Annual report of the Australian Meningococcal Surveillance Programme, 2001

The Australian Meningococcal Surveillance Programme

Abstract

Since 1994, The National Neisseria Network has examined and analysed isolates of *Neisseria meningitidis* from cases of invasive meningococcal disease in Australia by means of a collaborative laboratory program. The phenotypes (serogroup, serotype and serosubtype) and antibiotic susceptibility of 338 isolates of *N. meningitidis* from invasive cases of meningococcal disease were determined in 2001. Most disease was caused by serogroup B (206 isolates, 61%) or serogroup C (122 isolates, 36%) meningococci. However, there was considerable diversity in the phenotypes circulating in the different states and territories. Serogroup B strains predominated in all jurisdictions except Victoria and Tasmania and were isolated from sporadic cases of invasive disease. Serogroup B phenotypes were generally disparate with phenotype B:4:P1.4 being the most common and phenotype B:15:P1.7 was also widely distributed. Infections with a novel phenotype that was first noted in 1999, C:2a:P1.4(7), were again common in Victoria, especially in adolescents and adults, but were infrequently seen elsewhere in Australia. In Tasmania, a different phenotype, C:2a:P1.5,2 accounted for 11 of 16 isolates, again predominantly in infections of young adults. The number of isolates in Queensland increased to 78 from 43 in 2000 and was due to more strains of both serogroup B and serogroup C meningococci. About two-thirds of all isolates showed decreased susceptibility to the penicillin group of antibiotics (MIC 0.06 to 0.5 mg/L). All isolates tested were susceptible to third generation cephalosporins. From 1999, reports have also included diagnoses made by non-culture based methods in these analyses. Data relating to 135 laboratory-confirmed but culture negative cases supplemented information on culture-confirmed cases in this report. *Commun Dis Intell* 2002;26:407–418.

Keywords: antibiotic resistance, Neisseria meningitidis, *meningococcal disease*

Introduction

A national laboratory-based program for the examination of isolates of *Neisseria meningitidis* from cases of invasive meningococcal disease (IMD) commenced in 1994 through the collaboration of reference laboratories in each jurisdiction and is designed to supplement data from clinical notification schemes. Information on the phenotype (the serogroup, the serotype and subserotype), on occasion the genotype, and the antibiotic susceptibility of invasive isolates are obtained from examination of isolates. In addition, data from non-culture based laboratory testing, derived from nucleic acid amplification assays and serological examination, are included in the analyses. The characteristics of the meningococci responsible for IMD are important both for individual patient management and to tailor the public health response. The recent availability of a conjugate serogroup C vaccine and the prospect of porin-based vaccines for serogroup B meningococcal disease increase the need for precise data on circulating meningococcal subtypes.

Annual reports summarising data gathered since the inception of the program were published in *Communicable Diseases Intelligence*.[1-7] The following report analyses the characteristics of meningococci isolated in the calendar year 2001.

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Methods

The National Neisseria Network (NNN) is a collaborative program for the laboratory surveillance of the pathogenic *Neisseria*, *N. meningitidis* and *N. gonorrhoeae*.[1-8] A network of reference laboratories in each Australian State and Territory (see acknowledgments) undertakes meningococcal isolate surveillance throughout Australia.

Isolate based surveillance

Each case was based upon isolation of a meningococcus from a normally sterile site and defined as IMD according to the Public Health Laboratory Network definitions. Information on the site of infection, the age and sex of the patient and the outcome (survived/died) of the infection was sought. The isolate-based subset of the program categorises cases on the basis of site of isolation of the organism. Where an isolate is grown from both blood and cerebrospinal fluid (CSF) cultures in the same patient, the case is classified as one of meningitis. It is recognised that total number of cases and particularly the number of cases of meningitis, e.g. where there was no lumbar puncture or else where lumbar puncture was delayed and the culture sterile, is underestimated. However, the above approach has been used since the beginning of this program and is continued for comparative purposes.

Phenotyping of invasive isolates of meningococci by serotyping and serosubtyping was based on the detection of outer membrane protein antigens using a standard set of monoclonal antibodies obtained from the National Institute for Public Health, the Netherlands.

Antibiotic susceptibility was assessed by determining the minimal inhibitory concentration (MIC) to antibiotics used for therapeutic and prophylactic purposes. This program uses the following parameters to define the various levels of penicillin susceptibility/resistance when determined by a standardised agar plate dilution technique.[8]

sensitive, MIC ≤ 0.03 mg/L;

less sensitive, MIC 0.06 — 0.5 mg/L;

relatively resistant MIC ≥ 1 mg/L.

Strains with MICs which place them in the category of 'sensitive' or 'less sensitive' would be considered to be amenable to penicillin therapy when used in currently recommended doses. However, precise MIC/outcome correlations are difficult to obtain because of the nature of IMD.

Non-culture-based laboratory-confirmed cases

Additional laboratory confirmation of suspected cases of IMD is increasingly available by means of non-culture-based methods such as nucleic acid based amplification assays (NAA) and serological techniques. NAA testing is essentially by polymerase chain reaction (PCR) techniques[9] and has been progressively introduced in the different jurisdictions. Data from the results of these investigations were included for the first time in the 1999 report. The serological results are based on results of tests performed using the methods and test criteria of the Manchester PHLS reference laboratory, the United Kingdom as assessed for Australian conditions.[10,11] Where age, sex and outcome data for patients with non-culture-based diagnoses are available these were also recorded. The site of a sample of a positive PCR test is also used to define the clinical syndrome. This separation is not possible for cases diagnosed serologically.

Results

Numbers of isolates from culture-confirmed cases

A total of 338 invasive isolates of meningococci were examined in 2001, 50 less than the 388 examined in 2000. There were 100 isolates from patients whose infections were acquired in New South Wales (30% of all isolates), 78 (23%) from Queensland, 77 (23%) from Victoria, 32 (9%) from Western Australia, 22 (6%) from South Australia, 16 (5%) from Tasmania, 8 (2%) from the Northern Territory and 5 (1%) from the Australian Capital Territory (Table 1). The number of isolates increased in Queensland to 78 from 43 in 2000. In New South Wales there were 41 fewer isolates and in Victoria 31 isolates less than in 2000. Numbers also decreased in Western Australia to 32 from 50 in 2000 but in other jurisdictions the total numbers of isolates were little changed.

Table 1. *Neisseria meningitidis* isolates, Australia, 2001, by State or Territory and serogroup

State/ Territory	Serogroup										Total	
	B		C		A	Y		W135		NG*		
	n	%	n	%	n	n	%	n	%	n	n	%
ACT	5	100.0	0	0.0	0	0	0.0	0	0.0	0	**5**	**1.5**
NSW	65	65.0	33	33.0	0	1	1.0	1	1.0	0	**100**	**29.5**
NT	7	87.5	1	12.5	0	0	0.0	0	0.0	0	**8**	**2.5**
Qld	49	62.8	25	32.0	0	3	4.0	1	1.2	0	**78**	**23.0**
SA	14	63.6	7	31.8	0	0	0.0	1	4.6	0	**22**	**6.5**
Tas	3	18.8	13	81.2	0	0	0.0	0	0.0	0	**16**	**4.7**
Vic	37	48.0	38	49.4	0	1	1.3	1	1.3	0	**77**	**22.8**
WA	26	81.2	5	15.6	0	0	0.0	1	3.2	0	**32**	**9.5**
Total	**206**	**61.0**	**122**	**36.0**	**0**	**5**	**1.5**	**5**	**1.5**	**0**	**338**	**100.0**

* Not viable for serogrouping or not serogroupable.

Seasonality

Sixty-nine (21%) cases occurred between 1 January and 31 March, 62 (19%) between 1 April and 30 June, 127 (39%) between 1 July and 30 September and 70 (21%) between 1 October and 31 December. A winter peak of meningococcal disease is usual.

Age group

The age distribution of patients infected with invasive isolates in each State and Territory is shown in Table 2. Nationally, the peak incidence of meningococcal disease occurred in those aged 4 years and under. Those aged less than one year or in the 1–4 age group accounted for 47 (14%) and 62 (18%) cases respectively. A secondary peak was noted in the 15–19 year age group when 54 cases accounting for 16 per cent of the total were recorded. A further 35 cases (10%) occurred in those aged 20–24 years. The number (89) and proportion (26%) of culture-positive cases in the 15–24 year age range was less than the 126 (32%) recorded in 2000. This age range was particularly affected in Queensland and Tasmania in 2001.

Serogroup, serotype and serosubtype (phenotype) distribution

The distribution of the isolates by serogroup is shown in Table 1. Nationally, 206 serogroup B isolates represented 61 per cent of all strains. The 122 serogroup C strains (36%) was similar to the number (128) and proportion (33%) detected in 2000. The number of serogroup W135 and serogroup Y strains was lower than in recent years. No serogroup A isolates were encountered.

Some important differences in the distribution of serogroups were evident when data were disaggregated by region. Serogroup B predominated in national data (61%) and in all jurisdictions except Victoria and Tasmania. When examined regionally, Western Australia (81% of isolates), the Australian Capital Territory (100%), South Australia (63%), the Northern Territory (87%), Queensland (63%) and New South Wales (65%) had high proportions of serogroup B strains. However, in Victoria serogroup B isolates were 48 per cent of the total and in Tasmania only 18 per cent. Group B disease comprised mainly unlinked and apparently sporadic cases.

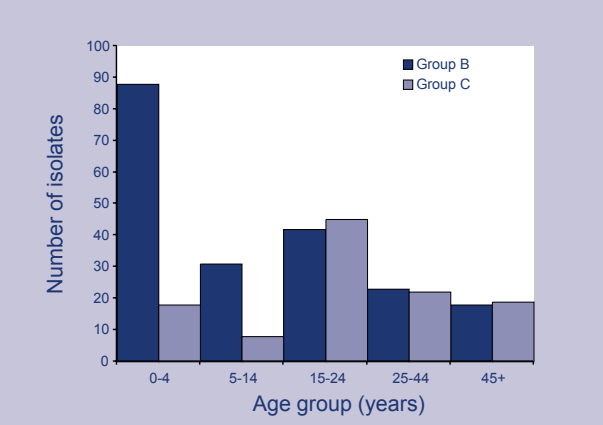
Serogroup C strains were most prominent in Tasmania where 13 of 16 isolates were serogroup C. The proportion of serogroup C infections in Victoria

decreased slightly to 49 per cent and their number decreased to 38 from the 58 isolated in 2000. In 1998, there were only 7 (17.5%) serogroup C strains in Victoria. Serogroup C isolates also declined in number in New South Wales in 2001 and the 33 strains represented 33 per cent of all isolates. In 2000, there were 55 (39%) serogroup C isolates and in 1999, 45 (37%) group C strains in New South Wales. There were 25 group C isolates (32%) in Queensland, 7 (32%) in South Australia, 5 (15%) in Western Australia, one in the Northern Territory but none in the Australian Capital Territory.

The increase in numbers of isolates in Queensland was in both serogroup B (18 more cases) and serogroup C (15 more cases). The decrease in culture-positive cases in Victoria was mainly in serogroup C isolates. Twenty fewer serogroup C meningococci were isolated in 2001. In Tasmania, there was a significant shift to serogroup C from serogroup B isolates.

Serogroup distribution has been typically age-associated, with serogroup B disease concentrated in younger age groups and serogroup C infections predominating in adolescents and young adults. In 2001, 89 (82%) of all isolates in those aged less than 4 years were serogroup B and the 18 serogroup C isolates comprised 16 per cent of cultures nationally in this age group (Table 2, Figure 1). In those aged 5–14 years, 31 serogroup B meningococcal cultures represented over 60 per cent of the 50 isolates and the 18 serogroup C strains represented 36 per cent. Serogroup B and C isolates were isolated in essentially equal proportions for all age groups over 14 years (Figure 1).

Figure 1. Number of serogroup B and C isolates, Australia, 2001, by age



However, jurisdictional differences in the distribution of serogroup B and C meningococcal isolates were again evident in 2001 (Table 2, Figures 1, 2, 3 and 4). In Western Australia and the Territories, serogroup B isolates predominated in all age groups, and in all centres, serogroup B was more commonly encountered in those aged 4 years and under. New South Wales, Queensland and South Australia closely followed the national pattern with regard to age-associated serogroup distribution. In Victoria and Tasmania serogroup C isolates were especially prominent in older, i.e. adolescent and young adult, age groups but were also seen more often in younger age groups than in other jurisdictions.

Figure 2. Number of serogroup B and C isolates, Victoria, 2001, by age

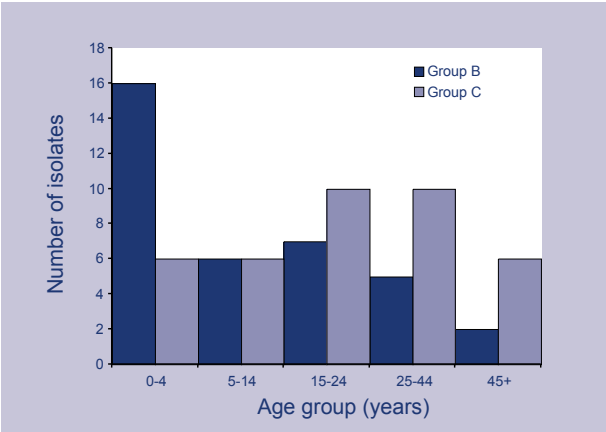


Figure 3. Number of serogroup B and C isolates, New South Wales, 2001, by age

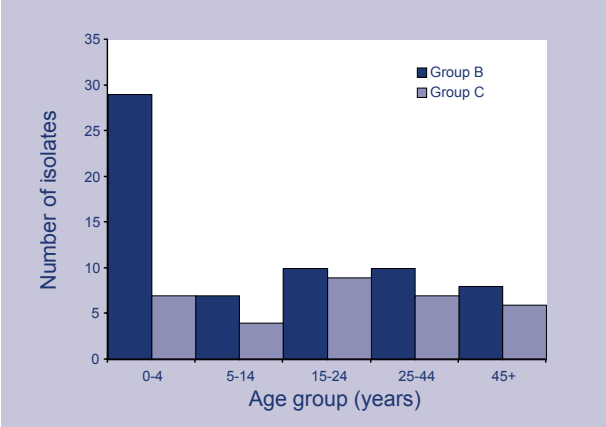


Figure 4. Number of serogroup B and C isolates, Queensland, 2001, by age

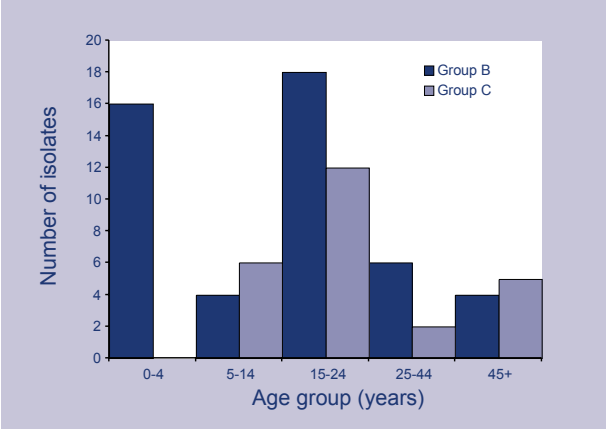


Table 2. *Neisseria meningitidis* isolates, Australia, 2001, by State or Territory, serogroup and age

		Age group (years)										
		<1	1–4	5–9	10–14	15–19	20–24	25–44	45–64	65+	NS	Total
ACT	Total	1	0	0	0	2	0	1	1	0	0	**5**
	B	1	0	0	0	2	0	1	1	0	0	**5**
NSW	Total	20	16	5	6	11	8	17	9	7	1	**100**
	B	18	11	3	4	5	5	10	6	2	1	**65**
	C	2	5	2	2	6	3	7	2	4	0	**33**
NT	Total	2	2	1	1	0	0	0	0	1	1	**8**
	B	2	1	1	1	0	0	0	0	1	1	**7**
	C	0	1	0	0	0	0	0	0	0	0	**1**
Qld	Total	5	12	8	3	16	15	8	5	5	1	**78**
	B	5	11	4	0	10	8	6	3	1	1	**49**
	C	0	0	4	2	6	6	2	1	4	0	**25**
SA	Total	3	5	3	2	3	3	0	1	2	0	**22**
	B	2	5	2	2	1	1	0	0	1	0	**14**
	C	0	0	1	0	2	2	0	1	1	0	**7**
Tas	Total	2	2	1	0	6	3	2	0	0	0	**16**
	B	1	1	1	0	0	0	0	0	0	0	**3**
	C	1	1	0	0	6	3	2	0	0	0	**13**
Vic	Total	6	16	6	6	12	6	15	4	5	1	**77**
	B	5	11	3	3	5	2	5	1	1	1	**37**
	C	1	5	3	3	6	4	10	3	3	0	**38**
WA	Total	8	9	5	3	4	0	2	1	0	0	**32**
	B	7	7	4	3	3	0	1	1	0	0	**26**
	C	0	2	1	0	1	0	1	0	0	0	**5**
Australia	n	47	62	29	21	54	35	45	21	20	4	**338**
	%	13.9	18.3	8.5	6.2	15.9	10.5	13.3	6.2	6	1.2	
Serogroup B	n	41	47	18	13	26	16	23	12	6	4	**206**
Australia	%	20	22.8	8.7	6.3	12.6	7.8	11.1	5.9	3	1.5	**61**
Serogroup C	n	4	14	11	7	27	18	22	7	12	0	**122**
Australia	%	3.2	11.4	9	5.7	22.1	14.7	18	5.7	9.9	0	**36**
Other Australia	n	2	1	0	1	1	1	0	2	1	1	**10**

Table 3. Commonly isolated serotypes and serosubtypes and phenotypes of *N. meningitidis* of interest, Australia, 2001, by State or Territory

	Serogroup B				Serogroup C			
	Serotype	n	Serosubtype	n	Serotype	n	Serosubtype	n
ACT	4	2	1.4	2				
	14	1	1.4	1				
			1.6	1				
NSW	4	35	1.4	22	2a	28	1.5	16
			1.7	1			1.5,2	2
			1.14	4			1.2	2
			1.15	1			1.4	2
			1.13	1			nst	6
		nst†	4		2b	0		
	15	5	1.7	3	nt*	3	1.15	1
	1	3	1.5	1			1.16	1
			1.14	1	1	2	1.14	2
	nt*	21	1.4	6				
			1.5,2	1				
			nst	6				
NT	4	3	1.4	3	2a	1	1.5,2	1
	15	1	1.15	1				
	14	3	nst	3				
Qld	4	4	1.4	4	2a	19	1.5	8
	15	8	1.7	5			1.5,2	4
	1	5	1.14	3			1.4	4
	nt	32	1.4	12	2b	1	1.2	1
			1.14	3	nt	5	1.15	4
Vic	4	4	1.4	3	2a	37	1.5	3
	15	8	1.7(16)	5			1.2	2
			nst	2			1.4	19
	2b	2	1.16	1			nst	13
	nt	22	1.4	7	2b	1	nst	1
			1.15	4				
			nst	8				
SA	4	4	1.4	2	2a	2	1.4	2
	15	3	1.7	2	1	3	1.14	3
	14	1	nst	1				
	1	2	1.14	1	nt	2	1.16	1
	nt	2	1.4	1			nst	1
			1.15	1	2b	0		
Tas					2a	12	1.5,2	11
							1.4,7	1
WA	4	0			2a	4	1.5	4
	15	3	1.7(16)	3	2b	0		
	nt	23	1.4	7	nt	1	1.15	1
			1.15	4				
			nst	7				

* Not typeable.

† Not serosubtypeable.

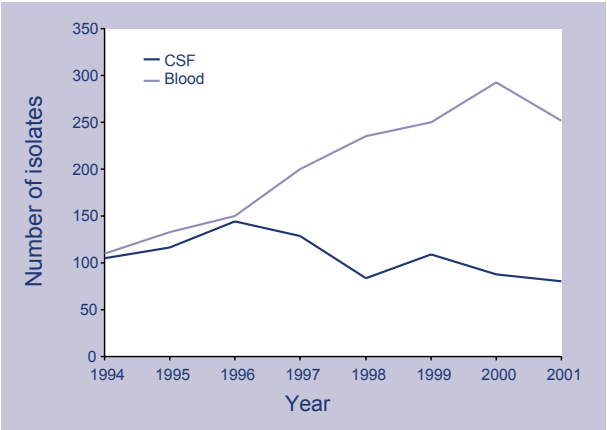
There was again considerable phenotypic heterogeneity amongst invasive isolates as determined by serotyping and serosubtyping. The predominant serotypes/serosubtypes in each State and Territory are shown in Table 3. Serogroup B meningococci are more difficult to characterise by serological methods and a number could not be phenotyped. B:4:P1.4(7) strains predominated in New South Wales and were also present in Queensland, South Australia and Victoria. B:15:P1.7 strains were present in New South Wales, Queensland, Victoria, and Western Australia.

There was less heterogeneity amongst serogroup C meningococci. Isolates were usually serotype 2a. Phenotype C:2a:P1.4(7), which appeared in Victoria in 1999, requires special comment. There were 10 such isolates in Victoria in 1999, 24 in 2000 and 19 in 2001. This phenotype remains uncommon elsewhere in Australia. Phenotype C:2a:P1.2 was also frequently isolated in Victoria in 2000 (10 isolates) but only 2 strains of this phenotype were seen in Victoria in 2001. This phenotype was also rarely identified in other centres. New South Wales was the other state where serogroup C strains were present in larger numbers. Phenotypes C:2a:P1.5 and C:2a:P1.5,2 accounted for 70 per cent of the 33 serogroup C strains isolated there. The C:2a:P1.5 phenotype was present in most jurisdictions and 11 of a total of 16 isolates in Tasmania were of this phenotype. Serotype 2b strains were rarely encountered.

Site of isolation

There were 80 isolates from CSF either alone or with a blood culture isolate and 252 from blood cultures alone. There were 5 isolates from synovial fluid and one from skin. Trends in the relative number of isolates from CSF and blood are shown in Figure 5. The ratio of CSF isolates to blood culture isolates was 0.31:1, similar to that recorded in 2000.

Figure 5. Numbers of meningococcal isolates from CSF and blood culture, Australia, 1994 to 2001



Outcome data for cases with sterile site isolates

Outcome data (survived or died) were available for 180 patients (53%). Twenty-three deaths were recorded (12.7%) (Table 4). Outcomes were available in 53 per cent of both serogroup B infections and serogroup C infections.

Table 4. Outcome of meningitic and septicaemic cases of meningococcal infection, culture positive cases, Australia, 2001, by serogroup

Disease type	Outcome	Serogroup					Total
		B	C	Y	W135	NG	
Meningitis	Survived	24	11	0	0	0	**35**
	Died	2	3	0	0	0	**5**
	Total	26	14	0	0	0	**40**
Septicaemia	Survived	77	35	3	2	0	**117**
	Died	5	13	0	0	0	**18**
	Total	82	48	3	2	0	**135**
All cases*	Total	110	65	3	2	0	**180**
	Died	7	16	0	0	0	**23**

* Includes 3 serogroup C and 2 serogroup B isolates from joint aspirates from patients who survived.

There were 7 (6.3%) deaths in patients with serogroup B infections and 16 (24%) in patients with serogroup C infections.

Where outcomes were known, there were 5 deaths in 40 patients (12%) with meningitis. Two of these patients were infected with serogroup B, and 3 with a serogroup C strain.

Eighteen deaths were recorded in 135 bacteraemic patients (13%). There were 82 cases of serogroup B meningococcal bacteraemia with 5 deaths (6%) and another 48 cases were caused by serogroup C strains among whom 13 fatalities were recorded (27%). No fatalities were recorded with serogroup Y or W135 bacteraemias.

Antibiotic susceptibility surveillance of invasive meningococcal isolates

Penicillin

All of the 338 isolates were tested for their susceptibility to penicillin. Using defined criteria, 112 strains (33%) were fully sensitive to penicillin and 226 (67%) less sensitive (MIC 0.06 to 0.5 mg/L). These proportions differ only slightly from those recorded in recent years. The highest MIC was 0.5 mg/L, recorded for 2 isolates.

Other antibiotics

All isolates were susceptible to ceftriaxone (and by extrapolation to other third generation cephalosporins). Three isolates were resistant to the prophylactic antibiotic rifampicin at 1 mg/L but all isolates were susceptible to ciprofloxacin.

Numbers and sources of non-culture diagnoses of invasive meningococcal disease

One hundred and thirty-five additional cases of invasive meningococcal disease were diagnosed by non-culture methods in 2001. There were 137 diagnoses of invasive meningococcal disease where PCR and/or serology were positive in the absence of positive cultures (Table 5). In two instances where both serology and PCR testing were performed, both tests were positive. However, it was more usual to have available samples suitable for testing by only one of the above techniques. Thus there were 107 instances where PCR testing in isolation was positive and 28 cases where serology testing alone was positive.

With PCR testing it was also possible to categorise the disease type by source of specimen in a manner similar to that used for culture-positive cases (Table 5). Of the 109 cases positive by PCR, 56 were from CSF or CSF and blood, 52 from blood only and one from another site. This is a different distribution from that obtained with culture-based diagnosis. Culture-based diagnosis of blood yielded 2.5 times the number of positive cultures compared with cultures of CSF. With PCR based diagnosis equal numbers of positive results were obtained from blood and CSF.

Serogroup and age distribution of non-culture based invasive meningococcal disease

In addition to diagnostic PCR, this technique can also be used to ascertain the serogroup involved in the disease process. In most centres this is still restricted to serogroup B and C determinations. There were 109 cases where a PCR-based diagnosis was made and in 84 of these the serogroup was also determined (Table 6).

For those cases diagnosed by serology alone, age distribution was different with most diagnoses (25/28) occurring in those aged 10 years or more (Table 7). This reflects in part the difficulty in obtaining serum samples from young children. The categorisation of IMD by site of organism capture cannot be determined in those diagnosed by serological methods. Additionally, serogroup determination by serological testing was not possible in 2001, although this will be available for serogroup C cases from 2002.

Outcome data for invasive meningococcal disease based on non-culture-based diagnosis

For IMD diagnosed by PCR-based tests, the outcome was known in 47 instances, with 5 deaths (10.6%). There were 3 deaths where blood PCR alone was positive (2 of serogroup B and one serogroup C). There were two instances of deaths (one each of serogroup B and C) where PCR was positive on a CSF sample. Twenty-seven of 28 cases diagnosed serologically survived and the outcome was unknown in the remaining case.

Table 5. Source of non-culture-based diagnosis of invasive meningococcal disease, Australia, 2001

Diagnostic method	Number
All non-culture-based diagnoses	137
PCR positive*	109
CSF PCR positive	48
CSF and blood PCR both positive	8
Blood PCR positive	52
Other	1
Serology positive in the absence of positive PCR	28

* Including those with positive serology.

Table 6. Serogroup and age distribution of invasive meningococcal disease diagnosed by PCR, Australia, 2001

	Age group (years)										
Group	**<1**	**1–4**	**5–9**	**10–14**	**15–19**	**20–24**	**25–44**	**45–64**	**64+**	**Unknown**	**Total**
B	7	12	5	2	6	9	5	4	1	1	**52**
C	3	6	2	0	6	5	3	5	0	1	**31**
Y	0	0	0	0	1	0	0	0	0	0	**1**
U*	5	5	5	2	1	2	1	4	0	0	**25**
All	**15**	**23**	**12**	**4**	**14**	**16**	**9**	**13**	**1**	**2**	**109**

* Undetermined

Table 7. Age distribution of serologically diagnosed cases of invasive meningococcal disease, Australia, 2001

Age group (years)	<1	1–4	5–9	10–14	15–19	20–24	25–44	45–64	>65	Total
Cases	1	0	3	3	6	4	8	2	1	**28**

Discussion

The total of 338 isolates examined by the NNN laboratories in the Australian Meningococcal Surveillance Programme in 2001 was less than the 388 examined in 2000. The number of isolates examined by the NNN from 1994 until 2000 has ranged between 323 and 388. When data are disaggregated by jurisdiction however, differences become more apparent. The number of isolates available in Victoria increased from 41 in 1998 to 94 in 1999 and 108 in 2000, but declined to 77 in 2001. In contrast, the number of isolates from Queensland decreased from 81 in 1998 to 66 and 43 in 1999 and 2000 respectively, then increased to 78 in 2001. Isolate numbers in New South Wales and Western Australia decreased in 2001 but in other centres varied little from 2000 totals.

It is difficult to be certain of the reliability of these numbers of positive cultures if used as an index of trends in disease rates. The number of isolates available for examination will always be less than the number of clinically notified cases because clinical surveillance case definitions include culture-negative cases. The number of culture-negative cases will vary according to the implementation of and adherence to the 'early treatment' practices now advocated for management of IMD. These culture-negative cases are increasingly confirmed by other methods, but the introduction and use of non-culture-based diagnostic methods has varied in different jurisdictions over time. For these reasons, there should be some wariness in comparing trend data from different states and territories in recent years. Nevertheless in 2001, 137 cases were confirmed by non-culture-based methods and when these were added to the 338 positive cultures, a total of 475 laboratory-confirmed cases was recorded. In 2000, 147 clinical cases were confirmed only by non-culture-based laboratory examinations and there were a further 388 culture-positive cases giving a total of 535 laboratory-confirmed cases.

The ratio of cases of meningitis to bacteraemia in culture-confirmed cases (0.31:1) maintained an existing trend (Figure 5). Previous reports also noted differences in meningitis/septicaemia rates when these were derived from culture-based and non-culture-based methods. This trend was the subject of comment in earlier reports.[6,7] It was noted that the initial introduction of PCR-based diagnosis saw positive CSF samples representing 2.5 times the number of diagnoses from blood. It was suggested that a possible bias arises insofar as PCR was initially more often performed only on CSF samples and that the sensitivity of PCR techniques in blood samples is less than that for CSF. In the 2000 data, there was an increase in PCR based diagnoses from blood and a corresponding 'correction' in the proportions of diagnoses from CSF and blood by this technique. In 2001 the numbers diagnosed from each source by PCR were again almost identical.

The predominant disease pattern throughout the country remained sporadic infection with serogroup B meningococci. The proportion of serogroup C cases in aggregated data (36%) was essentially unchanged from 2000 (37%) after increasing from 25 per cent in 1998 and 32.5 per cent in 1999. Serogroup C were the majority of strains isolated in Tasmania and Victoria but serogroup C represented about one third of cases in New South Wales, Queensland and South Australia. In Western Australia and the Territories, serogroup C was uncommonly encountered. While serogroup C infections have been prominent in Victoria and New South Wales for a number of years, their numbers in Tasmania in 2001 represent a significant change and their proportions in both Queensland and South Australia also increased. No serogroup A meningococci were isolated and the proportion of serogroup Y and W135 strains declined.

In 2001, the age distribution of IMD was typical with children aged 4 years or less the most frequently infected. A secondary peak in incidence in young adults and adolescents was also observed. By contrast, in 2000, those in the 15–24 age group had more infections than those aged 4 years or less in aggregated data. The larger case numbers in young adults in New South Wales and Victoria influenced this aspect of meningococcal disease patterns in 2000. However, this pattern again varied by region in 2001 with Queensland and Tasmania having the highest proportion of young adult cases while New South Wales and Victoria returned to the usual pattern. Serogroup B infections were the most frequently seen in the infant age group whereas serogroup C isolates continued to be over-represented in the young adult age group (Figures 1, 2, 3 and 4).

Phenotyping data emphasise the considerable heterogeneities that exist in meningococcal subtypes causing IMD in different jurisdictions. The group B phenotype B:4:P1.4(7), associated with hyperendemic disease in New Zealand for many years, is of more than academic interest. A trial of a porin-based vaccine for infections with serogroup

B:4:P1.4 strains will commence shortly in New Zealand so the presence of this strain in Australia warrants particular attention. In New South Wales this phenotype represented at least 20 per cent of all isolates, although it was not as prominent in other jurisdictions. Because a proportion of serogroup B strains are normally not typable with monoclonal antibodies, use of por gene sequencing techniques may be required to establish the real incidence of infection due to this subtype. Phenotype B:15:P1.7 remained widely distributed.

In 1999 the group C phenotype C:2a:P1.4(7) was detected in Victoria, accounting for much of the increase in serogroup C disease in that State at that time. This phenotype persisted in 2000 and represented about 22 per cent of all isolates. In 2001, about 25 per cent of all isolates in Victoria were C:2a:P1.4(7), although their number declined. In contrast, in Tasmania phenotype C:2a:P1.5,2 predominated (11 of 16 isolates) and only a single strain of the 'Victorian' phenotype was identified. Elsewhere C:2a:P1.5 was more common. The 'Victorian' phenotype was found infrequently in other states. This considerable temporal and geographic variation in meningococcal subtypes and the volatility in the predominant phenotypes is well-recognised and is a result of genetic recombination through horizontal gene transfer.[12]

Mortality data was assessable in only 180 culture positive cases and the 23 deaths, giving a mortality of 12.7 per cent, may not accurately represent the true situation. Although a higher mortality was observed for serogroup C infections, other factors such as age, and time from onset to presentation and treatment, on which data were not available, may also explain the difference between outcomes due to different serogroups. The 5 fatal cases recorded from another 47 cases of PCR-based diagnoses was slightly less in percentage terms and the rate was not different between serogroups. Serologically diagnosed cases are by their nature milder and in patients who by definition survive long enough to mount a detectable antibody response. The combined mortality for all serogroups was 11 per cent.

No invasive isolates resistant to penicillin were detected in 2001. The highest MIC recorded was 0.5 mg/L in 2 isolates and the proportion of 'less susceptible' strains was unchanged. All isolates were susceptible to the third generation cephalosporins and the prophylactic agent ciprofloxacin. Occasionally isolates resistant to rifampicin are encountered and in 2001, 3 strains were resistant at 1 mg/L.

Since 1994, the NNN has examined over 2,500 strains from all states and territories. There has been a continuing evolution and development of laboratory techniques over this period so that it is not always possible to make full comparisons of data gathered in different years. Additionally, the NNN data are used to supplement information collected separately by clinically based surveillance of invasive meningococcal disease. Within this context however, the NNN data remain an essential component of IMD surveillance in Australia. Accurate data are needed to allow informed responses by those responsible for individual and public health management of IMD. The recent release of conjugate serogroup C vaccines reinforces this need. For further details the relevant NNN member in each jurisdiction should be contacted.

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