	15	32	566	623	1,130	1,546	1,189	4,482	0.4

Table 2. Notifications of diseases received by State and Territory health authorities in the period 1 April to30 June 2002, by date of notification* (continued)

Disease	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Total 2nd quarter 2002[1]	Total 1st quarter 2002[1]	Total 2nd quarter 2001[1]	Last 5 years mean 2nd quarter	Year to date 2002	Last 5 years YTD mean	Ratio†
Zoonoses															
Anthrax‡	0	0	0	0	0	0	0	0	0	0	0	N/A	0	N/A	N/A
Australian bat lyssavirus‡	0	0	0	0	0	0	0	0	0	0	0	N/A	0	N/A	N/A
Brucellosis	0	1	0	5	0	0	1	1	8	13	2	5	21	13	1.7
Leptospirosis	0	9	1	30	1	0	3	0	44	62	60	68	106	127	0.6
Other lyssavirus (NEC‡	0	55	0	0	0	1	11	0	67	13	23	17	80	34	3.9
Ornithosis	0	0	0	0	0	0	0	0	0	0	0	N/A	0	N/A	N/A
Q fever	0	63	0	96	7	0	44	4	214	158	150	142	372	275	1.5
Other bacterial infections															
Legionellosis	1	13	0	17	17	0	38	10	96	54	76	105	150	158	0.9
Leprosy	0	0	0	0	0	0	0	0	0	2	0	1	2	4	0.0
Meningococcal infection	0	61	4	27	9	11	44	14	170	114	143	120	284	183	1.4
Tuberculosis	2	107	11	31	17	2	66	9	245	175	125	232	420	508	1.1
Total	364	6,739	1,238	6,004	1,879	481	5,624	2,600	24,929	24,802	21,432	21,481	49,731	46,234	1.2

1. Totals comprise data from all States and Territories. Cumulative figures are subject to retrospective revision so there may be discrepancies between the number of new notifications and the increment in the cumulative figure from the previous period.
2. Not reported for NSW because it is only notifiable as 'foodborne disease' or 'gastroenteritis in an institution'.
3. Infections with Shiga-like toxin (verotoxin) producing *E. coli* (SLTEC/VTEC).
4. Northern Territory, Qld, SA , Vic and WA: includes gonococcal neonatal ophthalmia.
5. Includes congenital syphilis.
6. Includes congenital rubella.

* Date of notification = a composite of three dates: (i) the true onset date from a clinician, if available, (ii) the date the laboratory test was ordered, or (iii) the date reported to the public health unit.

† Ratio = ratio of current month total to mean of last 5 years calculated as described above.

‡ Notifiable from January 2001 only.

NA Not calculated as only notifiable for under 5 years.

NDR No data received.

NN. Not Notifiable

NEC Not Elsewhere Classified.

\- Elsewhere Classified.

Table 3. Notification rates of diseases by State or Territory, 1 April to 30 June 2002 (Rate per 100,000 population)

Disease[1]	State or Territory								
	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Australia
Bloodborne diseases									
Hepatitis B (incident)	0.0	1.3	18.0	2.3	0.5	3.4	4.2	2.5	2.4
Hepatitis B (unspecified)	23.5	53.3	NN	20.3	17.6	0.8	41.1	19.1	36.0
Hepatitis C (incident)	3.7	2.3	NN	NN	3.4	4.2	2.0	6.9	3.0
Hepatitis C (unspecified)	63.1	97.9	86.2	70.6	41.3	74.3	83.4	56.1	79.5
Hepatitis D	0.0	0.2	0.0	0.0	0.0	0.0	0.2	0.0	0.1
Hepatitis E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hepatitis (NEC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gastrointestinal diseases									
Botulism	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Campylobacterosis[2]	118.8	NN	110.2	94.8	119.7	84.5	93.3	100.9	98.5
Cryptosporidiosis	11.1	5.2	80.2	30.7	11.0	7.6	7.3	12.5	12.6
Haemolytic uraemic syndrome	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Hepatitis A	1.2	2.2	18.0	2.1	1.3	0.0	0.4	1.2	1.7
Hepatitis E	0.0	0.2	0.0	0.1	0.0	0.0	0.2	0.0	0.1
Listeriosis	0.0	0.1	0.0	1.0	0.0	0.8	0.5	0.4	0.4
Salmonellosis	23.5	30.5	182.4	71.0	42.6	29.6	29.6	36.4	40.8
Shigellosis	0.0	1.1	44.1	2.7	2.1	0.0	1.7	7.1	2.6
SLTEC,VTEC[3]	0.0	0.0	0.0	0.1	2.1	0.0	0.2	0.2	0.2
Typhoid	1.2	0.1	0.0	0.3	0.0	0.0	0.2	0.2	0.2
Quarantinable diseases									
Cholera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Plague	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rabies	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Viral haemorrhagic fever	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Yellow fever	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sexually transmissible infections									
Chlamydial infection	153.4	83.4	767.5	173.7	132.6	105.6	106.3	153.3	125.3
Donovanosis	0.0	0.0	6.0	0.1	NN	0.0	0.0	0.0	0.1
Gonococcal infection[4]	0.0	23.5	801.6	23.2	17.9	0.0	18.9	76.7	34.0
Syphilis[5]	6.2	9.7	224.4	11.2	2.9	0.8	9.4	11.9	11.5
Vaccine preventable diseases									
Diphtheria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Haemophilus influenzae type b	0.0	0.3	2.0	0.1	0.0	0.0	0.1	0.6	0.2
Influenza	8.7	12.7	2.0	13.4	35.8	0.8	15.0	15.0	15.0
Measles	0.0	0.1	0.0	0.1	0.0	0.0	0.3	0.0	0.1
Mumps	0.0	0.5	2.0	0.2	0.8	0.0	0.1	0.6	0.4
Pertussis	16.1	27.0	12.0	35.8	27.6	2.5	18.5	9.8	24.0
Pneumococcal disease	11.1	13.8	30.1	11.1	16.0	22.0	8.3	9.1	11.9
Poliomyelitis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rubella[6]	2.5	0.2	0.0	4.4	0.0	0.0	0.3	0.0	1.0
Tetanus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 3. Notification rates of diseases by State or Territory, 1 April to 30 June 2002 (Rate per 100,000 population), continued

Disease[1]	State or Territory								
	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Australia
Vectorborne diseases									
Arbovirus infection NEC	0.0	0.4	0.0	0.1	0.0	0.0	0.0	0.0	0.1
Barmah Forest virus infection	0.0	12.2	10.0	14.1	0.0	0.0	0.9	2.3	7.3
Dengue	0.0	1.2	16.0	2.7	0.8	0.0	0.1	1.7	1.3
Japanese encephalitis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kunjin virus infection	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Malaria	2.5	1.2	12.0	6.1	1.8	4.2	1.0	1.7	2.4
Murray Valley encephalitis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ross River virus infection	0.0	5.8	24.0	36.6	2.9	53.2	1.2	6.7	11.5
Zoonoses									
Anthrax	0.0	0.0	0.0	0.0	NN	0.0	0.0	0.0	0.0
Australian bat lyssavirus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Brucellosis	0.0	0.1	0.0	0.5	0.0	0.0	0.1	0.2	0.2
Leptospirosis	0.0	0.5	2.0	3.3	0.3	0.0	0.2	0.0	0.9
Other lyssavirus (NEC)	0.0	3.3	0.0	0.0	0.0	0.8	0.9	0.0	1.4
Ornithosis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Q fever	0.0	3.8	0.0	10.4	1.8	0.0	3.6	0.8	4.4
Other bacterial infections									
Legionellosis	1.2	0.8	0.0	1.8	4.5	0.0	3.1	2.1	2.0
Leprosy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Meningococcal infection	0.0	3.7	8.0	2.9	2.4	9.3	3.6	2.9	3.5
Tuberculosis	2.5	6.4	22.0	3.4	4.5	1.7	5.4	1.9	5.0

1. Rates are subject to retrospective revision.
2. Not reported for New South Wales because it is only notifiable as ‘foodborne disease’ or ‘gastroenteritis in an institution’.
3. Infections with Shiga-like toxin (verotoxin) producing *E. coli* (SLTEC/VTEC).
4. Northern Territory, Queensland, South Australia, Victoria and Western Australia: includes gonococcal neonatal ophthalmia.
5. Includes congenital syphilis.
6. Includes congenital rubella.

NN Not Notifiable.

NEC Not Elsewhere Classified.

— Elsewhere Classified.

Table 3. Notification rates of diseases by State or Territory, 1 September to 31 December 2002 (Rate per 100,000 population)

Disease[1]	State or Territory								
	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Australia
Bloodborne diseases									
Hepatitis B (incident)	0.0	0.8	16.0	0.8	0.4	5.2	2.0	1.6	1.6
Hepatitis B (unspecified)	22.4	46.8	NN	21.6	12.8	10.0	33.2	21.2	32.0
Hepatitis C (incident)	1.2	0.8	NN	NN	2.0	1.6	2.0	6.8	1.6
Hepatitis C (unspecified)	65.6	89.6	124.0	70.8	28.0	74.4	73.2	65.2	74.4
Hepatitis D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hepatitis E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hepatitis (NEC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gastrointestinal diseases									
Botulism	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Campylobacterosis[2]	121.2	NN	88.0	124.4	196.4	168.8	122.0	134.8	88.8
Cryptosporidiosis	4.8	2.4	104.0	6.0	2.8	13.6	4.8	11.6	6.0
Haemolytic uraemic syndrome	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
Hepatitis A	0.0	2.0	18.0	1.2	1.2	1.6	0.8	1.6	1.6
Hepatitis E	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0
Listeriosis	0.0	0.4	0.0	0.4	0.4	0.8	0.0	0.8	0.4
Salmonellosis	33.2	31.6	134.0	64.4	31.6	41.2	20.8	36.4	36.8
Shigellosis	0.0	1.2	56.0	2.8	0.0	0.8	0.4	6.0	2.4
SLTEC,VTEC[3]	0.0	0.0	0.0	0.4	2.0	0.0	0.0	0.0	0.4
Typhoid	0.0	0.4	0.0	0.0	0.4	0.0	0.0	0.4	0.4
Quarantinable diseases									
Cholera	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0
Plague	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rabies	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Viral haemorrhagic fever	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Yellow fever	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sexually transmissible infections									
Chlamydial infection	114.8	76.4	871.6	174.4	102.4	102.0	*	160.0	95.6
Donovanosis	0.0	0.0	2.0	0.4	NN	0.0	*	0.0	0.0
Gonococcal infection[4]	8.8	18.0	691.6	25.6	10.4	5.2	*	68.4	25.6
Syphilis[5]	0.0	11.6	204.0	2.4	0.4	8.4	*	3.6	7.2
Vaccine preventable diseases									
Diphtheria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Haemophilus influenzae type b	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.4	0.0
Influenza	0.0	4.8	20.0	6.4	3.6	0.0	0.8	6.0	4.0
Measles	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0
Mumps	0.0	0.4	0.0	0.4	0.4	0.0	0.0	0.4	0.4
Pertussis	16.0	24.0	2.0	56.0	13.6	12.0	18.0	7.6	25.6
Pneumococcal disease	13.6	11.2	30.0	10.0	11.6	9.2	8.2	9.2	10.4
Poliomyelitis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rubella[6]	0.0	0.8	0.0	5.2	0.8	0.0	0.0	0.4	1.2
Tetanus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 3. Notification rates of diseases by State or Territory, 1 September to 31 December 2002 (Rate per 100,000 population), continued

Disease[1]	State or Territory								
	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Australia
Vectorborne diseases									
Arbovirus infection NEC	0.0	0.4	0.0	0.0	0.0	0.0	0.4	0.0	0.4
Barmah Forest virus infection	0.0	2.8	2.0	9.2	0.0	0.0	0.0	1.6	2.8
Dengue	0.0	0.8	4.0	1.2	0.0	0.0	0.0	0.4	0.4
Japanese encephalitis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kunjin virus infection		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Malaria	4.8	0.8	12.0	6.4	0.4	3.2	1.6	0.8	2.0
Murray Valley encephalitis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ross River virus infection	0.0	0.8	18.0	6.0	0.0	0.0	0.0	5.2	2.0
Zoonoses									
Anthrax	0.0	0.0	0.0	0.0	NN	0.0	0.0	0.0	0.0
Australian bat lyssavirus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Brucellosis	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.4
Leptospirosis	0.0	0.8	2.0	0.4	0.0	0.8	0.4	0.4	0.4
Other lyssavirus (NEC)	0.0	0.8	0.0	0.0	0.0	0.0	0.4	0.0	0.0
Ornithosis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4
Q fever	0.0	5.6	0.0	2.8	1.6	0.0	0.0	0.8	3.2
Other bacterial infections									
Legionellosis	1.2	0.4	0.0	0.0	4.4	0.0	2.0	4.0	1.2
Leprosy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Meningococcal infection	1.2	2.8	4.0	2.4	0.8	4.4	4.8	3.2	3.2
Tuberculosis	3.6	4.4	20.0	2.0	2.0	2.4	5.2	2.8	4.0

1. Rates are subject to retrospective revision.
2. Not reported for New South Wales because it is only notifiable as ‘foodborne disease’ or ‘gastroenteritis in an institution’.
3. Infections with Shiga-like toxin (verotoxin) producing *E. coli* (SLTEC/VTEC).
4. Northern Territory, Queensland, South Australia, Victoria and Western Australia: includes gonococcal neonatal ophthalmia.
5. Includes congenital syphilis.
6. Includes congenital rubella.

NN Not Notifiable.
NEC Not Elsewhere Classified.
— Elsewhere Classified.

Communicable diseases surveillance

Highlights for 2nd quarter, 2003

Communicable disease surveillance highlights report on data from various sources, including the National Notifiable Diseases Surveillance System (NNDSS) and several disease specific surveillance systems that provide regular reports to Communicable Diseases Intelligence. *These national data collections are complemented by intelligence provided by State and Territory communicable disease epidemiologists and/or data managers. This additional information has enabled the reporting of more informative highlights each quarter.*

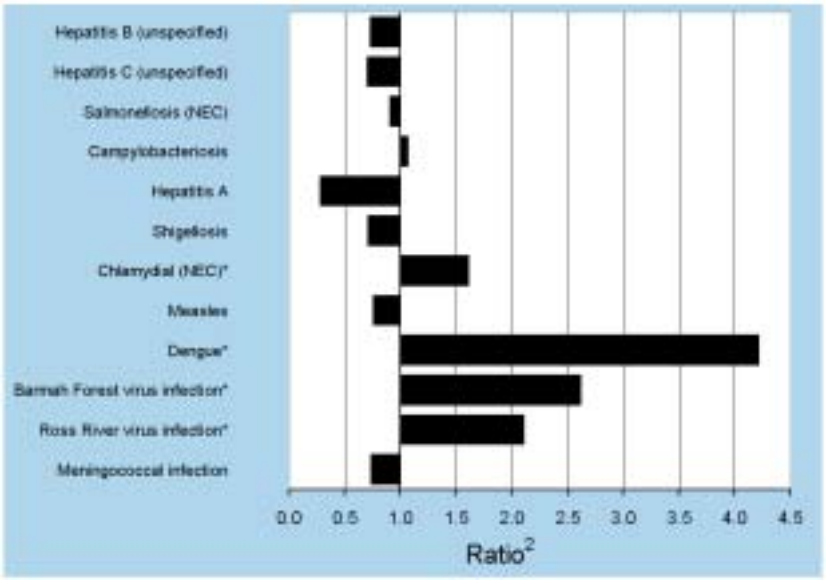
The NNDSS is conducted under the auspices of the Communicable Diseases Network Australia. NNDSS collates data on notifiable communicable diseases from State or Territory health departments. The Virology and Serology Laboratory Reporting Scheme (LabVISE) is a sentinel surveillance scheme which collates information on laboratory diagnosis of communicable diseases. In this report, data from the NNDSS are referred to as 'notifications' or 'cases', and those from ASPREN are referred to as 'consultations' or 'encounters' while data from the LabVISE scheme are referred to as 'laboratory reports'.

Figure 1 shows the changes in disease notifications with an onset in the second quarter of 2003, compared with the 5-year second quarter mean. Disease notifications above or below the 5-year mean, plus or minus two standard deviations are marked with an asterisk. Diseases where the number of cases reported was two standard deviations above the mean of the same quarter in the last five years were dengue, Ross River virus infection, Barmah Forest virus infection and Chlamydial (NEC) infections. The rest of notifiable diseases were within the expected range (2 standard deviations) of the five year second quarter mean (Figure 1).

Foodborne disease outbreaks

This quarter's highlights incorporates the OzFoodNet quarterly report for the second quarter of 2003. Data were received from all OzFoodNet sites. During the second quarter of 2003, OzFoodNet sites reported 61 outbreaks of gastrointestinal infections of which 11 were either confirmed or suspected to be foodborne (Table 1). These 11 outbreaks affected 174 identified persons but the number of persons not identified may be considerably higher. The agent responsible for three outbreaks was unknown.

Figure 1. Selected[1] diseases from the National Notifiable Diseases Surveillance System, comparison of provisional totals for the period 1 April to 30 June 2003 with historical data[2]



1. Selected diseases are chosen each quarter according to current activity.
2. Ratio of current quarter total to mean of corresponding quarter for the previous five years.

* Notifications above or below the 5-year mean for the same period plus- or minus- two standard deviations.

Disease outbreaks associated with the consumption of fish

Three of the outbreaks, which occurred in home settings, were associated with the consumption of fish: escolar, cod head and giant trevally. The Australian Capital Territory OzFoodNet site reported an outbreak of a diarrhoea following the consumption of escolar fish by three members of one family. Escolar is an ocean fish which is caught as a by-catch from tuna longlines. Consumption of escolar causes oily diarrhoea in 45 to 67 per cent of people due to a high per cent of indigestible wax-ester oil content.[1-5]

Two outbreaks of ciguatera poisoning following the consumption of cod head and giant trevally were reported from Queensland. Ciguatera poisoning causes neurological symptoms and is mainly reported in Queensland and the Northern Territory. The disease is associated with the consumption of fish contaminated by algal dinoflagellate associated with coral reefs. Ciguatoxin is concentrated in the liver, roe, head and other viscera of the fish and is thermostable, that is; it can not be destroyed by cooking or freezing. In 2002 OzFoodNet reported four outbreaks of ciguatera poisoning in home settings following the consumption of coral trout, Spanish mackerel, spotted mackerel and barracuda. These outbreaks resulted in 11 hospitalisations and one death.[6] A large outbreak of ciguatera poisoning in a restaurant setting was reported in Victoria in 1997.[7]

Clostridium perfringens

The Victorian OzFoodNet site reported two diarrhoea outbreaks in nursing homes, affecting 14 residents in one and 12 in another. Stool samples (four and three from each outbreak) tested positive for *C. perfringens*. Whilst no enterotoxin was detected in the faecal specimens, the symptoms, duration of illness and isolation of the organism in the faeces, were consistent with *C. perfringens* as the cause of illness. Heather O'Donnell, Communicable Diseases Section, Victorian Department of Human Services, said that site investigations conducted by local Council and Regional Environmental Health Officers could not identify specific food sources, but identified poor food handling and storage (cooling) practices in one of the outbreak sites and deficiencies in food safety plan in the other.

In Mackay, Queensland an investigation of an outbreak of gastrointestinal illness in a cohort of 30 guests at a catered function, identified *C. perfringens* as a suspected agent of illness. Sixty-three per cent of guests (n=19) reported diarrhoea and abdominal cramps. Russell Stafford, OzFoodNet Epidemiologist in Queensland said that a retrospective cohort study identified curried prawns as the likely food vehicle. Whilst the *C. perfringens* spore-count from stool samples was not diagnostic, the median incubation period (13 hours), symptomatology and isolation of the bacteria from stool samples, were suggestive of *C. perfringens*.

C. perfringens is a spore-forming bacillus, ubiquitous in the environment and a frequent contaminant of meat. It can survive high temperatures by sporulating during initial cooking; its spores germinate during cooling of the food, and vegetative forms of the organism multiply if the food is subsequently held at temperatures of 16^{o} C – 52^{o} C.[8] If served without adequate reheating, live vegetative forms of *C. perfringens* may be ingested causing the characteristic symptoms. Gastrointestinal illness outbreaks associated with *C. perfringens* occur in institutions where food is prepared in bulk increasing the likelihood of poor holding or reheating.

Salmonella

There were 1,568 reports of salmonellosis received by the National Notifiable Diseases Surveillance System (NNDSS) during the second quarter of 2003, representing a 43 per cent reduction in notifications from the previous quarter and a 22 per cent reduction from the same quarter last year. Queensland and New South Wales OzFoodNet sites each reported one outbreak of *Salmonella* infection (Table 1).

In Queensland, an outbreak of *S.* Typhimurium U307 infection, associated with eating at two Sunshine Coast surf clubs was investigated. There were 15 laboratory-confirmed and six probable cases identified during the investigation. Microbiological testing of food and condiment samples, environmental swabs and faecal specimens from 36 food handlers were negative for *Salmonella*. A case control study, identified roast pork (OR 12.0, 95%CI 1.6-91.1, p=0.03) as the likely source of infection. In 2002, *S.* Typhimurium U307 was among the top 10 *Salmonella* infections reported in the Hunter, New South Wales.[9]

In New South Wales, the South Western Sydney Public Health Unit investigated an outbreak of gastrointestinal illness among 112 persons attending a birthday party held at a restaurant on 25 May 2003. Fifty-one per cent (n=57) of attendees reported illness, including diarrhoea, vomiting, abdominal pain, nausea, headache, fever and chills with onset on 26 May. Among persons who reported ill, 86 per cent (n=49) consulted medical practitioners and 9 per cent (n=5) were hospitalised. Microbiological testing isolated *S.* Typhimurium 99 from all stool samples tested (n=26) and from samples of pigeon meat consumed at the party. Leonie Neville, OzFoodNet Epidemiologist in New South Wales said that steps had been taken to educate the food handlers at the venue. In the past *S.* Typhimurium 99 has been linked to the consumption of lamb's fry at a local hotel buffet in southern Victoria.[10]

Table 1. Outbreaks reported by OzFoodNet sites, Australia, April to June 2003

State	Setting	Agent responsible	Number exposed	Number affected	Evidence	Responsible vehicle
ACT	Home	Escolar fish	3	3	D	Escolar fish
NSW (Hunter)	Restaurant	Unknown	Unknown	24	D	Unknown
NSW	Restaurant	*Salmonella* Typhimurium 99	112	57	M	Pigeon meat
NT	–	–	–	–	–	–
Qld	Catered function	*Clostridium perfringens*	Unknown	19	C	Curried prawns
	Restaurant	*Salmonella* Typhimurium U307	Unknown	21	D & CC	Unknown
	Home	Ciguatera		2	D	Cod fish heads
	Home	Ciguatera		5	D	Giant Trevally
SA	–	–	–	–	–	–
Tas	–	—	–	–	–	–
Vic	Nursing Home	*Clostridium perfringens*	110	14	D	Unknown
	Nursing Home	*Clostridium perfringens*	unknown	12	D	Unknown
	Restaurant	Unknown	40	7	D	Unknown
WA	Catered function	Unknown	Unknown	10	D	Meat suspected

* D= Descriptive Study; M=Microbiological evidence; C=Cohort study; CC=Case control study

Campylobacter

There were 3,307 reports of campylobacteriosis infection received by the NNDSS in the second quarter of the year; a decrease of 26 per cent from the last quarter but an increase of 3 per cent from the same quarter last year. No disease outbreaks were associated with campylobacteriosis in this quarter of 2003.

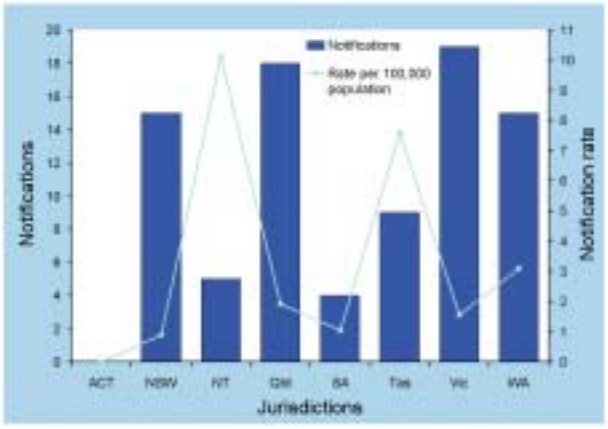
Hepatitis A

There were 85 hepatitis A cases reported with an onset in the second quarter of 2003; 72 per cent lower than the mean number of notifications of the same quarter for the last five years (Figure 1), and 26 per cent lower than the number of notifications received during the first quarter of 2003. The national notification rate in this quarter was 1.7 cases per 100,000 population. The Northern Territory had the highest notification rate at 10 cases per 100,000 population (Figure 2); representing a 73 per cent reduction from the number of notifications reported in the Northern Territory during the first quarter.

Multi-jurisdiction hepatitis A outbreak investigation

Twenty-five per cent of cases notified during the second quarter were linked to a hepatitis A outbreak that occurred at an interstate gathering in the Northern Territory.

Figure 2. Number of notifications and notification rate per 100,000 population of hepatitis A, Australia, April to June 2003, by jurisdiction



On 29 May 2003 OzFoodNet and the Communicable Diseases Network Australia (CDNA) initiated a multi-state/territory outbreak investigation of the disease. The investigation was triggered by the identification by Tasmanian health authorities of six cases of hepatitis A infection in people who had attended a public gathering of 300 persons in the Northern Territory between 24 and 27 April 2003. Persons from Queensland, Tasmania, Victoria, New South

Wales and Western Australia attended the gathering. Public health authorities contacted all exposed persons in their jurisdiction in order to identify cases and to offer prophylaxis to prevent secondary cases among their contacts. The CDNA had also issued a health alert to the public. Rosie Ashbolt, OzFoodNet Epidemiologist in Tasmania said that 21 cases were identified: 8 of 111 persons who attended the Northern Territory gathering from Tasmania, 8 of 75 persons from Queensland, 4 of 47 persons from Victoria and 1 of 45 persons from New South Wales. Two cases were hospitalised. No new cases have been reported since 13 June.

Hepatitis A is commonly spread from person to person via close contact or from food or water that had been inadvertently contaminated by infected persons. Rosie Ashbolt said that the investigation, which included serological testing of food handlers, testing of water samples, food samples and a site investigation by a Northern Territory environmental health officer, did not reveal any likely sources of contamination. Health authorities conducted a national cohort study to determine the likely source for the outbreak and data are currently being analysed. In 2002, overseas travel and household contact with a confirmed case were the main risk factors hepatitis A infection.[11]

Vaccine preventable diseases

Measles

Twenty-six measles cases, 18 in Victoria, five in New South Wales, two in South Australia and one in Queensland were reported in the second quarter. No cases of measles with onset in this period were reported from Tasmania, the Northern Territory, the Australian Capital Territory or Western Australia.

In New South Wales, two unrelated cases of measles in young adults were reported in April and a cluster of three cases was reported in June. The index case in the cluster was a 29-year-old male whose exposure was suspected to have occurred during recent travel in Nepal. The two secondary cases were a six-week-old male and his 27-year-old father. Mark Bartlett, Communicable Diseases Branch NSW Health Department, said that the outbreak is ongoing with further transmission past the two secondary cases noted for the period of this report.

The two cases in South Australia were linked to each other with the index case having a history of travel to South Africa.

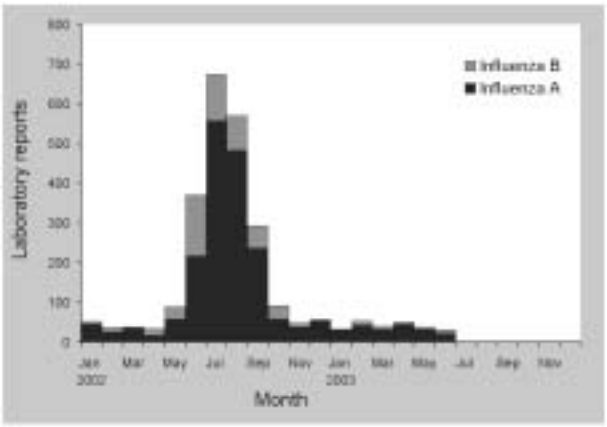
Three cases in Victoria were linked to a measles (Genotype H1) outbreak geographically clustered around two towns in central northern Victoria that started in the first quarter of the year, bringing the number of cases in the outbreak to 20 cases, including three unvaccinated children. The disease mostly affected adults and resulted in three generations of infections. No new cases linked to the outbreak had been reported since April 2003. However, in the same state, in April, 11 cases of measles including a vaccinated two-year-old and a nine-month-old, were linked to a cluster of measles (Genotype D8) in Western metropolitan Melbourne. The index case in this cluster was a student who travelled to Australia from Germany via Singapore.

The exposure history of the measles cases in Queensland was not known.

Influenza

There were 121 notifications of laboratory-confirmed influenza reported to the NNDSS in the quarter, a 31 per cent rise from the previous quarter but an 84 per cent decrease from the second quarter of 2002. Reports to LabVISE this quarter show that the ratio of influenza A to B remained stable at 4:1 (Figure 3).

Figure 3. Laboratory reports of influenza A and B to LabVISE, Australia, 2002 to 2003, by month of specimen collection



The low level of influenza activity this quarter was reflected in the reports from the Australian Sentinel Practice Research Network (ASPREN). Presentations of 'influenza-like illness' (ILI) during the week ending on 29 June (week 26) were 9.8 cases per 1,000 consultations. The highest rate per 1,000 consultations this year to date was 14.4, reported in the week ending on 15 June 2003 (Figure 4). ASPREN is a network of general practices, that collects data on clinical presentations of ILI from between 35 and 70 practices per week, located mostly on the east coast of Australia.

Figure 4. Comparison of consultation rates of influenza-like illness reported to the Australian Sentinel Practice Research Network, in 2002 to 2003, by week

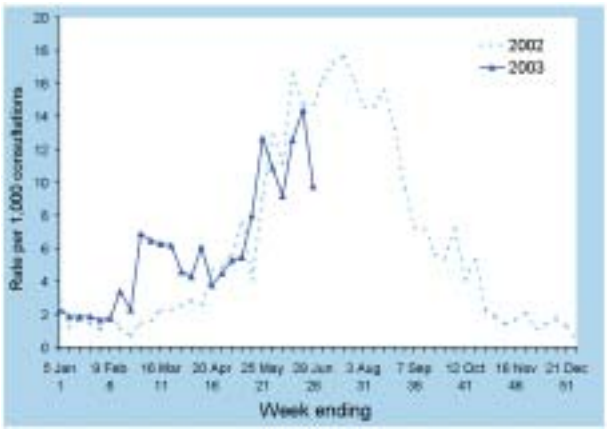
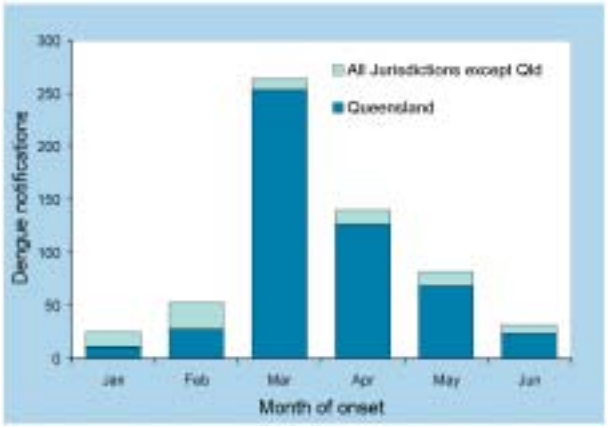


Figure 5. Cairns dengue fever outbreak, Australia, 1 January to 14 July 2003, by onset date



Influenza activity in the tropical north of Australia was reported to be at base line level during the quarter. The Northern Territory Tropical Influenza Surveillance reported a decrease in ILI rates since the peak rate of ILI consultations (21 cases per 1,000 consultations) during week 14 (7 April). No ILI was reported in the period between 9 May and mid-June.

Vectorborne diseases

Dengue

The number of dengue notifications continued to exceed the mean number of notifications for the second quarter in the last five years (Figure 1). There were 247 cases reported to NNDSS in the second quarter of 2003. Of these 211 (85%) notifications were in Queensland (Figure 5) and 17 (7%) in New South Wales. In Queensland, this number of notifications represents a 27 per cent reduction from the previous quarter, when a number of dengue outbreaks were reported in the state. The first outbreak of dengue type 2 occurred in Cairns, two other dengue type 2 outbreaks were identified in Townsville and Mareeba and a fourth, a dengue type 1 outbreak, occurred in Cairns. Despite different serotypes of dengue viruses circulating in the area (the 1997-1999 Cairns dengue outbreak was of dengue type 3), there has been no dengue haemorrhagic fever cases or deaths to date.

The Cairns Public Health Unit continued public health activities during the second quarter of the year to curtail the dengue outbreak. This has significantly contributed to the decline in the number of cases in the second quarter of the year. The Dengue Action Response Team undertook inspections of premises for mosquito breeding sites, and interviewed potential cases. Local general practitioners were alerted to look for symptoms, and numerous media alerts were issued to raise public awareness. Craig Davis, Epidemiologist, Queensland Health, said that although the extent to which increased serological testing for dengue may have resulted in increased number of notifications in Queensland is not known, it is likely to have had some impact.

Barmah Forest virus infection and Ross River virus infection

The number of notifications for Barmah Forest virus infection and Ross River virus infection during the second quarter of 2003 was 715 (15 cases per 100,000 population) notifications and 2,267 (46 cases per 100,000 population) notifications, respectively. These numbers surpassed the mean plus two standard deviation of the number of notifications for the second quarter in the last five years (Figure 1).

Sixty-nine per cent of Barmah Forest virus infection notifications and 84 per cent of Ross River virus infection notifications were received from Queensland, where the notification rates for Barmah Forest virus infection and Ross River virus infection were 52 cases per 100,000 population and 203 cases per 100,000 population, respectively. While a late autumn increase in notifications was expected in this state, the size of the increase was higher than expected. Increases on previous years were widespread, although the highest rates (more than one third of all notifications) were recorded in the Statistical Divisions of Fitzroy and West Moreton (Figures 6a and 6b). Information obtained from Queensland public health units suggests that media releases in early April 2003 regarding the increases of Barmah Forest and Ross River virus infections and vector control activity in the Sunshine Coast area (Moreton Statistical Division) may have contributed to increased testing and notifications compared with previous years.

New South Wales contributed 30 per cent of Barmah Forest virus infection and 12 per cent of Ross River virus infection to the notifications received by the NNDSS in the second quarter of 2003. Mark Bartlett, Communicable Diseases Branch, NSW Health Department, said, that 85 per cent of Barmah Forest virus infection and 79 per cent of Ross River virus infection notifications occurred on the far north coast of New South Wales. This area is adjacent to the affected south east corner of Queensland where these two vectorborne diseases are endemic (Figures 6a and 6b).

In response to the rise in the number of cases throughout April and May, the Public Health Unit in the north coast region of New South Wales intensified media messages about arboviruses and personal protective measures against mosquito bites. Currently, it is organising a forum involving health agencies, medical entomologists and Councils, to look at human activity and environmental management in relation to vectorborne diseases.

Meningococcal infections

There were 101 notifications of meningococcal disease in the quarter, an increase of 15 per cent from the last quarter but a decrease of 41 per cent from the same quarter last year, and 30 per cent less than the mean of the same quarter for the last five years (Figure 7). For the year to date (30 June 2003) 189 cases of meningococcal disease resulting in eight deaths, were reported to the Communicable Disease Network Australia. Of the eight deaths, three were due to serotype B infection and five due to serotype C infection. As at June 2003, 32 per cent of all isolates were typed. The serotype B to C ratio for the year to date nationally was 1.5:1; however Victoria reported a higher proportion of cases of serotype C than serotype B.

Figure 7. Meningococcal notifications, Australia, 1992 to 2003, by year and month of onset

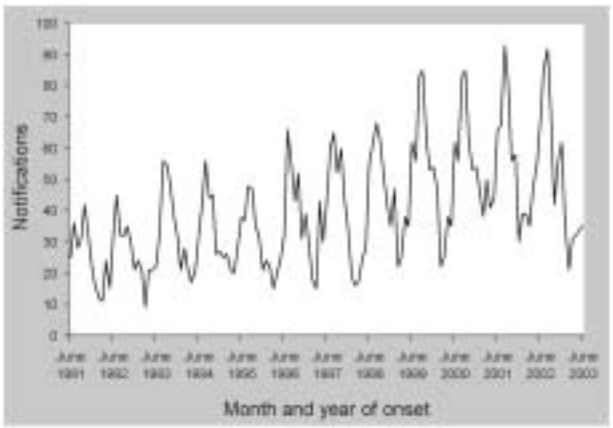


Figure 6a. Geographic distribution of notified cases of Barmah Forest virus infection in Queensland, Australia, April to June 2003

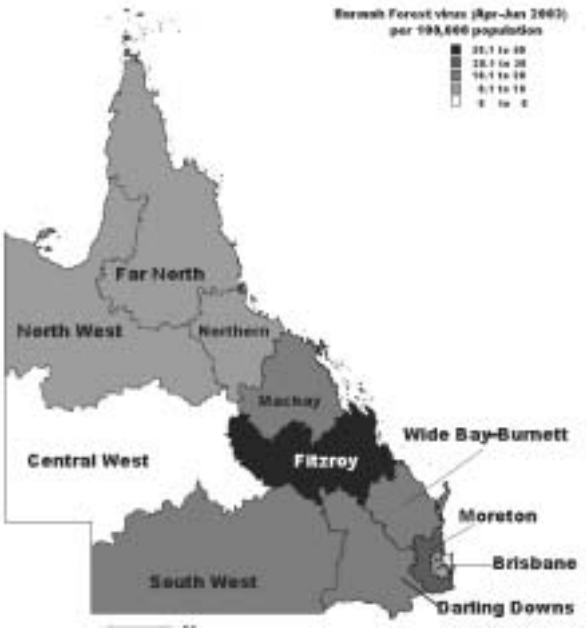
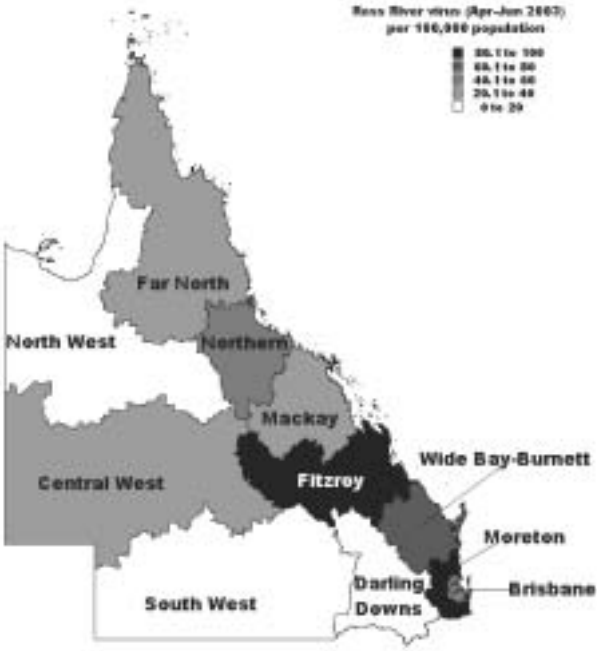


Figure 6b. Geographic distribution of notified cases of Ross River virus infection in Queensland, Australia, April to June 2003



With thanks to:

Craig Davies, Queensland Health,

Megan Counahan and Heather O'Donnell, Department of Human Services, Victoria

David Coleman, Department of Health and Human Services, Tasmania

Mark Bartlett, New South Wales Health Department

Rosie Ashbolt, OzFoodNet, Tasmania

Russell Stafford, OzFoodNet, Queensland

Joy Gregory, OzFoodNet, Victoria

Leonie Neville, OzFoodNet, New South Wales

Geoff Millard, OzFoodNet, Australian Capital Territory

References

1. Nichols P, Mooney B, Elliot N. Unusually high levels of non-saponifiable lipids in the fishes escolar and rudderfish identification by gas an thin-layer chromatography. *J Chromatographer A* 2001;936: 183-191.
2. Shadbolt C, M K, Roche P. Diarrhoea associated with consumption of escolar (rudderfish). *Commun Dis Intell* 2002;26:436-438.
3. Gregory JE. Outbreaks of diarrhoea associated with butterfish in Victoria. *Commun Dis Intell* 2002;26: 439-440.
4. Givney C. Illness associated with rudderfish/escolar in South Australia. *Commun Dis Intell* 2002;26: 440-441.
5. Yohannes K, Dalton CB, Halliday L, Unicomb LE, Kirk M. An outbreak of gastrointestinal illness associated with the consumption of escolar fish. *Commun Dis Intell* 2002;26:441-445.
6. Ashbolt R, Givney R, Gregory JE, Hall G, Hundy R, Kirk M, *et al*. Enhancing foodborne disease surveillance across Australia in 2001: the OzFoodNet Working Group. *Commun Dis Intell* 2001;26:375-406.
7. NG S, Gregory J. An outbreak of ciguatera fish poisoning in Victoria. *Commun Dis Intell* 2000;24: 344-346.
8. Hall H, Angelott R. *Clostridium perfringens* in meat and meat products. *Appl Microbiol* 1965;13:352-357.
9. OzFoodNet Working Group. Foodborne disease in Australia: incidence, notifications and outbreaks. Annual report of OzFoodNet Working Group, 2002. *Commun Dis Intell* 2003;27:209-243.
10. Greig J, Lalor K, Ferreira C, McCormick E. An outbreak of *Salmonella* Typhimurium phage type 99 linked to a hotel buffet. *Commun Dis Intell* 2001;25: 277-278.
11. Blumer C, Roche P, Spencer J, Lin M, Milton A, Bunn C, *et al*. Australia's notifiable diseases status, 2001. *Commun Dis Intel*l 2003;27:1-78.

Tables

A summary of diseases currently being reported by each jurisdiction is provided in Table 2. There were 24,512 notifications to the National Notifiable Diseases Surveillance System (NNDSS) with a notification date between 1 April and 30 June 2003 (Table 3). The notification rate of diseases per 100,000 population for each State or Territory is presented in Table 4.

There were 5,331reports received by the Virology and Serology Laboratory Reporting Scheme (LabVISE) in the reporting period, 1 April to 30 June 2003 (Tables 5 and 6).

Table 2. Reporting of notifiable diseases by jurisdiction

Disease	Data received from:*
Bloodborne diseases	
Hepatitis B (incident)	All jurisdictions
Hepatitis B (unspecified)	All jurisdictions except NT
Hepatitis C (incident)	All jurisdictions except Qld
Hepatitis C (unspecified)	All jurisdictions
Hepatitis D	All jurisdictions
Gastrointestinal diseases	
Botulism	All jurisdictions
Campylobacteriosis	All jurisdictions except NSW
Cryptosporidiosis	All jurisdictions
Haemolytic uraemic syndrome	All jurisdictions
Hepatitis A	All jurisdictions
Hepatitis E	All jurisdictions
Listeriosis	All jurisdictions
Salmonellosis	All jurisdictions
Shigellosis	All jurisdictions
SLTEC, VTEC	All jurisdictions
Typhoid	All jurisdictions
Quarantinable diseases	
Cholera	All jurisdictions
Plague	All jurisdictions
Rabies	All jurisdictions
Viral haemorrhagic fever	All jurisdictions
Yellow fever	All jurisdictions
Sexually transmissible infections	
Chlamydial infection	All jurisdictions
Donovanosis	All jurisdictions
Gonococcal infection	All jurisdictions
Syphilis	All jurisdictions

Disease	Data received from:*
Vaccine preventable diseases	
Diphtheria	All jurisdictions
Haemophilus influenzae type b	All jurisdictions
Influenza	All jurisdictions
Measles	All jurisdictions
Mumps	All jurisdictions
Pertussis	All jurisdictions
Pneumococcal disease	All jurisdictions
Poliomyelitis	All jurisdictions
Rubella	All jurisdictions
Tetanus	All jurisdictions
Vectorborne diseases	
Arbovirus infection NEC	All jurisdictions
Barmah Forest virus infection	All jurisdictions
Dengue	All jurisdictions
Japanese encephalitis	All jurisdictions
Kunjin	All jurisdictions except ACT†
Malaria	All jurisdictions
Murray Valley encephalitis	All jurisdictions except ACT†
Ross River virus infection	All jurisdictions
Zoonoses	
Anthrax	All jurisdictions
Australian Bat lyssavirus	All jurisdictions
Brucellosis	All jurisdictions
Leptospirosis	All jurisdictions
Ornithosis	All jurisdictions
Other lyssaviruses (NEC)	All jurisdictions
Q Fever	All jurisdictions
Other bacterial infections	
Legionellosis	All jurisdictions
Leprosy	All jurisdictions
Meningococcal infection	All jurisdictions
Tuberculosis	All jurisdictions

* Jurisdictions not yet reporting on diseases either because legislation has not yet made some diseases notifiable in that jurisdiction or data are not yet being reported to the Commonwealth

† In the Australian Capital Territory, Murray Valley encephalitis virus and Kunjin are combined under Murray Valley encephalitis

Table 3. Notifications of diseases received by State and Territory health authorities in the period 1 April to 30 June 2003, by date of notification*

Disease	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Total 2nd quarter 2003[1]	Total 1st quarter 2003[1]	Total 2nd quarter 2002[1]	Last 5 years mean 2nd quarter	Year to date 2003	Last 5 years YTD mean	Ratio†
Bloodborne diseases															
Hepatitis B (incident)	0	15	6	7	3	6	35	10	82	84	83	92	135	126	0.9
Hepatitis B (unspecified)	15	631	NN	205	58	13	382	119	1,423	1,489	1,444	1,795	2,207	2,396	0.8
Hepatitis C (incident)	2	15	NN	NN	12	2	21	30	82	81	79	105	162	159	0.8
Hepatitis C (unspecified)	55	1,362	43	550	147	100	897	281	3,435	3,790	3,400	4,405	5,315	6,326	0.8
Hepatitis D	0	3	0	1	0	0	1	0	5	4	2	5	6	6	1.0
Hepatitis E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Hepatitis (NEC)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Gastrointestinal diseases															
Botulism	0	0	0	0	1	0	0	0	1	0	0	1	1	2	1.0
Campylobacterosis[2]	95	NN	76	873	633	143	1,093	394	3,307	4,482	3,696	3,100	5,905	4,738	1.1
Cryptosporidiosis	4	43	18	47	25	2	41	112	292	504	2,094	N/A	676	N/A	N/A
Haemolytic uraemic syndrome	0	1	0	0	0	0	0	1	2	5	2	3	6	6	0.7
Hepatitis A	0	15	5	18	4	9	19	15	85	116	137	302	151	456	0.3
Hepatitis E	0	0	0	0	0	0	0	0	0	2	1	5	2	4	0.0
Listeriosis	0	10	0	0	1	0	7	1	19	20	14	15	30	25	1.3
Salmonellosis	20	386	92	515	105	30	265	155	1,568	2,747	2,765	1,738	3,529	3,470	0.9
Shigellosis	0	10	33	7	6	1	15	28	100	149	136	142	192	221	0.7
SLTEC,VTEC[3]	0	0	0	1	9	0	0	1	11	20	16	8	26	19	1.3
Typhoid	0	0	0	1	1	0	2	2	6	19	29	12	21	29	0.5
Quarantinable diseases															
Cholera	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0.0
Plague	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Rabies	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Viral haemorrhagic fever	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Yellow fever	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Table 3 (continued). Notifications of diseases received by State and Territory health authorities in the period 1 April to 30 June 2003, by date of notification*

Disease	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Total 2nd quarter 2003[1]	Total 1st quarter 2003[1]	Total 2nd quarter 2002[1]	Last 5 years mean 2nd quarter	Year to date 2003	Last 5 years YTD mean	Ratio†
Sexually transmissible infections															
Chlamydial infection	138	1,527	340	1,835	468	158	1,576	861	6,903	7,230	5,410	4,286	9,873	6,534	1.6
Donovanosis	0	0	0	2	0	0	0	1	3	7	8	5	11	10	0.6
Gonococcal infection[4]	7	286	374	239	77	3	304	287	1,577	1,679	1,479	1,532	2,410	2,166	1.0
Syphilis[5]	5	223	63	31	2	2	74	25	425	465	257	449	636	596	0.9
Vaccine preventable diseases															
Diphtheria	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.0
Haemophilus influenzae type b	0	3	1	0	1	1	0	0	6	2	10	11	7	9	0.6
Influenza‡	0	41	2	47	16	0	7	8	121	87	107	N/A	149	N/A	N/A
Measles	0	5	0	1	2	0	18	0	26	21	6	34	34	68	0.8
Mumps	0	5	0	3	2	0	1	1	12	19	16	45	27	50	0.3
Pertussis	44	312	0	130	47	12	97	24	666	862	1,625	1,161	1,165	1,758	0.6
Pneumococcal disease‡	14	160	15	126	40	12	100	32	499	286	242	N/A	436	N/A	N/A
Poliomyelitis	0	0	0	0	0	0	0	0	0	0	0	0		0	0.0
Rubella[6]	0	7	0	4	1	0	0	1	13	38	53	88	43	105	0.1
Tetanus	0	0	0	0	0	0	0	0	0	1	2	1	2	2	0.0
Vectorborne diseases															
Arbovirus infection NEC	0	2	0	22	0	0	2	0	26	28	7	13	31	31	2.0
Barmah Forest virus infection	0	216	3	493	0	0	2	1	715	277	251	273	668	434	2.6
Dengue	2	17	9	211	2	0	2	4	247	336	73	59	500	194	4.2
Japanese encephalitis	0	0	0	0	0	0	0	0	0	0	0	N/A	0	N/A	N/A
Kunjin virus infection	-	0	0	5	0	0	0	0	5	4	0	N/A	14	N/A	N/A
Malaria	8	20	17	60	10	3	8	21	147	175	142	173	234	287	0.8
Murray Valley encephalitis	0	0	0	0	0	0	0	0	0	0	3	N/A	0	N/A	N/A
Ross River virus infection	0	289	22	1,891	5	0	1	59	2,267	571	623	1,074	1,833	2,172	2.1

Table 3 (continued). Notifications of diseases received by State and Territory health authorities in the period 1 April to 30 June 2003, by date of notification*

Disease	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Total 2nd quarter 2003[1]	Total 1st quarter 2003[1]	Total 2nd quarter 2002[1]	Last 5 years mean 2nd quarter	Year to date 2003	Last 5 years YTD mean	Ratio†
Zoonoses															
Anthrax‡	0	0	0	0	0	0	0	0	0	0	0	N/A	0	N/A	N/A
Australian bat lyssavirus‡	0	0	0	0	0	0	0	0	0	0	0	N/A	0	N/A	N/A
Brucellosis	0	0	0	6	0	0	0	0	6	4	13	5	6	9	1.2
Leptospirosis	0	6	1	15	0	0	1	1	24	46	62	70	58	100	0.3
Other lyssavirus (NEC‡	0	0	0	0	0	0	0	0	0	0	0	N/A	0	N/A	N/A
Ornithosis	0	11	0	0	0	0	16	1	28	24	13	31	38	32	0.9
Q fever	0	57	0	30	5	0	3	5	100	199	158	156	260	226	0.6
Other bacterial infections															
Legionellosis	1	17	0	10	9	0	27	8	72	83	54	111	123	136	0.6
Leprosy	0	0	0	0	0	0	1	0	1	1	2	2	3	2	0.5
Meningococcal infection	2	38	3	21	4	2	23	8	101	86	114	138	130	141	0.7
Tuberculosis	1	40	4	5	8	0	34	12	104	168	175	236	258	348	0.4
Total	413	5,773	1,127	7,412	1,704	499	5,075	2,509	24,512	26,211	24,804	22,504	37,313	34,362	1.1

1. Totals comprise data from all States and Territories. Cumulative figures are subject to retrospective revision so there may be discrepancies between the number of new notifications and the increment in the cumulative figure from the previous period.
2. Not reported for NSW because it is only notifiable as 'foodborne disease' or 'gastroenteritis in an institution'.
3. Infections with Shiga-like toxin (verotoxin) producing *E. coli* (SLTEC/VTEC).
4. Northern Territory, Qld, SA , Vic and WA: includes gonococcal neonatal ophthalmia.
5. Includes congenital syphilis.
6. Includes congenital rubella.

* Date of notification = a composite of three dates: (i) the true onset date from a clinician, if available, (ii) the date the laboratory test was ordered, or (iii) the date reported to the public health unit.

† Ratio = ratio of current month total to mean of last 5 years calculated as described above.

‡ Notifiable from January 2001 only.

NA Not calculated as only notifiable for under 5 years.

NDR No data received.

NN Not Notifiable

NEC Not Elsewhere Classified.

\- Elsewhere Classified.

Table 4. Notification rates of diseases by State or Territory, 1 April to 30 June 2003. (Rate per 100,000 population)

Disease[1]	State or Territory								
	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Australia
Bloodborne diseases									
Hepatitis B (incident)	0.0	0.9	12.1	0.8	0.8	5.1	2.9	2.1	1.7
Hepatitis B (unspecified)	18.6	37.9	NN	22.0	15.2	11.0	31.3	24.6	29.1
Hepatitis C (incident)	2.5	0.9	NN	NN	3.2	1.7	1.7	6.2	2.1
Hepatitis C (unspecified)	68.3	81.8	87.0	59.0	38.6	84.5	73.4	58.1	69.6
Hepatitis D	0.0	0.2	0.0	0.1	0.0	0.0	0.1	0.0	0.1
Hepatitis E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hepatitis (NEC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gastrointestinal diseases									
Botulism	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0
Campylobacterosis[2]	117.9	NN	153.8	93.6	166.3	120.8	89.4	81.5	101.2
Cryptosporidiosis	5.0	2.6	36.4	5.0	6.6	1.7	3.4	23.2	5.9
Haemolytic uraemic syndrome	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.2	0.0
Hepatitis A	0.0	0.9	10.1	1.9	1.1	7.6	1.6	3.1	1.7
Hepatitis E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Listeriosis	0.0	0.6	0.0	0.0	0.3	0.0	0.6	0.2	0.4
Salmonellosis	24.8	23.2	186.1	55.2	27.6	25.3	21.7	32.0	31.8
Shigellosis	0.0	0.6	66.8	0.8	1.6	0.8	1.2	5.8	2.0
SLTEC,VTEC[3]	0.0	0.0	0.0	0.1	2.4	0.0	0.0	0.2	0.2
Typhoid	0.0	0.0	0.0	0.1	0.3	0.0	0.2	0.4	0.1
Quarantinable diseases									
Cholera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Plague	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rabies	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Viral haemorrhagic fever	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Yellow fever	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sexually transmissible									
Chlamydial infection	171.3	91.7	687.9	196.8	123.0	133.5	129.0	178.0	140.0
Donovanosis	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.2	0.1
Gonococcal infection[4]	8.7	17.2	756.7	25.6	20.2	2.5	24.9	59.3	32.0
Syphilis[5]	6.2	13.4	127.5	3.3	0.5	1.7	6.1	5.2	8.6
Vaccine preventable									
Diphtheria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Haemophilus influenzae type b	0.0	0.2	2.0	0.0	0.3	0.8	0.0	0.0	0.1
Influenza	0.0	2.5	4.0	5.0	4.2	0.0	0.6	1.7	2.5
Measles	0.0	0.3	0.0	0.1	0.5	0.0	1.5	0.0	0.5
Mumps	0.0	0.3	0.0	0.3	0.5	0.0	0.1	0.2	0.2
Pertussis	54.6	18.7	0.0	13.9	12.3	10.1	7.9	5.0	13.5
Pneumococcal disease	17.4	9.6	30.3	13.5	10.5	10.1	8.2	6.6	10.1
Poliomyelitis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rubella[6]	0.0	0.4	0.0	0.4	0.3	0.0	0.0	0.2	0.3
Tetanus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 4 (continued). Notification rates of diseases by State or Territory, 1 April to 3 0 June 2003. (Rate per 100,000 population)

Disease[1]	State or Territory								
	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Australia
Vectorborne diseases									
Arbovirus infection NEC	0.0	0.1	0.0	2.4	0.0	0.0	0.2	0.0	0.5
Barmah Forest virus infection	0.0	13.0	6.1	52.9	0.0	0.0	0.2	0.2	14.5
Dengue	2.5	1.0	18.2	22.6	0.5	0.0	0.2	0.8	5.0
Japanese encephalitis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kunjin virus infection	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.1
Malaria	9.9	1.2	34.4	6.4	2.6	2.5	0.7	4.3	3.0
Murray Valley encephalitis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ross River virus infection	0.0	17.4	44.5	202.8	1.3	0.0	0.1	12.2	46.0
Zoonoses									
Anthrax	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Australian bat lyssavirus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Brucellosis	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.1
Leptospirosis	0.0	0.4	2.0	1.6	0.0	0.0	0.1	0.2	0.5
Other lyssavirus (NEC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ornithosis	0.0	0.7	0.0	0.0	0.0	0.0	1.3	0.2	0.6
Q fever	0.0	3.4	0.0	3.2	1.3	0.0	0.2	1.0	2.0
Other bacterial infections									
Legionellosis	1.2	1.0	0.0	1.1	2.4	0.0	2.2	1.7	1.5
Leprosy	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Meningococcal infection	2.5	2.3	6.1	2.3	1.1	1.7	1.9	1.7	2.0
Tuberculosis	1.2	2.4	8.1	0.5	2.1	0.0	2.8	2.5	2.1

1. Rates are subject to retrospective revision.
2. Not reported for New South Wales because it is only notifiable as ‘foodborne disease’ or ‘gastroenteritis in an institution’.
3. Infections with Shiga-like toxin (verotoxin) producing *E. coli* (SLTEC/VTEC).
4. Northern Territory, Queensland, South Australia, Victoria and Western Australia: includes gonococcal neonatal ophthalmia.
5. Includes congenital syphilis.
6. Includes congenital rubella.

NN Not Notifiable.

NEC Not Elsewhere Classified.

— Elsewhere Classified.

Table 5. Virology and serology laboratory reports by State or Territory[1] for the reporting period 1 April to 30 June 2003, and total reports for the year[2]

	State or Territory[1]								This period 2003	This period 2002	Year to date 2003[3]	Year to date 2002
	ACT	NSW	NT	Qld	SA	Tas	Vic	WA				
Measles , mumps, rubella												
Measles virus	-	-	-	-	2	-	21	1	24	4	38	9
Mumps virus	-	-	-	-	-	-	1	-	1	6	6	11
Rubella virus	-	-	-	1	2	-	-	1	4	29	12	49
Hepatitis viruses												
Hepatitis A virus	1	-	1	8	5	-	-	4	19	18	36	39
Hepatitis D virus	-	-	-	-	-	-	1	1	2	2	8	3
Arboviruses												
Ross River virus	1	46	4	809	3	-	-	36	899	146	1,111	348
Barmah Forest virus	-	39	1	219	1	-	-	3	263	63	340	129
Dengue type 1	-	-	-	-	-	-	-	1	1	1	3	1
Dengue not typed	-	1	2	-	-	-	-	4	7	34	22	144
Flavivirus (unspecified)	-	-	-	62	-	-	3	-	65	18	104	28
Adenoviruses												
Adenovirus type 40	-	-	-	-	-	-	-	9	9	12	20	21
Adenovirus not typed/pending	-	23	6	8	118	-	3	42	200	204	400	369
Herpes viruses												
Herpes virus type 6	-	-	-	-	-	-	1	-	1		2	
Cytomegalovirus	7	35	-	30	122	4	8	-	206	246	467	538
Varicella-zoster virus	1	24	5	174	52	1	11	92	360	404	776	896
Epstein-Barr virus	1	4	11	158	152	-	16	36	378	384	836	883
Other DNA viruses												
Molluscum contagiosum	-	-	-	-	-	-	-	1	1	7	9	12
Contagious pustular dermatitis (Orf virus)	-	-	-	-	-	-	1	-	1		2	
Parvovirus	-	-	-	14	3	-	22	12	51	76	100	174
Picornavirus family												
Coxsackievirus A16	-	1	-	-	-	-	-	-	1	2	3	2
Coxsackievirus B3	-	1	-	-	-	-	-	-	1		1	
Echovirus type 9	-	1	-	-	-	-	-	-	1	6	5	14
Echovirus type 11	-	1	-	-	-	-	-	-	1	1	2	1
Poliovirus type 1 (uncharacterised)	-	7	-	-	-	-	-	-	7	10	16	14
Poliovirus type 2 (uncharacterised)	-	2	-	-	-	-	-	-	2	6	2	8
Rhinovirus (all types)	1	46	1	1	2	-	-	54	105	100	229	194
Enterovirus not typed/pending	-	1	1	7	-	-	-	19	28	141	67	266
Picornavirus not typed	-	-	-	-	-	-	2	-	2		4	12

Table 5 (continued). Virology and serology laboratory reports by state or territory[1] for the reporting period 1 April to 30 June 2003, and total reports for the year[2]

	State or Territory[1]								This period 2003	This period 2002	Year to date 2003[3]	Year to date 2002
	ACT	NSW	NT	Qld	SA	Tas	Vic	WA				
Ortho/paramyxoviruses												
Influenza A virus	-	6	-	12	75	-	1	2	96	289	198	390
Influenza B virus	-	-	-	-	26	-	-	4	30	204	57	230
Parainfluenza virus type 1	-	4	-	-	3	-	1	1	9	141	25	183
Parainfluenza virus type 2	1	9	-	1	15	-	-	1	27	36	46	45
Parainfluenza virus type 3	-	15	-	6	53	-	-	7	81	89	192	150
Parainfluenza virus type 4	-	-	-	-	-	-	-	1	1	1	1	1
Respiratory syncytial virus	-	261	1	54	38	3	4	25	386	981	521	1,106
Other RNA viruses												
HTLV-1	-	-	1	-	2	-	-	-	3	1	7	1
Rotavirus	-	14	-	-	13	2	1	42	72	295	131	386
Calicivirus	-	-	2	1	-	-	-	43	46		80	8
Norwalk agent	-	-	-	-	-	-	8	-	8	86	35	137
Other												
Chlamydia trachomatis not typed	6	116	7	397	298	18	2	197	1,041	956	2,272	1,879
Chlamydia pneumoniae	2	3	-	-	-	-	-	-	5	5	9	7
Chlamydia psittaci	-	1	-	1	1	-	21	-	24	16	41	28
Mycoplasma pneumoniae	3	30	3	91	40	5	53	4	229	301	429	583
Coxiella burnetii (Q fever)	1	-	-	9	21	-	4	1	36	53	92	112
Rickettsia australis	-	-	-	-	-	-	1	-	1	1	1	1
Rickettsia tsutsugamushi	-	-	-	-	-	-	-	1	1		1	
Streptococcus group A	1	3	-	83	-	-	39	-	126	123	271	217
Streptococcus group B	1	-	-	-	-	-	-	-	1	1	75	1
Yersinia enterocolitica	-	1	-	-	-	-	-	-	1	2	3	4
Brucella abortus	-	-	-	-	-	-	1	-	1	1	2	1
Bordetella pertussis	4	6	-	10	52	-	42	-	114	193	250	564
Legionella pneumophila	-	-	-	-	1	-	6	1	8	30	50	46
Legionella longbeachae	-	-	-	-	6	-	5	6	17	15	27	22
Legionella species	-	-	-	-	-	-	1	-	1	3	4	5
Cryptococcus species	-	-	-	4	5	-	-	-	9	8	12	14
Leptospira species	-	-	-	5	-	-	-	-	5	5	11	16
Treponema pallidum	-	17	-	122	154	-	-	3	296	411	668	690
Entamoeba histolytica	-	1	-	-	-	-	1	1	3	10	6	15
Toxoplasma gondii	-	1	-	1	5	-	-	-	7	5	21	15
Echinococcus granulosus	-	-	-	-	6	-	-	-	6	10	11	20
Total	31	720	46	2,288	1,276	33	281	656	5,331	6,192	10,170	11,042

1. State or Territory of postcode, if reported, otherwise State or Territory of reporting laboratory.
2. From January 2000 data presented are for reports with report dates in the current period. Previously reports included all data received in that period.
3. Totals comprise data from all laboratories. Cumulative figures are subject to retrospective revision, so there may be discrepancies between the number of new notifications and the increment in the cumulative figure from the previous period.

– No data received this period.

Table 6. Virology and serology laboratory reports by laboratories for the reporting period 1 April to 30 June 2003[1]

State or Territory	Laboratory	April 2003	May 2003	June 2003	Total this period
Australian Capital Territory	The Canberra Hospital	7	6	5	18
New South Wales	Institute of Clinical Pathology and Medical Research, Westmead	69	96	18	183
	New Children's Hospital, Westmead	36	96	119	251
	Repatriation General Hospital, Concord	-	-	-	-
	Royal Prince Alfred Hospital, Camperdown	5	20	20	45
	South West Area Pathology Service, Liverpool	36	3	92	131
Queensland	Queensland Medical Laboratory, West End	941	983	492	2,416
	Townsville General Hospital	-	-	-	-
South Australia	Institute of Medical and Veterinary Science, Adelaide	406	474	394	1,274
Tasmania	Northern Tasmanian Pathology Service, Launceston	10	10	14	34
	Royal Hobart Hospital, Hobart	-	-	-	-
Victoria	Monash Medical Centre, Melbourne	12	8	-	20
	Rickettsia Reference Laboratory, Geelong*	-	-	-	-
	Royal Children's Hospital, Melbourne	25	40	31	96
	Victorian Infectious Diseases Reference Laboratory, Fairfield	67	57	38	162
Western Australia	PathCentre Virology, Perth	8	329	317	654
	Princess Margaret Hospital, Perth	-	-	-	-
	Western Diagnostic Pathology	-	47	-	47
Total		1,622	2,169	1,540	5,331

1. The complete list of laboratories reporting for the 12 months, January to December 2003, will appear in every report regardless of whether reports were received in this reporting period. Reports are not always received from all laboratories.

— Nil reports

Additional reports

Australian Sentinel Practice Research Network

The Research and Health Promotion Unit of the Royal Australian College of General Practitioners operates the Australian Sentinel Practice Research Network (ASPREN). ASPREN is a network of general practitioners who report presentations of defined medical conditions each week. The aim of ASPREN is to provide an indicator of the burden of disease in the primary health setting and to detect trends in consultation rates.

There are currently about 50 general practitioners participating in the network from all states and territories. Seventy-five per cent of these are in metropolitan areas and the remainder are rural based. Between 4,000 and 6,000 consultations are recorded each week.

The list of conditions is reviewed annually by the ASPREN management committee and an annual report is published.

In 2003, 13 conditions are being monitored, five of which are related to communicable diseases. These include influenza, gastroenteritis, antibiotic prescription for acute cough, varicella and shingles. Definitions of these conditions were published in Commun Dis Intell 2003;27:125–126.

Data from 1 April to 30 June 2003 are shown as the rate per 1,000 consultations in Figures 8, 9 and 10.

Figure 8. Consultation rates for influenza-like illness, ASPREN, 1 January to 30 June 2003, by week of report

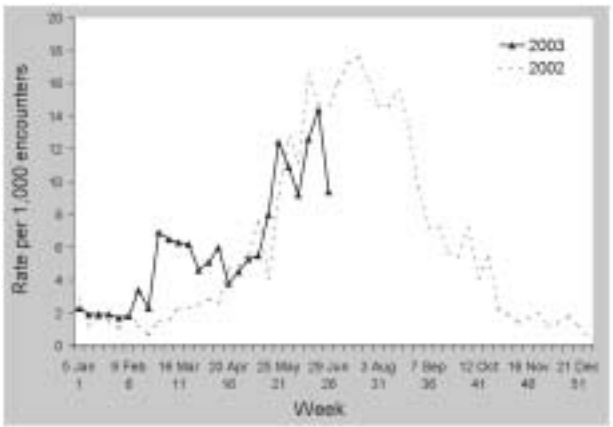


Figure 9. Consultation rates for gastroenteritis, ASPREN, 1 January to 30 June 2003, by week of report

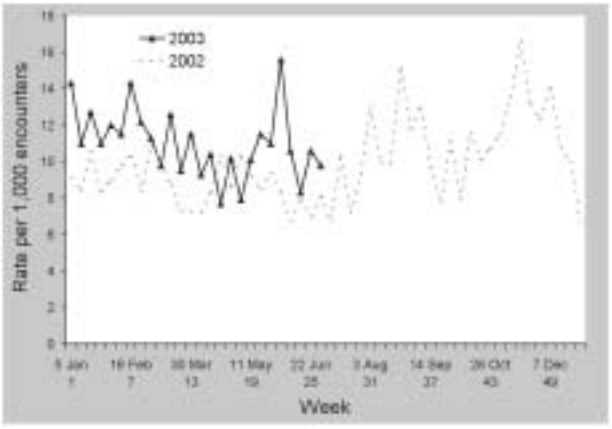
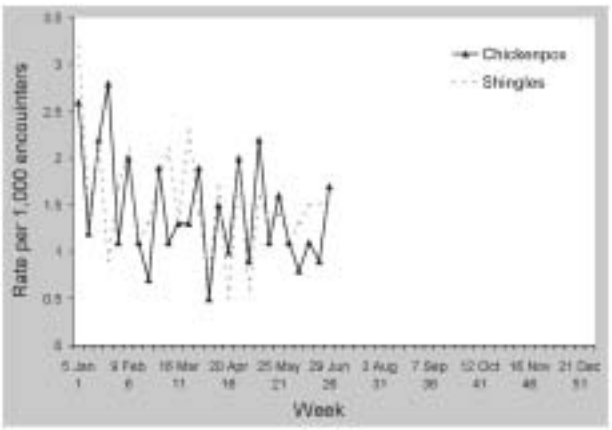


Figure 10. Consultation rates for varicella, ASPREN, 1 January to 30 June 2003, by week of report



Gonococcal surveillance

John Tapsall, The Prince of Wales Hospital, Randwick, NSW, 2031 for the Australian Gonococcal Surveillance Programme.

The Australian Gonococcal Surveillance Programme (AGSP) reference laboratories in the various States and Territories report data on sensitivity to an agreed 'core' group of antimicrobial agents quarterly. The antibiotics currently routinely surveyed are penicillin, ceftriaxone, ciprofloxacin and spectinomycin, all of which are administered as single dose regimens and currently used in Australia to treat gonorrhoea. When in vitro resistance to a recommended agent is demonstrated in 5 per cent or more of isolates from a general population, it is usual to remove that agent from the list of recommended treatment.[1] Additional data are also provided on other antibiotics from time to time. At present all laboratories also test isolates for the presence of high level (plasmid-mediated) resistance to the tetracyclines, known as TRNG. Tetracyclines are however, not a recommended therapy for gonorrhoea in Australia. Comparability of data is achieved by means of a standardised system of testing and a program-specific quality assurance process. Because of the substantial geographic differences in susceptibility patterns in Australia, regional as well as aggregated data are presented. For more information see Commun Dis Intell 2003;27:128.

Reporting period 1 January to 31 March 2003

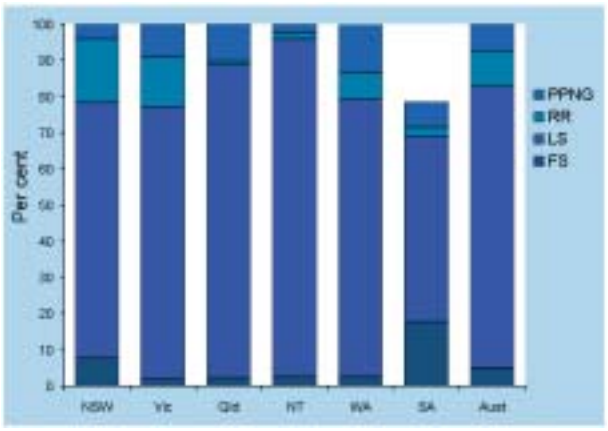
The AGSP laboratories received a total of 1,051 isolates in the first quarter of 2003 of which 1,010 remained viable for susceptibility testing. This number is almost identical to that examined in 2002. About 32 per cent of this total was from New South Wales, 22.5 per cent from Victoria, 17.6 per cent from Queensland, 12 per cent from the Northern Territory, 8 per cent from Western Australia and 7 per cent from South Australia. Isolates from other centres were few. Numbers decreased in New South Wales, but increased in Victoria, Queensland and South Australia when compared with the same period in 2002.

Penicillins

In this quarter about 17.3 per cent of all isolates were penicillin resistant by one or more mechanisms—7.3 per cent penicillinase producing *Neisseria gonorrhoeae* (PPNG) and 10 per cent by chromosomal mechanisms (CMRNG). The number and proportion of PPNG was unchanged from the same period in 2002, but the number of CMRNG decreased. The proportion of all strains resistant to the penicillins by any mechanism ranged from 4.3 per cent in the Northern Territory to 22.8 per cent in Victoria.

Figure 11 shows the proportions of gonococci fully sensitive (MIC 0.03 mg/L), less sensitive (MIC 0.06 – 1 mg/L), relatively resistant (MIC 1 mg/L) or else penicillinase producing aggregated for Australia and by state or territory. A high proportion those strains classified as PPNG or else resistant by chromosomal mechanisms fail to respond to treatment with penicillins (penicillin, amoxycillin, ampicillin) and early generation cephalosporins.

Figure 11. Categorisation of gonococci isolated in Australia, 1 January to 31 March 2003, by penicillin susceptibility and region



FS	Fully sensitive to penicillin, MIC 0.03 mg/L
LS	Less sensitive to penicillin, MIC 0.06 – 0.5 mg/L
RR	Relatively resistant to penicillin, MIC 1 mg/L
PPNG	Penicillinase producing *Neisseria gonorrhoeae*

The number of PPNG isolated across Australia (n=74) was little different from the corresponding period in 2002 (n=75). The highest proportion of PPNG was found in isolates from Western Australia (13.4%). PPNG were present in all jurisdictions including three (2.5%) in the Northern Territory. More isolates were resistant to the penicillins by separate chromosomal mechanisms (n=101) but this number was less than the 142 identified in the first quarter of 2002. CMRNG were especially prominent in New South Wales (17.6% of isolates there) and Victoria (13.6%). Only two CMRNG were detected in the Northern Territory.

Ceftriaxone

Three isolates with decreased susceptibility to ceftriaxone were present in New South Wales and one in South Australia.

Spectinomycin

All isolates were susceptible to this injectable agent.

Quinolone antibiotics

The total number (114) and proportion (11.3%) of all quinolone resistant *N. gonorrhoeae* (QRNG) was higher than seen in the first quarter of 2002 (95 isolates, 9%). The majority of QRNG (92 of 114, 80%) continue to exhibit higher level resistance. QRNG are defined as those isolates with an MIC to ciprofloxacin equal to or greater than 0.06 mg/L. QRNG are further subdivided into less sensitive (ciprofloxacin MICs 0.06 – 0.5 mg/L) or resistant (MIC 1 mg/L) groups.

QRNG were again widely distributed. The highest number (39) was found in both Victoria and New South Wales with the highest rate (17%) in Victoria (Figure 12). High rates were maintained in all other centres except for the Northern Territory (2.5%). Local and overseas acquisitions, where known, were in equal proportions and MICs ranged up to 16mg/L.

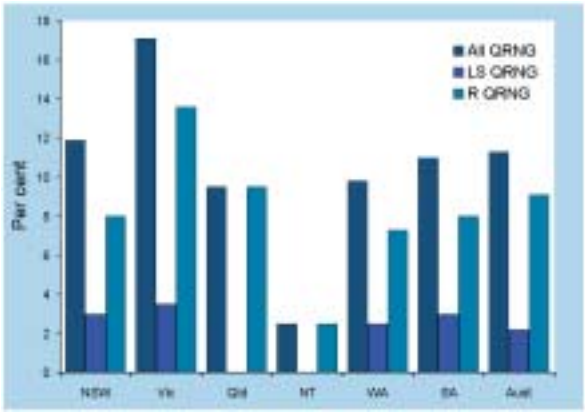
High level tetracycline resistance

The number (127) and proportion (12.5%) of tetracycline resistance *N. gonorrhoeae* (TRNG) was little changed from the 2002 figures. TRNG represented between 5 and 19.5 per cent of isolates from Queensland, Victoria, South Australia, Western Australia and New South Wales with three TRNG present in the Northern Territory.

Reference

1. Management of sexually transmitted diseases. World Health Organization 1997; Document WHO/GPA/TEM94.1 Rev.1 p 37.

Figure 12. Distribution in Australia of *N. gonorrhoeae* showing quinolone resistance, 1 January to 31 March 2003



LS QRNG = Ciprofloxacin MICs 0.06 – 0.5 mg/L

R QRNG = Ciprofloxacin MICs 1 mg/L

HIV and AIDS surveillance

National surveillance for HIV disease is coordinated by the National Centre in HIV Epidemiology and Clinical Research (NCHECR), in collaboration with State and Territory health authorities and the Commonwealth of Australia. Cases of HIV infection are notified to the National HIV Database on the first occasion of diagnosis in Australia, by either the diagnosing laboratory (Australian Capital Territory, New South Wales, Tasmania, Victoria) or by a combination of laboratory and doctor sources (Northern Territory, Queensland, South Australia, Western Australia). Cases of AIDS are notified through the State and Territory health authorities to the National AIDS Registry. Diagnoses of both HIV infection and AIDS are notified with the person's date of birth and name code, to minimise duplicate notifications while maintaining confidentiality.

Tabulations of diagnoses of HIV infection and AIDS are based on data available three months after the end of the reporting interval indicated, to allow for reporting delay and to incorporate newly available information. More detailed information on diagnoses of HIV infection and AIDS is published in the quarterly Australian HIV Surveillance Report, and annually in 'HIV/AIDS, viral hepatitis and sexually transmissible infections in Australia, annual surveillance report'. The reports are available from the National Centre in HIV Epidemiology and Clinical Research, 376 Victoria Street, Darlinghurst NSW 2010. Internet: http://www.med.unsw.edu.au/nchecr. Telephone: +61 2 9332 4648. Facsimile: +61 2 9332 1837. For more information see Commun Dis Intell 2003;27:57.

HIV and AIDS diagnoses and deaths following AIDS reported for 1 January to 31 March 2003, as reported to 30 June 2003, are included in this issue of Communicable Diseases Intelligence (Tables 7 and 8).

Table 7. New diagnoses of HIV infection, new diagnoses of AIDS and deaths following AIDS occurring in the period 1 January to 31 March 2003, by sex and State or Territory of diagnosis

		State or territory								Totals for Australia			
		ACT	NSW	NT	Qld	SA	Tas	Vic	WA	This period 2003	This period 2002	Year to date 2003	Year to date 2002
HIV diagnoses	Female	0	9	0	5	0	0	4	3	21	32	21	32
	Male	0	108	1	35	2	0	44	5	195	188	195	188
	Sex not reported	0	1	0	0	0	0	0	0	1	1	1	1
	Total[1]	0	118	1	40	2	0	48	8	217	223	217	223
AIDS diagnoses	Female	0	0	0	0	0	0	0	1	1	7	1	7
	Male	0	5	0	3	0	0	8	2	18	56	18	56
	Total[1]	0	5	0	3	0	0	8	3	19	64	19	64
AIDS deaths	Female	0	1	0	1	1	0	0	1	4	2	4	2
	Male	0	5	0	2	1	0	4	1	13	14	13	14
	Total[1]	0	6	0	3	2	0	4	2	17	16	17	16

1. Persons whose sex was reported as transgender are included in the totals.

Table 8. Cumulative diagnoses of HIV infection, AIDS and deaths following AIDS since the introduction of HIV antibody testing to 31 March 2003, by sex and State or Territory

		State or Territory								
		ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Australia
HIV diagnoses	Female	28	699	14	198	78	7	275	150	1,449
	Male	238	12,053	117	2,296	755	85	4,443	1,025	21,012
	Sex not reported	0	235	0	0	0	0	24	0	259
	Total[1]	266	13,013	131	2,501	833	92	4,760	1,181	22,777
AIDS diagnoses	Female	9	212	0	54	30	4	85	33	427
	Male	90	4,920	38	931	376	47	1,788	396	8,586
	Total[1]	99	5,145	38	987	406	51	1,882	431	9,039
AIDS deaths	Female	4	125	0	38	19	2	57	22	267
	Male	71	3,396	26	610	252	31	1,332	273	5,991
	Total[1]	75	3,530	26	650	271	33	1,396	296	6,277

1. Persons whose sex was reported as transgender are included in the totals.

Childhood immunisation coverage

Tables 9, 10 and 11 provide the latest quarterly report on childhood immunisation coverage from the Australian Childhood Immunisation Register (ACIR).

The data show the percentage of children fully immunised at 12 months of age for the cohort born between 1 January and 31 March 2002, at 24 months of age for the cohort born between 1 January and 31 March 2001, and at 6 years of age for the cohort born between 1 January and 31 March 1997 according to the Australian Standard Vaccination Schedule. A full description of the methodology used can be found in Commun Dis Intell 1998;22:36-37.

Commentary on the trends in ACIR data is provided by the National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases (NCIRS). For further information please contact the NCIRS at telephone: +61 2 9845 1256, Email: brynleyh@chw.edu.au.

Immunisation coverage for 'fully immunised' children at 12 months for Australia has decreased marginally from the last quarter by 0.3 percentage points to 91.2 per cent (Table 9). There was very little change in 'fully immunised' coverage by state and territory. The Northern Territory showed the biggest change (+0.8%). Only three jurisdictions had changes in coverage of greater than 0.5 per cent for individual vaccines: Tasmania, with decreases in coverage for diphtheria, tetanus, pertussis (DTP) (-0.9%), and poliomyelitis (OPV) (-1.1%); Queensland, with decreases in coverage for DTP (-0.9%) and OPV (-0.9%); and the Northern Territory, with increases in coverage for *Haemophilus influenzae* type b (Hib) (1.4%) and hepatitis B (Hep B) (1.2%).

Of note is the difference in coverage between Hep B and DTP antigens at 12 months of age for the jurisdictions that use the combined DTP/HepB vaccine (New South Wales, Queensland, South Australia, the Australian Capital Territory and the Northern Territory). These range from 1.7 to 5 per cent. This is accounted for by the way coverage is calculated at the 12 month milestone. To be consistent with those jurisdictions that use the combined Hib/Hep B vaccine (Comvax), the coverage algorithm allows receipt of either two or three doses for a child to be considered up-to-date for Hep B. In contrast, receipt of three doses is required for a child to be considered up-to-date for DTP at 12 months. This means that hepatitis B and Hib coverage (where only 2 doses are required) is uniformly higher than DTP and OPV coverage.

Coverage measured by 'fully immunised' at 24 months of age for Australia increased marginally from the last quarter by 0.3 percentage points to 89.3 per cent (Table 10). Coverage for individual vaccines for Australia remained unchanged with DTP still almost 3 percentage points lower than other vaccines for this age group. This difference is again due to the greater number of DTP doses required to be considered up-to-date at 24 months of age.

The only important jurisdictional changes in coverage at 24 months of age occurred in the Northern Territory, with a 2.3 per cent increase in DTP and a 2 per cent increase in 'fully immunised' coverage. This is the second consecutive quarter where 'fully immunised' coverage in the Northern Territory has increased by 2 percentage points at 24 months.

Table 9. Percentage of children immunised at 1 year of age, preliminary results by disease and State or Territory for the birth cohort 1 January to 31 March 2002; assessment date 30 June 2003

	State or Territory								
Vaccine	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Australia
Total number of children	904	19,432	845	11,209	4,132	1,326	13,812	5,632	57,292
Diphtheria, tetanus, pertussis (%)	92.6	92.2	92.3	92.0	92.4	92.9	92.7	90.9	92.2
Poliomyelitis (%)	92.6	92.1	91.9	91.9	92.2	92.7	92.6	90.8	92.1
Hepatitis B (%)	93.8	94.3	96.8	94.3	94.9	95.5	95.1	94.0	94.6
Haemophilus influenzae type b (%)	94.3	95.1	97.3	94.7	95.2	95.4	95.0	93.8	94.9
Fully immunised (%)	91.5	91.0	91.7	91.1	91.5	91.9	91.8	89.9	91.2
Change in fully immunised since last quarter (%)	-1.4	-0.3	+0.8	-0.6	+0.0	-0.9	-0.1	-0.2	-0.3

Table 10. Proportion of children immunised at 2 years of age, preliminary results by disease and State or Territory for the birth cohort 1 January to 31 March 2001; assessment date 30 June 2003[1]

Vaccine	State or Territory								
	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Australia
Total number of children	885	18,785	767	11,164	4,004	1,415	13,631	5,394	56,045
Diphtheria, tetanus, pertussis (%)	90.4	90.8	90.5	91.8	91.8	94.3	92.1	89.2	91.3
Poliomyelitis (%)	93.4	94.7	97.6	94.8	95.3	96.7	95.6	94.2	95.0
Haemophilus influenzae type b (%)	92.9	93.5	95.2	93.8	94.4	96.2	94.4	92.5	93.8
Measles, mumps, rubella (%)	93.4	93.8	96.3	93.9	94.5	96.0	94.7	93.3	94.1
Hepatitis B (%)	94.6	95.4	98.5	95.2	95.7	97.5	96.4	95.1	95.7
Fully immunised (%)[2]	86.9	88.4	89.0	89.8	90.4	93.6	90.5	87.0	89.3
Change in fully immunised since last quarter (%)	+0.2	+0.4	+1.9	+0.1	+0.4	+0.7	+0.5	-0.3	+0.3

1. The 12 months age data for this cohort was published in *Commun Dis Intell* 2002;26:490.
2. These data relating to 2 year-old children should be considered as preliminary. The proportions shown as 'fully immunised' appear low when compared with the proportions for individual vaccines. This is at least partly due to poor identification of children on immunisation encounter forms.

Table 11. Proportion of children immunised at 6 years of age, preliminary results by disease and State for the birth cohort 1 January to 31 March 1997; assessment date 30 June 2003[1]

Vaccine	State or Territory								
	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Australia
Total number of children	861	17,900	13,389	10,367	3,806	5,307	1,234	662	53,526
Diphtheria, tetanus, pertussis (%)	82.3	84.3	86.5	83.6	83.2	82.5	83.7	82.0	84.4
Poliomyelitis (%)	82.5	84.1	87.0	83.9	83.7	82.9	84.1	84.9	84.6
Haemophilus influenzae type b (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Measles, mumps, rubella (%)	81.8	82.7	86.5	83.5	82.7	82.2	82.6	83.0	83.7
Hepatitis B (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fully immunised (%)[1]	80.4	81.2	85.3	82.0	81.3	80.6	82.2	81.1	82.3
Change in fully immunised since last quarter (%)	-1.4	+0.7	-1.1	-0.3	+0.5	-1.6	-0.1	+0.6	+0.1

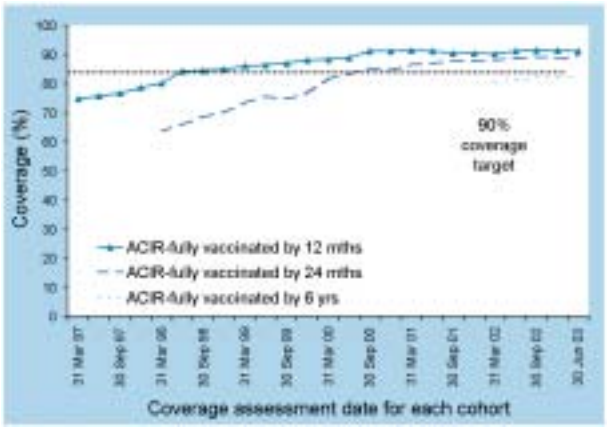
1. These data relating to 6 year-old children should be considered as preliminary. The proportions shown as 'fully immunised' appear low when compared with the proportions for individual vaccines. This is at least partly due to poor identification of children on immunisation encounter forms.

Table 11 shows immunisation coverage estimates for 'fully immunised' and for individual vaccines at 6 years of age for Australia and by state or territory. 'Fully immunised' coverage at 6 years of age for Australia remained virtually unchanged from the previous quarter at 82.3 per cent but decreased in Tasmania (-1.6%) and the Northern Territory (-1.1%).

Figure 13 shows the trends in vaccination coverage from the first ACIR-derived published coverage estimates in 1997 to the current estimates. There is a clear trend of increasing vaccination coverage over time for children aged 12 months, 24 months and 6 years, although the rate of increase has slowed over the past two years.

Acknowledgment: These figures were provided by the Health Insurance Commission (HIC), to specifications provided by the Commonwealth Department of Health and Ageing. For further information on these figures or data on the Australian Childhood Immunisation Register please contact the Immunisation Section of the HIC: Telephone: +61 2 6124 6607.

Figure 13. Trends in vaccination coverage, Australia, 1997 to 2003, by age cohorts



National Enteric Pathogens Surveillance System

The National Enteric Pathogens Surveillance System (NEPSS) collects, analyses and disseminates data on human enteric bacterial infections diagnosed in Australia. These pathogens include Salmonella, E. coli, Vibrio, Yersinia, Plesiomonas, Aeromonas *and* Campylobacter. Communicable Diseases Intelligence *quarterly reports include only* Salmonella.

Data are based on reports to NEPSS from Australian laboratories of laboratory-confirmed human infection with Salmonella. Salmonella *are identified to the level of serovar and, if applicable, phage-type. Infections apparently acquired overseas are included. Multiple isolations of a single* Salmonella *serovar/phage-type from one or more body sites during the same episode of illness are counted once only. The date of the case is the date the primary diagnostic laboratory isolated a* Salmonella *from the clinical sample.*

Note that the historical quarterly mean counts should be interpreted with caution, and are affected by surveillance artefacts such as newly recognised (such as S. *Typhimurium 197 and* S. *Typhimurium U290) and incompletely typed* Salmonella.

Reported by Joan Powling (NEPSS Co-ordinator) and Mark Veitch (Public Health Physician), Microbiological Diagnostic Unit, Public Health Laboratory, Department of Microbiology and Immunology, University of Melbourne. NEPSS can be contacted at the above address or by telephone: +61 3 8344 5701, facsimile: +61 3 9625 2689. For more information see Commun Dis Intell 2003;27:129.

Reports to the National Enteric Pathogens Surveillance System of Salmonella infection for the period 1 April to 30 June 2003 are included in Tables 12 and 13. Data include cases reported and entered by 11 July 2003. Counts are preliminary, and subject to adjustment after completion of typing and reporting of further cases to NEPSS.

1 April to 30 June 2003

The total number of reports to NEPSS of human *Salmonella* infection declined to 1,505 in the second quarter of 2003, 39 per cent less than the first quarter of 2003. This represents typical seasonal decline in the overall incidence of human salmonellosis. Case counts to 11 July 2003 are approximately 90 per cent of the expected final counts for the quarter.

During the second quarter of 2003, the 25 most common *Salmonella* types in Australia accounted for 985 (65%) of all reported human *Salmonella* infections.

Twenty-one of the 25 most common *Salmonella* infections in the second quarter of 2003 were amongst the 25 most commonly reported in the previous quarter.

Notable increases in particular salmonellae include *S*. Typhimurium phage type 9 (in New South Wales and Victoria), *S*. Typhimurium phage type 99 (in New South Wales), and *S*. Typhimurium phage type U307 (in Queensland).

S. Typhimurium phage type 170 was the third most commonly reported *Salmonella* in Australia in the second quarter of 2003. There were a further 8 reports of the similar phage type, *S*. Typhimurium phage type 108.

The incidence of S. Typhimurium phage type 135 decreased, particularly in the eastern mainland States.

Acknowledgement: Thanks to contributing laboratories and scientists.

Table 12. Reports to the National Enteric Pathogens Surveillance System of *Salmonella* isolated from humans during the period 1 April to 30 June 2003, as reported to 11 July 2003

	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Aust
Total all *Salmonella* for quarter	19	410	73	453	82	34	291	143	1,505
Total contributing *Salmonella* types	7	90	38	100	42	10	82	56	200

Table 13. Top 25 *Salmonella* types identified in Australian States and Territories, 1 April to 30 June 2003

National rank	*Salmonella* type	State or territory								Total 2nd quarter 2003	Last 10 years mean 2nd quarter	Year to date 2003	Year to date 2002
		ACT	NSW	NT	Qld	SA	Tas	Vic	WA				
1	*S.* Typhimurium 9	2	61	2	10	6	2	76	5	164	105	295	439
2	*S.* Typhimurium 135	10	32	1	13	3	2	18	20	99	121	509	441
3	*S.* Typhimurium 170	2	54	0	13	0	0	27	1	97	24	302	260
4	*S.* Infantis	1	35	3	7	3	0	8	5	62	25	133	62
5	*S.* Saintpaul	0	5	7	38	1	1	2	6	60	83	185	255
6	*S.* Virchow 8	0	2	1	41	0	0	1	0	45	37	114	223
7	*S.* Birkenhead	0	15	0	26	0	0	1	0	42	53	123	167
8	*S.* Anatum	0	5	7	19	1	0	3	7	42	25	77	51
9	*S.* Chester	0	6	2	15	3	0	0	11	37	38	150	108
10	*S.* Typhimurium U290	2	5	0	3	0	2	24	1	37	3	73	56
11	*S.* Typhimurium 197	0	10	0	12	0	0	6	0	28	2	107	24
12	*S.* Muenchen	0	2	3	12	1	0	1	8	27	35	89	88
13	*S.* Mississippi	0	0	0	0	0	22	2	0	24	16	66	69
14	*S.* Typhimurium 99	0	22	0	0	1	1	0	0	24	2	25	9
15	*S.* Aberdeen	0	0	0	21	0	0	0	0	21	27	56	98
16	*S.* Hvittingfoss	0	0	1	19	0	0	0	1	21	19	56	111
17	*S.* Agona	0	7	2	3	2	1	6	0	21	15	41	53
18	*S.* Typhimurium 12	0	4	0	11	1	0	4	0	20	11	62	43
19	*S.* Waycross	0	4	0	14	0	0	1	0	19	26	49	73
20	*S.* Havana	0	3	1	7	0	0	3	4	18	11	39	17
21	*S.* Typhimurium 126	0	10	0	1	1	0	4	0	16	26	42	141
22	*S.* Typhimurium 4	1	5	0	2	4	0	4	0	16	9	41	46
23	*S.* Mbandaka	0	3	1	2	1	0	0	8	15	18	32	17
24	*S.* Singapore	0	7	0	4	2	0	0	2	15	16	45	35
25	*S.* Typhimurium U307	0	2	1	11	0	0	1	0	15	2	17	18

Overseas briefs

World Health Organization

This material has been summarised from information on the World Health Organization Internet site. A link to this site can be found under 'Other Australian and international communicable diseases sites' on the Communicable Diseases Australia homepage.

SARS transmission interrupted in last outbreak area

On 5 July 2003 the World Health Organization (WHO) removed Taiwan from its list of areas with recent local transmission of SARS. This achievement meant that all known chains of person-to-person transmission of the SARS virus have now been broken. The last reported probable case in Taiwan, and—for the moment—in the world, was detected and isolated on 15 June. Two consecutive 10-day incubation periods have now passed with no further cases detected.

The achievement comes just slightly more than four months since the virus began moving around the world, in late February, along the routes of international air travel.

Taiwan eventually had to cope with the third largest outbreak on record, including 674 cases and 84 deaths. The largest outbreaks occurred in Mainland China (5,327 cases and 348 deaths) and Hong Kong (1,755 cases and 298 deaths).

The global SARS outbreak developed quickly and dramatically, creating challenging and stressful demands on staff and health authorities at every outbreak site. The containment of SARS required heroic efforts and extraordinary measures that are difficult to sustain over time.

WHO continues to receive rumours of possible cases, which indicates that surveillance systems are working well. To date, all recently reported possible cases have been aggressively investigated and determined to have other causes. Failure to detect new cases for a further two weeks would greatly increase confidence that the SARS coronavirus has indeed been pushed out of its new human host, although a return of the disease cannot be ruled out completely on the basis of current knowledge.

ProMED-mail

This material has been summarised from information provided by ProMED-mail (http://ww.promedmail.org). A link to this site can be found under 'Other Australian and international communicable diseases sites' on the Communicable Diseases Australia homepage.

Cholera, diarrhoea and dysentery update

Hong Kong

Source: Xinhuanet, 21 June 2003 (edited)

On 21 June 2003 the Department of Health of Hong Kong urged the public to be on guard against foodborne infections following the confirmation of a case of coinfection with *Vibrio cholerae* and *Vibrio parahaemolyticus*. The case, which was the first reported cholera case in Hong Kong in 2003, was a 39-year-old woman. She is now in stable condition in a hospital, according to the health department. Four confirmed cholera cases were reported in 2002, among which two were imported and two were local cases.

Iraq

Source: WHO Outbreak Reports, 19 June 2003 (edited)

From 28 April to 4 June 2003, a total of 73 laboratory-confirmed cholera cases were reported in Iraq. No deaths were reported. From 17 May to 4 June 2003, the daily surveillance system of diarrhoeal disease cases in the 4 main hospitals of Basra reported a total of 1,549 cases of acute watery diarrhoea. The water supply situation is critical. Short-term measures have been undertaken by UNICEF and local authorities to improve accessibility to safe drinking water and to limit the spread of water-borne epidemics.

Mozambique

Source: WHO Outbreak Reports, 16 June 2003 (edited)

As of 15 June 2003, a total of 11,796 cases and 87 deaths (case fatality rate, 0.74%) were reported by the Ministry of Public Health in Mozambique. From 1 January to 15 June 2003, Maputo province registered 4,124 cases with 31 deaths, with the number of cases now declining. The peak of the outbreak in Maputo province and Maputo city occurred at the same time as a cholera outbreak began in Mpumalanga province, South Africa. During the same period, cholera cases were also reported in Northern Hohho, Swaziland which borders on Mpumalanga province, South Africa. WHO was therefore proposing cross-border initiatives to control these cholera outbreaks.

Congo

Source: WHO Outbreak News, 13 June 2003 (edited)

As of 8 June 2003, the Ministry of Health, Democratic Republic of the Congo reported a total of 13,452 cases of cholera including 380 deaths (case fatality rate, 2.82%) in the country.

Typhoid

Haiti

Source: WHO Outbreak Reports, 17 June 2003 (edited)

As of 30 May 2003, 200 cases of typhoid and 40 deaths have been reported by the WHO Regional Office for the Americas and the Ministry of Health, Haiti. Three cases have been laboratory-confirmed. The outbreak started in April 2003 during the dry season and affected remote villages in the Grand Bois Area, bordering the Dominican Republic. These villages lack access to health care facilities and to safe water; all water points in the area showed a maximum level of *E. coli* pollution. Most of the deaths occurred in persons who had no access to health care facilities.

Report on actions taken by Canada in response to the confirmation of an indigenous case of BSE

Source: Canadian Food Inspection Agency, 26 June 2003 (edited)

The Canadian investigation into an indigenous case of bovine spongiform encephalopathy (BSE) has looked at both the circumstances surrounding the index case of BSE and the macro-epidemiological risk factors, which have contributed to the expression and detection of the first indigenous case in North America. It is important to acknowledge that measures previously in place achieved their designed outcome as demonstrated by the identification of the positive animal in a manner which precluded its entry into the human food chain. Furthermore, the various risk management measures implemented by Canada over a number of years have reduced the risks of spread and amplification of the disease.

The Canadian experts have established epidemiological evidence that supports the probability that the expression of BSE in the case animal was associated with exposure to infective material through the feeding system at some point early in the life of the animal.

Prior to the implementation of the feed ban in 1997, opportunities existed for animals in the source herd to have been legally fed rations containing ruminant meat and bone meal (MBM). It cannot be determined whether the contaminated MBM was of imported or domestic origin. Neither can past exposure of other cattle to contaminated feed be discounted. The possibility that products were derived from the positive cow, and the possibility that other infected cattle in the late stages of incubation are present in Canadian herds, lead to the conclusion that the adoption of additional measures to reduce or eliminate future exposure are warranted.

Monkeypox, human, prairie dogs – USA

Source: Morbidity and Mortality Weekly Report, 27 June 2003;52:589–590 (edited)

The Centers for Disease Control and Prevention (CDC) and state and local health departments continue to investigate cases of monkeypox among persons who had contact with wild or exotic mammalian pets or persons with monkeypox.[1,2] As of 25 June 2003, a total of 79 cases of monkeypox had been reported to CDC; these included 29 cases which were laboratory-confirmed at CDC and 51 cases under investigation by state and local health departments. Of the 79 cases, 37 (47%) were among males; the median age was 28 years (range: 1 to 51 years). Among 75 patients for whom data were available, 19 (25%) were hospitalised. Two patients have had a serious clinical illness. The first patient was a child with a previously reported laboratory-confirmed case of severe monkeypox-associated encephalitis;[1,2] the child subsequently improved and was discharged after requiring hospitalisation for 14 days. A second child, who was exposed to three ill prairie dogs, was hospitalised with profound painful cervical and tonsillar adenopathy and diffuse pox lesions, including lesions in the oropharynx. Although the child had difficulty breathing and swallowing, mechanical ventilation was not required. The adenopathy peaked five days after rash onset and seven days after onset of initial prodromal symptoms of general malaise, myalgia, and fever. Preliminary testing of skin rash lesions was positive for orthopoxvirus infection; confirmatory testing for monkeypox virus is pending at CDC.

All confirmed patients reported a rash and at least one other clinical sign or symptom, including fever, respiratory symptoms, and/or lymphadenopathy. The median incubation period (i.e. first exposure date to illness onset date) was 12 days (range: 2 to 26 days). The majority of confirmed patients reported exposure to wild or exotic mammals, including prairie dogs; some patients also had contact with other persons with monkeypox virus infection in a household setting. No cases of monkeypox that could be attributed exclusively to person-to-person contact have been confirmed.

To prevent further transmission of monkeypox, 26 residents of five states have received smallpox vaccine since 13 June 2003; recipients included 24 adults and two children. CDC has issued updated interim guidance on the use of smallpox vaccine, cidofovir, and vaccinia immune globulin for prevention and treatment in the setting of an outbreak of monkeypox.[3]

References

1. Centers for Disease Control and Prevention. Multi-state outbreak of monkeypox—Illinios, Indiana, and Wisconsin, 2003. *MMWR Morb Mortal Wkly Rep* 2003;52:537–540.
2. Centers for Disease Control and Prevention. Update: multistate outbreak of monkeypox—Illinois, Indiana, Kansas, Missouri, Ohio, and Wisconsin, 2003 *MMWR Morb Mortal Wkly Rep* 2003;52:561–564.
3. Centers for Disease Control and Prevention. Interim guidance for use of smallpox vaccine, cidofovir, and VIG for prevention and treatment in the setting of an outbreak of monkeypox infections. Available from http://www.cdc.gov/ncidod/monkeypox/clinicians.htm.

Dengue/DHF update

The Philippines

Source: Sun Star, 21 June 2003 (edited)

Health authorities have declared a dengue outbreak in Paracelis, Mt Province following 107 cases of dengue fever recorded from January to May 2003. No fatalities have been recorded but some of the dengue patients, whose ages range from one month to 68 years, are in critical conditions. An initial report showed that: 'The present outbreak can be attributed to the onset of rainy days, which signalled an increase in mosquito breeding sites.' The report added that most of these breeding grounds include artificial containers like uncovered drums, pails and discarded litter like tins, bottles, coconut shells and tires. A massive fogging activity has already been implemented in identified dengue endemic areas to eliminate the dengue carriers.

Thailand

Source: Business Day, Agence France Presse, 17 June 2003 (edited)

The authorities are predicting a deadly wave of dengue fever this year, the third consecutive year the kingdom has been hit hard by the mosquito-borne disease. The public health ministry said that so far this year there have been 24,004 registered cases of dengue fever, with 23 deaths. But it warned that infections would rise during the approaching rainy season.

India

Source: The Times of India, 17 June 2003 (edited)

A total of 279 cases and 16 deaths have been reported in Kerala. A special response team had been constituted in the affected districts and extra funds allotted for disease control.

Myanmar

Source: Xinhuanet, 18 June 2003 (edited)

The World Health Organization (WHO) has called for increased public involvement in the control and prevention of dengue haemorrhagic fever (DHF), a life threatening disease occurring intermittently in Myanmar especially in the northern Mandalay division.

DHF mostly causes death among children aged under 15 in South East Asia including Myanmar, and the factors that contribute to DHF include population increase, urbanisation and a lack of effective mosquito control. DHF was first detected in Yangon in 1969 and a major outbreak of the disease followed in 1970, which was confined to Yangon until 1973. The first case in Mandalay division was detected in 1974 and major outbreaks have occurred in the division about every four years with the most recent in last year.

Laos

Source: Saudi Press Agency, 2 June 2003 (edited)

An epidemic of dengue fever has killed seven people and about 1,100 others have been infected by the disease in Vientiane, the capital of Laos, the government-run radio reported on 2 June 2003. Health officials were working to contain the outbreak of the disease.

Brazil

Source: EPTV Campinas & EPTV Ribeirão, 16 June 2003 (edited)

In spite of the mass prevention campaign, the number of cases of dengue reported in 2003 has already passed the total for 2002 in two cities in the interior of Sao Paulo state. According to the WHO Regional Office for the Americas provisional data, so far in 2003 DEN–1, DEN–2 and DEN–3 have been associated with dengue haemorrhagic fever cases in Brazil.

Honduras

Source: La Prensa, Honduras, 22 June 2003 (edited)

The Minister of Health, confirmed the death of one person from dengue haemorrhagic fever (DHF) in the township of Trinidad, Santa Barbara. This brings the number of cases of DHF in 2003 to nine. During 2002, the Health Secretary recorded 3,096 cases of dengue; in 2003, 2,096 cases have been reported nationwide so far. According to PAHO provisional data, so far in 2003 only DEN–2 has been recorded in association with dengue haemorrhagic fever cases in Honduras.

Smallpox vaccination adverse events – USA

Source: The New York Times, 19 June 2003 (edited)

On 18 June 2003 government officials reported that both the civilian and military smallpox vaccination programs had virtually come to a halt: the military program because it has vaccinated everyone it can and the civilian program because few people volunteered for it.

Officials also said that of the 493,000 people who had been vaccinated, the rate of dangerous side effects was lower than predicted. Although eight people had heart attacks after immunisations and three died, it is unclear whether the deaths were coincidental. The heart attack victims were middle aged, and several had clogged arteries, diabetes, or other risk factors like smoking. There were no deaths from encephalitis, eczema vaccinatum, progressive vaccinia, or the other side effects predicted last year based on studies from smallpox vaccination drives in the 1960s. About 125 women who were pregnant or became pregnant were inadvertently vaccinated, despite screening. Thus far, there has been no vaccinia in foetuses, and miscarriage rates have been normal, though they are still being followed. Vaccination did seem to increase the risk of myocarditis in the military vaccines.

CJD (new variant) – United Kingdom: update

Revised mortality predictions

Source: BBC News online, 20 May 2003 (edited)

The worst of the variant Creutzfeldt-Jakob disease (vCJD) problem could be over, researchers suggest. As few as 40 people in the United Kingdom could die from the human form of bovine spongiform encephalopathy over the next 80 years, according to researchers at Imperial College, London.

Statistics from the CJD Surveillance Unit show 131 people have died from vCJD in the UK since it emerged in 1995. Deaths are thought to have peaked in 2000, when 28 people died from the condition. In 2001, 20 died, falling to 17 in 2002. So far this year, 10 people have died from the disease.

Dr Azra Ghani, who carried out the work, said at worst, only another 540 cases would be reported in the UK by 2080. He said, 'Our results suggest that the vCJD epidemic will continue to decline, with a best estimate of only 40 future cases.' Dr Ghani's predictions are based on data up to the 2002 figures, and do not include any cases arising through secondary transmission, such as via surgical equipment. The research was published in the online version of BioMed Central Infectious Diseases magazine.

Monthly CJD statistics

Source: UK Department of Health, press release 2003/0217, CJD Monthly Statistics, 2 June 2003 (edited)

Summary of vCJD cases

Deaths from definite vCJD (confirmed): 97

Deaths from probable vCJD (without neuropathological confirmation): 30

Deaths from probable vCJD (neuropathological confirmation pending): 4

Number of deaths from definite or probable vCJD: 131

Number of probable vCJD cases still alive: 4

Total number of definite or probable vCJD (dead and alive): 135

Anthrax, 2001 attacks – USA: product reproduced

Source: Baltimore Sun, 11 April 2003 (edited)

Army scientists have reproduced the anthrax powder used in the 2001 mail attacks and concluded that it was made using simple methods, inexpensive equipment, and limited expertise, according to government sources familiar with the work. The findings reinforce the theory that has guided the FBI's 18-month-long investigation: that the mailed anthrax was probably produced by renegade scientists and not a military program such as Iraq's.

FBI and Postal Inspection Service agents initially considered a link to the 11 September hijackers or Iraq, however, after genetic analysis showed the anthrax was derived from the Ames strain used in the USA military biodefence program, investigators concentrated their effort on a domestic source.

Avian influenza – Europe

Source: European Union Press release IP/03/837, 13 June 2003 (edited)

The Standing Committee on the Food Chain and Animal Health agreed to reauthorise the export of live poultry and hatching eggs from certain parts of the Netherlands, provided no further outbreaks or suspicions are recorded. The decision was to take effect from 18 June 2003. Restrictions remain in place for the five provinces with surveillance zones. No further decisions were taken for Belgium or Germany.