An outbreak of serogroup C meningococcal disease associated with a secondary school

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Abstract

An outbreak of 3 cases of invasive meningococcal disease occurred in a secondary school on 2 campuses in Victoria. Despite having only one isolate (a C.2a:nst strain), meningococcal DNA was identified by polymerase chain reaction (PCR) in early culture-negative blood specimens of the other 2 cases. Both were subsequently shown by PCR to be capsule serogroup C by PCR. An committee was formed to manage the response to the outbreak. Chemoprophylaxis was offered to family and children who had been in close contact with the cases. As one strain had been confirmed as being of a vaccine-preventable group, vaccination was offered to the whole school community as well as the families of cases. The direct costs of the outbreak to public health, which would have been identical whatever the causative serogroup, was $8,178. Vaccine charges accounted for most of the additional $56,941 cost of vaccinating the target group of 1600 students, staff, and families. No further cases have been associated with this outbreak. *Commun Dis Intell* 2001;25:121-125.

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Introduction

At the end of August 1999, amongst the usual and expected seasonal rise in meningococcal infections, 3 children with meningococcal septicaemia, who attended the same secondary school, were notified to the Victorian Department of Human Services, Communicable Diseases Section within 48 hours of each other. Two presented to a local hospital and one consulted a general practitioner with a 13-19 hour history of symptoms. Blood for culture was collected from all 3 cases, one before and two after the administration of antibiotics. All 3 children were transferred to the same major paediatric facility by paediatric emergency transfer (PETS).

Public health management of meningococcal disease

There are 3 strategies for the control of meningococcal disease: chemoprophylaxis; vaccination; and the dissemination of information.

Chemoprophylaxis (antibiotics which efficiently remove meningococci from the nasopharynx) is given to prevent further transmission between carriers (including cases who are treated with penicillin alone) and susceptible individuals.[1-4] Public health case management begins with a review of the recent activities of cases in order to identify two groups of people who should be offered chemoprophylaxis:

- the group of people which includes the carrier who transmitted the organism to the case, and who may pose a risk to other susceptible individuals; and
- potential co-primary and secondary cases, who acquired meningococcal infection at the same time or shortly after the case. These people need special advice and monitoring, as prophylaxis may not prevent secondary cases.[5]

Vaccination for the protection of defined populations can be undertaken if characterisation of the organism proves it to be of a vaccine-preventable strain.[1,6] Almost half of microbiologically confirmed cases in Victoria in 1999, were shown to be due to serogroup C strains, for which polysaccharide vaccines are available. In developed countries, serogroup C strains are responsible for about two-thirds of outbreaks. It is helpful therefore to be able to characterise invasive strains to identify outbreaks. Appropriate specimens for culture for strain identification include blood, CSF, joint aspirates, throat swabs, and picked spots or punch biopsies of affected skin.[7,8]

Viable meningococci may be retrieved for up to 3 hours after instituting antimicrobial therapy,[9] and CSF and picked spots or punch biopsy specimens can provide a culture-positive specimen for somewhat longer after commencement of antibiotics.[10] In small children, a positive throat swab is uncommon,[11] whilst teenagers have a meningococcal nasopharyngeal colonisation rate of 10-30 per cent.[12-14] A positive throat swab in an otherwise clinical case therefore, provides useful microbiological guidance for public health purposes.[15]

Cases related in time may be from different or the same serogroup, type, subtype and molecular type; an outbreak

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involves cases of an identical strain. We report here the epidemiological and microbiological features and public health management of this small outbreak, including a public health interventions cost analysis.

Public health investigation

Epidemiology

We collected a routine case history from the primary contacts of each case, noting in particular, details of recent extra-curricular school activities.

Communication

Public health management of the outbreak included the design of the vaccination program, planning vaccine delivery, and the development of effective multiple communication strategies including the school, local newspaper, television and radio media.

Microbiology

Blood for culture was collected from all 3 cases prior to PETS transfer, but only those from Case 3 accompanied the case to hospital.

With the exception of a throat swab from Case 3 late on the day of admission, no specimens were collected for microscopy and culture by the paediatric facility. Thus we were reliant upon results from the blood specimens collected before admission, and on specimens collected for other purposes retrieved from the hospital laboratory, for decisions relating to public health management of these apparently related cases.

At the time of this outbreak, staff at the Microbiological Diagnostic Unit (MDU), State Neisseria Reference Laboratory, were investigating the possibility of using molecular techniques including polymerase chain reaction (PCR) and nucleotide sequencing methods to assist in the identification of strains of meningococci. Specimens from all 3 cases were therefore also subjected to molecular investigation.

Vaccination

The school meningococcal vaccination program was designed after ascertaining that sufficient polysaccharide vaccine was available to conduct the campaign.

Results

Epidemiology

The secondary school attended by the 3 cases has approximately 1500 enrolled pupils and 150 staff, divided into 2 campuses. Discussion with the parents of the cases identified several important considerations.

- The first 2 cases were close friends, but had spent much of their incubation times apart.
- The third case was unknown to the other two, and attended a separate campus.
- The 3 pupils had recently been involved in different school extension camp activities.
- One-hundred and forty students and 16 staff from one campus went to Canberra. Students attending this camp reported a high rate of coughs and colds.
- Eight students and a senior teacher from one campus went on a sports camp to Darwin involving in a great deal of physical activity, arriving home 'exhausted'.
- Fifty-six students and 12 staff from both campuses went on a one-day beach retreat day and picnic.
- Although the school camps to Canberra and Darwin involved only one campus, the retreat had involved students from both campuses.

The attack rate in the school community, with 3 cases in 1600 individuals, was high at 187/100,000. However, if the first 2 cases were considered to be co-primary and considered as a single case, the subsequent occurrence of a temporarily-linked but socially unlinked case from the same community alerted public health staff to the possibility of an outbreak with an attack rate of 114 per 100,000 population. A summary of the main temporal epidemiological features of the outbreak is presented in the Figure.

Microbiology

A single positive culture was retrieved from the blood specimen from Case 1. By conventional laboratory analysis, the group was confirmed as serogroup C, and by monoclonal antibody assay typing and subtyping, 2a:nst (see discussion). PCR quickly confirmed the presence of meningococcal DNA in early blood specimens of all 3 cases.

The subsequent use of another more specific PCR assay confirmed the 2 culture-negative specimens as serogroup C. Further molecular analysis revealed these organisms all had a specific and identical mutation in the *porA* sequence, strongly suggesting that the same strain of *Neisseria meningitidis* was the cause of all 3 cases.

Public health management of the outbreak

Prophylaxis to case contacts

In accordance with the National Health and Medical Research Council (NHMRC) guidelines, intimate family contacts (the parents, siblings, grandparents, and closest friends) were prescribed chemoprophylaxis (rifampicin). Because of the close nature of contact between pupils whilst on school camp, children who had attended camp with any of the cases were also considered to be close contacts in need of chemoprophylaxis. In practice, this involved the whole of a year group on one campus, and a number of children from a different year group from both campuses.

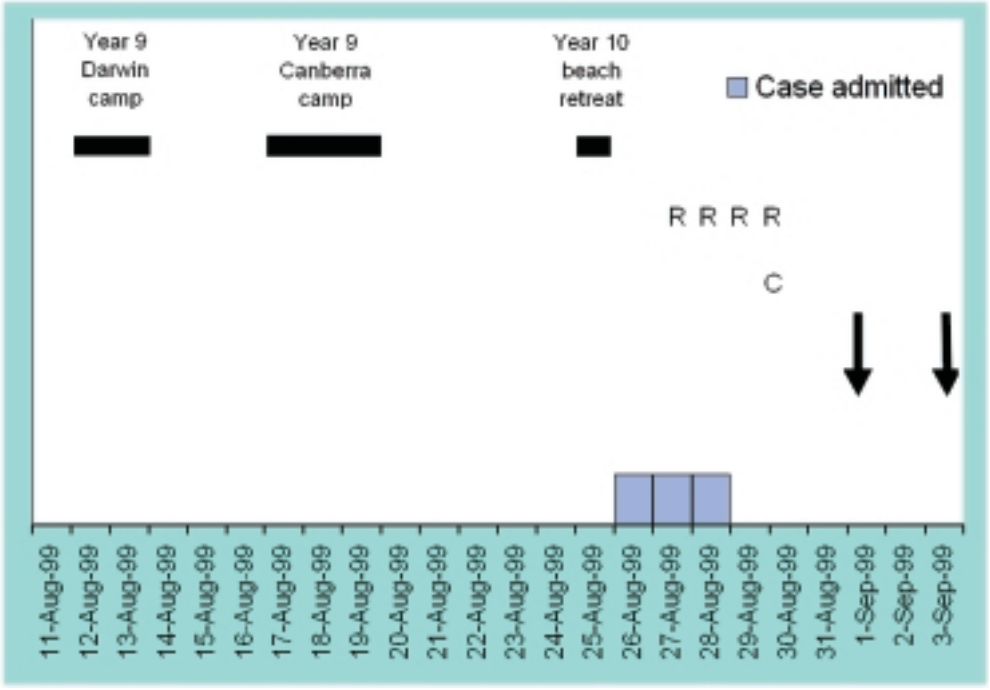
The vaccination campaign

As one case had been confirmed as being serogroup C, and the isolate had been recovered from one of the pair of friends, the likelihood of the second of these two being caused by a different strain was considered remote. It was therefore decided to offer vaccination to the group of people at high risk of secondary disease, including all students enrolled at the school, school staff, and close family contacts.

The organisation of equipment, staff, infrastructure support and vaccine supplies was completed in a single day. The following day 36 hours after the confirmation of a serogroup C strain in one of the cases and demonstration of the presence of capsule serogroup C meningococci in the blood of all three by PCR a mass meningococcal vaccination program was undertaken targeting all students enrolled at the school, school staff, and all close family contacts.

Our school-based communication strategy for parents resulted in a very high rate of signed parental consent to the

Figure. Temporal epidemiological feature of the outbreak, chemoprophylaxis and vaccination campaign, Victoria, 1999



R Rifampicin administered to family contacts and school camp/year group contacts.

C Confirmation that blood culture from case 2 had yielded strain of serogroup C.

Immunisation campaign and mop-up.

vaccination campaign. Of the target of 1600 staff and students of the school, 1530 were vaccinated on the campaign day. Vaccination sessions for the school were held on the school campuses, during school hours, over 4 hours, reaching over 95 per cent of the school population. The family members and the remaining students were vaccinated 2 days later. There were no major sequelae following vaccination.

Communication

Public anxiety surrounding the outbreak was very high. Responding to public queries and the preparation of press packs occupied many hours of staff time.

The cost of the outbreak

The costs associated with this outbreak are summarised in the Table. Early public health response to the outbreak was estimated to have cost $8,178, largely accounted for by staff time spent in response to public enquiries. These costs would have been incurred, whether the outbreak had been due to a serogroup B strain, for which no vaccine is currently available, or serogroup C. The cost of chemoprophylaxis, at $1.51 per adult course, was less that 5 per cent of the total cost of the public health management of the outbreak.

The cost of the vaccination campaign was $56,941, most of which was accounted for by vaccine, at a bulk rate of $27.50 per dose. The staff costs for delivering the vaccination campaign were very similar to those for the management of the outbreak.

The costs to agencies outside the Communicable Diseases Section have not been included in this analysis, because we have no means of estimating these. There undoubtedly will have been an equivalent cost to local health and education services, as many calls to public health were from other professionals ringing for advice to pass on to others, for example the safety or otherwise of children using communal school buses.

Discussion

The epidemiology of meningococcal disease of serogroups B and C disease is different. In developed countries, whilst serogroup B is the cause of most endemic disease, serogroup C is more often responsible for outbreaks. To illustrate, a recent analysis of school-based outbreaks of meningococcal disease reviewed the principles of school outbreak management in 22 outbreaks. Serogroup C was responsible for 14 outbreaks compared with serogroup B, 7, and serogroup Y, a single outbreak.[16]

Several serogroup C outbreaks have been reported in groups of teenagers since 1992, mainly C.2a:P1.2 and related strains. The first, in Ottawa, Canada, was loosely defined precipitating a fairly ineffectual prophylaxis program, followed by a vaccination program which halted the outbreak.[17] The following year a Danish report documented 20 teenage cases over 7 months in 3 outbreaks. In this group meningococcal carriage was studied in detail demonstrating that carriage patterns were unrelated to local attack rates.[14] The most recent report comes from England and documented a series of 7 cases in a population of 7100 during 2 months. A vaccination campaign reached 83 per cent of the identified risk groups. During the next year 3 further cases occurred in local teenagers, one a vaccinated child.[18]

An outbreak of the same phenotype based on a student population in Sydney over a 7-week period consisted of a pair of co-primary cases, a related secondary case, and a fourth case who was considered, by pulsed field gel electrophoresis (PFGE), to be unrelated.[19] Vaccination was

offered after the diagnosis but before PFGE results were available. The outbreak provoked much disquiet and the vaccination campaign caused considerable expense. The authors report that they would not have offered vaccination if the PFGE results, which suggested that the cases were unrelated, had been available earlier as the first 3 cases did not fulfill the definition of an outbreak provided in the NHMRC guidelines.

There are shortcomings with both chemoprophylaxis and polysaccharide vaccines as preventive public health tools. Chemoprophylaxis may only delay rather than prevent the onset of secondary cases.[20] Polysaccharide vaccine provides protection for up to 5 years,[21] however, it does not eliminate nasopharyngeal carriage[22] and cases have occurred shortly after a C-strain mass vaccination campaign.[18,23,24]

The secondary attack rate in the close contacts of cases however, has been variously reported as 4.34/1,000 in untreated contacts,[21] and 0.5 per cent (5/1,000) in micro-biologically confirmed cases in all close contacts.[25] On this basis, in the combined school and family population we would have expected to experience at least one and up to 6 more cases in this outbreak, if we had not undertaken the $57,000 vaccination campaign.

The early interpretation of these 3 cases as an outbreak was helpful in guiding our decision to vaccinate. The importance of incorporating molecular microbiological information in public health decision making is that we were sure that only one serogroup C strain was active in the community at that time. All 3 cases were subsequently shown to be have an unusual *porin* type* and were probably identical. Whilst gratifying, this does not alter the rationale for these decisions. In the future, molecular typing methods will provide powerful enhancement to public health management of meningococcal disease.

Acknowledgements

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Table. The cost of the outbreak and vaccination campaign

	Units	Average unit staff cost per day, Aus$	Total Aus$ cost
Outbreak costs			
Medical officers	13 days	> $345	4770
EHO and nursing staff	15 days	$169	2538
Administration and media staff	2 days	>$120	419
Total staff costs			7727
Telephone, fax, consumables			100
Rifampicin to contacts: 153 Year 9 & staff; 64 Year 10 & staff; 15 family and friends	232 courses of 16 capsules = 3712 capsules	$9.45 for 100 caps	351
Management and administration sub-total			8178
Vaccination campaign costs			
Medical officers	7.0	as above	2654
EHO and nursing staff	27.5	as above	4654
Administration and media staff	2.5	as above	333
Total staff costs			7641
Vaccine			
School	1600 doses		
Family members	15 doses		
Wastage	~ 105 doses	$27.50 per dose	47,300
Vaccination-associated consumables			500
Travel			1500
Sub-total of vaccination campaign costs			56,941
Total cost of the outbreak and vaccination campaign			65,119

NB. The costs of accommodating the vaccination sessions, printing and distributing parental information and consent forms, and the management of the students was borne by the school involved.

* *PorA* VR (variable region) Type 5-1, 10-4 with a G T base substitution at position 76 of the coding sequencing, which would make the encoded *porin* protein non-functional. See database at: http:// www.mlst.zoo.ox.uk/porA-vr/porA

this outbreak, from both within and outside the Department of Human Services.

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