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# INVASIVE MENINGOCOCCAL DISEASE IN NORTH QUEENSLAND, 1990-1994

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## Abstract

All episodes of invasive meningococcal disease (n=69) that occurred in north Queensland over the five-year period 1990-1994 are described. Aboriginal and Torres Strait Islander people had a considerably greater annual incidence (20.2 cases per 100,000) than did all other people (1.6 per 100,000 population). All three deaths were of young Aboriginal males. The majority (70%) of the isolates were serogroup C. Five outbreaks of serogroup C disease were identified, and these outbreaks accounted for nearly half of all the cases of serogroup C disease.

## Introduction

With the rapid decline in the incidence of invasive *Haemophilus influenzae* type b (Hib) disease following the introduction of conjugate Hib vaccines<sup>1</sup>, more attention is being given to two other important invasive bacterial pathogens - *Streptococcus pneumoniae* and *Neisseria meningitidis*<sup>2,3</sup>. Of the two, only invasive disease caused by *N. meningitidis* (the meningococcus) is notifiable throughout Australia<sup>3</sup>.

Meningococcal disease is usually manifest as either meningitis or septicaemia, usually occurring as sporadic cases, but on occasions as small focal clusters or outbreaks or even as large community-wide epidemics<sup>4,5,6</sup>. Recent attention has focussed on outbreaks of serogroup C meningococcal disease in North America, which have led some authorities to describe such outbreaks as *emergent infectious disease phenomena*<sup>7</sup>.

There is evidence that the epidemiology of meningococcal disease in Australia has undergone change in recent years, with an apparent increase and subsequent decrease in the proportion of cases caused by serogroup C in some parts of the country<sup>8</sup>. A similar changing epidemiology, with the emergence of serogroup C disease often associated with local outbreaks, has also been noted in North America<sup>7,9</sup>.

The objectives of the current study were to describe the epidemiology of invasive meningococcal disease occurring in north Queensland over a five-year period, and to describe any outbreaks of serogroup C disease that may have occurred.

## Methods

### Case definition

Only those cases of invasive meningococcal disease that were diagnosed in north Queensland between the beginning of 1990 and the end of 1994 were included in the study. Figure 1 shows north Queensland as defined for the purpose of the study.

A case of invasive meningococcal disease was defined as a clinically compatible illness and (1) the isolation of *N. meningitidis* from a normally sterile site, or (2) the detection of meningococcal antigen in a normally sterile fluid, or (3) the detection of Gram-negative intracellular diplococci in blood or cerebrospinal fluid (CSF)<sup>10</sup>.

**Figure 1. Map of Queensland showing north Queensland as defined for the purpose of the study**

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An outbreak of invasive meningococcal disease was defined as two or more cases caused by the same serogroup, occurring in people without close contact with each other but within the same community, during a four-week period<sup>11</sup>. Local health personnel were consulted to ensure that household and other close-contact cases were not included in defining the occurrence of an outbreak.

**Case ascertainment**

Four sources of information were used to identify potential cases of invasive meningococcal disease that occurred in north Queensland during the period of this study.

- (1) Notifications to Queensland Health. Invasive meningococcal disease is a laboratory-notifiable condition in Queensland, with all reports eventually being collated by the Communicable Diseases Branch, Queensland Health, Brisbane. A computerised printout of all the north Queensland meningococcal notifications from 1990 to 1994 was obtained from the Communicable Diseases Branch.
- (2) A computer search was made of hospital morbidity information held by the Epidemiology and Health Information Branch, Queensland Health. The 1990 information was coded according to the International Classification of Diseases, ninth revision, with the codes relevant to invasive meningococcal disease being 036 and 3205<sup>12</sup>. The information for the subsequent years was coded according to the International Classification of Diseases, ninth revision, Clinical Modification, with the relevant code being 036 only<sup>13</sup>.
- (3) A computer search was made of mortality information held by the Epidemiology and Health Information Branch, Queensland Health, using the codes described above.
- (4) A review was undertaken of all meningococcal isolates referred to the Laboratory of Microbiology and Pathology, Queensland Health, Brisbane, for serogrouping and other laboratory studies. Details about the serotypes and subtypes of outbreak-associated serogroup C isolates were retrieved from reports obtained from reference and research laboratories that had been sent the isolates for further characterisation.

**Data collection**

Hospital records of all the identified potential cases of invasive meningococcal disease were examined to determine whether they met the case definition criteria. If so, additional information about the sex, age (to the nearest half-year), pertinent clinical details, and race (either Aboriginal or Torres Strait Islander or other) were extracted from the records.

**Analysis**

To calculate incidence rates, population denominator data from the 1991 National Census (Australian Bureau of Statistics) were used. The total study population was 424,130, of whom 9% (38,572) were Aboriginal or Torres

Strait Islanders. The differences between the proportions were tested using the  $X^2$  test with Yates correction<sup>14</sup>.

**Results**

Seventy cases of invasive meningococcal disease that occurred in north Queensland during the five-year study period were identified. A 25 year old tourist developed serogroup Y meningococcal meningitis within 24 hours of arrival in north Queensland; this case was excluded from all further analyses.

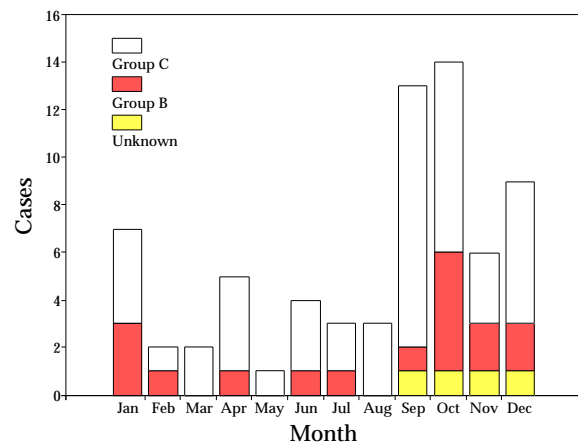
The number of cases per year ranged from 9 to 19 (median 11), with 37 cases occurring in the first two years, and 23 cases occurring in the last two years of the study ( $p < 0.05$ ). There appeared to be a seasonal variation, with a peak (39% of cases) in September and October, and a low (6% of cases) in February and March (Figure 2).

Thirty-nine (57%) of the 69 cases were male (a male:female ratio of 1.3:1), and thirty-nine (57%) of the cases were Aboriginal or Torres Strait Islanders. Eighteen (46%) of the Aboriginal and Torres Strait Islander cases were male compared with 21 (70%) in all other peoples ( $p > 0.05$ ).

The overall annual incidence was 3.3 cases per 100,000 population. The annual incidence for Aboriginal and Torres Strait Islanders was 20.2 cases per 100,000, whereas for all other peoples it was 1.6 cases per 100,000 population.

Twenty-three per cent of the cases occurred in children under two years of age and 41% occurred in children under five years of age. The annual incidence rates for Aboriginal and Torres Strait Islander children were 62.3 and 60.5 cases per 100,000 children aged <2 and <5 years respectively. The corresponding rates for all other Australian children were 15.4 and 7.5 cases per 100,000 children <2 and <5 years of age respectively.

**Figure 2. Invasive meningococcal disease: number of cases, by month, north Queensland, 1990-1994**



Seventeen (25%) of the meningococcal isolates were serogroup B, 48 (70%) serogroup C, and the serogroup of 4 (6%) cases was not able to be determined. There were no cases identified as being caused by serogroup A. Eight (21%) and 28 (72%) of all cases in Aboriginal and Torres Strait Islander people and 9 (30%) and 20 (67%) of cases in all other people were caused by serogroup B and serogroup C meningococci respectively.

The annual incidence of serogroup B disease in Aboriginal and Torres Strait Islander people was 4.1 cases per 100,000, whereas for all other peoples it was 0.5 cases per 100,000 population. The total and age-specific serogroup C disease incidence rates are shown in Table 1.

Meningitis was the primary clinical diagnosis for 60 (87%) of the cases, and bacteraemia/meningococcaemia for nine. Two patients, both Aborigines, had pre-existing conditions that probably put them at risk of developing invasive meningococcal disease. One was a ten year old boy with a ventriculo-peritoneal shunt following cryptococcal meningitis at five years of

age who developed meningococcal meningitis. The other was a 62 year old man with chronic renal failure on dialysis, who developed meningococcaemia.

There were three deaths, all of Aboriginal boys and all caused by serogroup C meningococci. A 17 month old and a 9 year old both died from meningococcaemia, and a six year old died from meningitis. The case-fatality rate for Aboriginal and Torres Strait Islanders was 8% (3/39), and the case-fatality rate for serogroup C disease was 6% (3/48).

The mean length of stay in hospital for the surviving Aboriginal and Torres Strait Islander patients (13.8 days; median 12, range 6-48 days) was no different ( $p>0.05$ ) from the mean length of stay for the other patients (10.6 days; median 10.5, range 5-24 days). Eight of the survivors developed either significant complications, or complications with sequelae (Table 2), a complication rate of 12% (8/66). Six of these cases were caused by serogroup C meningococcus, giving a complication rate from this serogroup of 12.5% (6/48).

**Table 1. The race and age-specific incidence rates of invasive serogroup C meningococcal disease, north Queensland, 1990-1994**

Age group (years)	Aboriginal/Torres Strait Islander		All other people		Total population	
	n	Incidence (cases per 100,000 population)	n	Incidence (cases per 100,000 population)	n	Incidence (cases per 100,000 population)
< 2	5	44.5	4	6.9	9	12.9
0 - 4	13	46.3	5	3.4	18	10.3
5 - 9	8	32.2	3	2.1	11	6.6
10 - 19	5	11.4	4	1.4	9	2.7
≥ 20	2	2.1	8	0.6	10	0.7
Total	28	14.5	20	1.0	48	2.3

**Table 2. Details of the cases of invasive meningococcal disease that developed complications and/or sequelae, north Queensland, 1990-1994**

Aboriginal/Torres Strait Islander	Sex	Age (years)	Serogroup	Diagnosis	Complications /sequelae
No	M	16	B	meningitis	pericardial effusion requiring pericardotomy
Yes	M	3.5	C	meningitis	unilateral hypopion, ophthalmitis; permanent ocular sequela
No	F	72	C	meningococcaemia	septic arthritis
Yes	M	1.5	C	meningitis	hemiparesis, epilepsy
Yes	M	7	C	meningitis	acute peritonitis diagnosed at exploratory laparotomy
No	M	22.5	C	meningitis	septic arthritis, multiple joints
Yes	F	10	?	meningitis	skin necrosis requiring plastic surgery
No	F	24.5	C	meningococcaemia	septic arthritis

**Table 3. Details of the recognised outbreaks of invasive serogroup C meningococcal disease, north Queensland, 1990-1994**

Date	Sept 90-Apr 91	Sept-Oct 90	Sept-Oct 91	Aug-Dec 93	June-July 94
Number of patients	11	2	2	3	4
Age	21mo-10yr	6,7yrs	3,8yrs	10mo-9.5yrs	2yr-59yrs
Aboriginal and Torres Strait Islander people	Yes	Yes	No	Yes	No
Serotype: subtype	2b:p1.2	2b:p1.2	2b:p1.2	2a:p1.2	2a:p1.2, 5
Mass vaccination	Yes	Yes	Yes	Yes	No

Therefore nine of the 48 (19%) cases of serogroup C disease were either fatal or complicated.

Five outbreaks of invasive meningococcal disease, all caused by serogroup C meningococci, were recognised (Table 3). Three outbreaks occurred in Aboriginal children in isolated communities, and included two, three and 11 confirmed cases of invasive meningococcal disease. Details of two of these outbreaks have been published elsewhere<sup>5,11</sup>. The other two outbreaks occurred in people in predominantly non-Aboriginal suburbs of metropolitan centres and included two and four confirmed cases. Mass vaccination was implemented in response to four of the five outbreaks.

## Discussion

This study has demonstrated that Aboriginal and Torres Strait Islander people in north Queensland are at an increased risk of developing invasive meningococcal disease, and that serogroup C predominated in the region during the study period. Outbreaks accounted for nearly half (46%) of all cases of serogroup C disease.

It is Aboriginal and Torres Strait Islander children in particular who are at increased risk of invasive meningococcal disease. A recent study has shown that a variety of extrinsic factors, such as passive smoking, household crowding, exposure to environmental dust and stressful life events, are all independently associated with invasive meningococcal disease in children elsewhere<sup>15</sup>. All of these factors are pertinent to Aboriginal and Torres Strait Islander children. If they have a cumulative effect, they may explain the increased risk experienced by these children.

The study identified five outbreaks of serogroup C meningococcal disease that occurred during the five-year study period. Because we do not have earlier data, we cannot determine whether or not these outbreaks have been a recent 'emergent' phenomena in north Queensland. Nevertheless there is a general consensus that there has been a recent increase in serogroup C disease in Australia<sup>8</sup>.

The recent increase in serogroup C outbreaks in North America have been ascribed to clonal strains that are of increased virulence when compared with serogroup C isolates that cause sporadic disease<sup>7,9</sup>. Much of the increase in serogroup C disease that has occurred in Canada since 1988 has been caused by serotype 2a

strains belonging to a single clonal complex<sup>16</sup>. Based upon the typing results, it is tempting to speculate that the north Queensland outbreaks were caused by two, perhaps three, clones of increased virulence, but this could only be determined by comparing the genotypes of outbreak-related isolates with those causing sporadic disease using sophisticated molecular techniques<sup>16,17</sup>.

In one review, serogroup C outbreaks in the United States of America were classified according to the population affected as either school/institutional or community outbreaks<sup>7</sup>. The school/institutional outbreaks were characterised by high attack rates, a short interval between cases, a readily apparent association between cases and prompt implementation of vaccination. Community outbreaks on the other hand were characterised by cases spanning a longer time interval, with a correspondingly longer time before the commencement of vaccination<sup>7</sup>.

Perhaps the three outbreaks that occurred in isolated Aboriginal communities were classifiable as institutional, as the associations were obvious, and vaccination was instituted promptly. The outbreak that occurred in September-October 1991 in a geographically discrete suburb of Cairns was also readily identifiable. However the suburban outbreak in mid-1994 was only recognised when the typing details of the isolates subsequently become available; the cases were diffusely scattered through coastal suburbs in the south of the study region. Even if the outbreak had been recognised promptly, defining a manageable target population for vaccination would have been extremely difficult given that the cases were so widely scattered. This was undoubtedly classifiable as a community outbreak<sup>7</sup>.

In one affected Aboriginal community, cases subsequently occurred in vaccinated children, leading to the suggestion that 'mass chemoprophylaxis and two doses of vaccine for children should be used in similar outbreaks'<sup>5</sup>. However, no further cases occurred in two other Aboriginal communities after the administration of a single dose of meningococcal vaccine<sup>11</sup>. Regardless, there should be a very low threshold in deciding when to commence vaccination when apparent outbreaks of either serogroup C or serogroup A meningococcal disease occur in Aboriginal or Torres Strait Islander communities<sup>6</sup>.

Meningococcal vaccines that are protective against serogroup B and serogroup C in early childhood will be required if meningococcal disease is to be adequately controlled. Immunogenicity trials of new conjugate serogroup A and C vaccines, and of experimental vaccines against serogroup B, are in progress in England where such vaccines are considered to be a high priority<sup>18,19</sup>. Surveillance of meningococcal disease in Australia should be improved so that the need for new meningococcal vaccines in Australia can be better understood<sup>3</sup>. In particular, the nationally collated annual data should include the proportion of cases that occur in Aboriginal and Torres Strait Islander people, as well as comprehensive serogroup information and the overall mortality from invasive meningococcal disease.

## Acknowledgments

We wish to thank all clinical, laboratory and clerical personnel who either cared for the patients or who assisted us with the study. Particular thanks are extended to Ms Christine Smerdon for generating the computerised list of all cases of meningococcal disease that had been notified to the Communicable Diseases Branch, and to the staff of the Epidemiology and Health Information Branch for carrying out computer searches of the hospital morbidity and mortality information.

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