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**Summary**

Between 8 December 1995 and 16 January 1996 seven laboratory confirmed cases of septicaemia owing to infection with *Neisseria meningitidis* serogroup C strains and one highly probable case of meningococcal septicaemia occurred in three electoral wards in south Rotherham and the Retford area of north Nottinghamshire. All cases occurred among children aged 1–17 years. One patient died. The public health response to this outbreak was the largest community prophylactic antibiotic and immunization programme against meningococcal infection, to date, in the United Kingdom. The target group for each Health Authority was 8900 for Rotherham Health Authorities and 8000 for North Nottinghamshire Health. Local logistical factors led to differences in the implementation of the programme by each Health Authority. At the completion of each programme, 8320 doses of vaccine had been administered (92.5 per cent coverage) during the Rotherham Health Authorities programme and 7660 (95.7 per cent coverage) during the North Nottinghamshire Health programme. The additional financial cost of the exercise amounted to approximately £125,000 for each Health Authority. This paper describes the evolution of the outbreak, the decision-making process resulting in the immunization programme in each Health Authority, the implementation of each programme, problems identified and lessons learned.

**Keywords:** invasive meningococcal disease, outbreak, community immunization programme

**Introduction**

We report a recent community outbreak of invasive infection owing to *Neisseria meningitidis* serogroup C strains in Rotherham and North Nottinghamshire health districts. The clinical picture in each case was one of septicaemia without features of meningitis. As a result of this outbreak the largest community prophylactic antibiotic and immunization programme against meningococcal infection in the United Kingdom, to date, was undertaken. Although a planned national mass immunization programme, against measles, has been organized recently in the United Kingdom, urgent large-scale community immunization programmes have not been implemented in this country since the 1950s and 1960s.\(^1\) Large-scale community immunization programmes against *N. meningitidis* have been implemented in other countries, e.g. in Africa, Canada, New Zealand, Brazil, Cuba and Norway.\(^2\)–\(^4\)

**Descriptive epidemiology**

Between 8 December 1995 and 16 January 1996 there were seven laboratory confirmed cases of septicaemia owing to infection with *N. meningitidis* serogroup C strains and one highly probable case of meningococcal septicaemia (Table 1). Meningococcal septicaemia is defined as a septicaemic illness owing to infection with *N. meningitidis* but without meningitis. All cases occurred among children aged 1–17 years. Five laboratory confirmed cases and one highly probable case occurred in three electoral wards in south Rotherham (St John's, Anston and Kiveton Park) and two laboratory confirmed cases in the Retford...
Table 1 Details of individual cases

<table>
<thead>
<tr>
<th>Case</th>
<th>Group/Type</th>
<th>Specimen</th>
<th>Date of onset</th>
<th>Date of 'notification'</th>
<th>Date organism identified</th>
<th>Date grouped</th>
<th>Date sub-typed</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>C</td>
<td>Serology only</td>
<td>08.12.1995</td>
<td>12.12.1995</td>
<td>08.01.1996</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>C</td>
<td>C 2b P1.5, P1.2</td>
<td>Throat swab only</td>
<td>31.12.1995</td>
<td>01.01.1996</td>
<td>04.01.1996</td>
<td>08.01.1996</td>
<td>09.01.1996</td>
</tr>
<tr>
<td>D</td>
<td>C 2b P1.5, P1.2</td>
<td>Throat swab only</td>
<td>02.01.1996</td>
<td>03.01.1996</td>
<td>08.01.1996</td>
<td>09.01.1996</td>
<td>09.01.1996</td>
</tr>
<tr>
<td>E</td>
<td>No culture</td>
<td>N/A</td>
<td>03.01.1996</td>
<td>04.01.1996</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>F</td>
<td>C 2b P1.5, P1.2</td>
<td>Throat swab only</td>
<td>03.01.1996</td>
<td>04.01.1996</td>
<td>05.01.1996</td>
<td>06.01.1996</td>
<td>09.01.1996</td>
</tr>
<tr>
<td>G</td>
<td>C 2b P1.5, P1.2</td>
<td>Throat swab and blood culture</td>
<td>03.01.1996</td>
<td>04.01.1996</td>
<td>06.01.1996</td>
<td>08.01.1996</td>
<td>09.01.1996</td>
</tr>
</tbody>
</table>

* Polymerase chain reaction.

A number of links between the eight cases were discovered (Fig. 3). Cases A and E lived in the same village and attended infant and junior schools which shared the same site. Cases E and F were close relatives who had been together for a two-day period and both became ill the same evening with an identical clinical presentation. No organism was isolated from case E; however, the isolation of *N. meningitidis* serogroup C from case

Figure 1 Cases of *N. meningitidis* septicaemia in South Rotherham and the Retford area of North Nottinghamshire, December 1995–January 1996.
Figure 2 Epidemic curve of outbreak of *N. meningitidis* septicaemia in South Rotherham and the Retford area of North Nottinghamshire, December 1995–January 1996.
The Communicable Disease Surveillance Centre (CDSC) was first contacted on Thursday, 4 January 1996, by Rotherham Health Authorities (RHA) for advice on the cases which had been reported in south Rotherham (A, B, D, E and F). By then, N. meningitidis serogroup C subtype 2b had been identified as the causative organism in one of the RHA cases (B). The Department of Public Health from Rotherham contacted the Department of Public Health in North Nottinghamshire Health (NNH) on Friday, 5 January 1996, to ascertain if any of the cases in the two districts were associated. No associations were identified.

On Saturday, 6 January 1996, an Infection Control Team in Rotherham discussed whether the then known south Rotherham cases constituted an outbreak. The team concluded that, as invasive infection with N. meningitidis had been confirmed in only two cases (B and F) and the strain was known in only one of these, an outbreak could not yet be declared. At this meeting a possible link between one south Rotherham case (D) and two cases in Retford (C and G) was discussed – roller-blading at Retford Leisure Centre. It was decided that urgent clarification on social links between cases would be sought. If a social network which included cases with infection caused by the same strain of N. meningitidis could be identified, this would represent a sub-group of the population of people under 19 years of age who were at higher risk of N. meningitidis acquisition and disease, and at whom prophylactic measures could be directed. The roller-blading link was reported to colleagues in NNH on Monday, 8 January 1996. After this, both Health Authorities and allied health service agencies actively sought details (names and contact information) of this wider social network.

Laboratory confirmation was obtained on Monday, 8 January 1996, that the organism in a further two of the Rotherham cases (A and D) and the second Retford case (G) was N. meningitidis and that the strain was serogroup C in all cases to date. The Meningitis Reference Laboratory, Manchester, confirmed that in cases C, D, F and G the organism sub-type was 2b P1.2, P1.5, late on Tuesday, 9 January 1996.

At a Joint Outbreak Control Team meeting of RHA and NNH the following day, a community outbreak was declared. It was agreed to continue to try to identify the links with the roller-blading group, which it was felt constituted an extended contact group, and offer them prophylaxis. An agreed press statement was also prepared. However, attempts to define this extended contact group were unsuccessful, and by the evening of Thursday, 11 January 1996, it was evident that this course of action would not be adequate. The possibility of extending antibiotic prophylaxis and immunization to the wider community was therefore discussed.

On Friday, 12 January 1996, a further case (H) was admitted to the Intensive Therapy Unit of the local district general hospital at 7.00 a.m. It was agreed with CDSC that a community prophylactic antibiotic and immunization programme was appropriate.

After consultation with colleagues at the Centers for Disease Control and Prevention, Atlanta, Georgia, USA, the following points were considered by CDSC in advising on community immunization in this outbreak:

1. The number of serogroup C cases: the number of clinical cases of meningococcal disease with definite or probable N. meningitidis serogroup C infection identified on laboratory testing. Linked cases, that is, cases which occur in the same household or in the same institutional setting (if this setting is considered to be the focus of a separate outbreak), are excluded.

2. The population at risk (target area): a community which is recognizable by the people who live inside and outside its borders, and which contains the cases.

3. The target group: the age group which contains the N. meningitidis serogroup C cases two years of age or over (current polysaccharide vaccines are less effective in children under two years of age).

4. Age-specific N. meningitidis serogroup C attack rate: the number of N. meningitidis serogroup C cases (minimum three) divided by the population at risk in the target age group within a three-month period.
In this outbreak there were eight cases. Two cases (E and F) occurred in the same ‘household’, although case E had not been confirmed as an \(N. \text{meningitidis}\) serogroup C case. Although there were social links between some of the cases, no other setting was considered as the focus of the outbreak. The age-specific \(N. \text{meningitidis}\) serogroup C attack rate had reached 43/100 000 in a five-week period when the decision to immunize was taken. The \(N. \text{meningitidis}\) serogroup C attack rate in England and Wales for people aged one to 19 years for the whole of 1995 was 4/100 000 (E. Kaczmarski, unpublished data, 1995). To set all of this in context, during the high incidence months of December and January in the previous three years, there had never been more than one case of meningococcal septicaemia notified in Rotherham.

The target area was defined in NNH as the area within a five-mile radius of Retford town centre, with an estimated target population of 7300. In RHA the target area encompassed three electoral wards, giving an estimated target population of 8900. The target group was defined as children and young people between two and 18 years of age inclusive, living in or attending schools in the target areas. In RHA it was also agreed that, because two cases had now arisen in one school, this school should be treated as a priority group, and that all pupils and staff in this school should have prophylactic antibiotics and vaccine as soon as this could be arranged. An urgent Joint Outbreak Control Team meeting was held on Friday, 12 January 1996, to make arrangements for this programme.

Two antibiotics were chosen for the programme. Rifampicin was offered to primary school and younger children (under 11 years of age). Ciprofloxacin was offered to secondary school age children and young adults (aged 11–18 years) to avoid possible interactions between rifampicin and the oral contraceptive pill. The use of antibiotics on such a large scale raised questions about the possible side effects, development of antibiotic resistance and eradication of potentially protective, non-virulent strains. It was considered that the carriage rate of outbreak strains was probably higher in the target group than in those outside this group, and that there was less risk of further cases in the target group in the five to seven days before protection from immunization developed (six of the eight cases had occurred in the previous 10 days). The rationale for use of antibiotics was that by reducing \(N. \text{meningitidis}\) carriage in the target group, the risk of further cases occurring within and without the target group would be reduced.

At a further meeting of the Joint Outbreak Control Team held on Sunday, 14 January 1996, the outbreak was declared a Regional Outbreak, i.e. an outbreak involving more than one District Health Authority area, the management of which would benefit from co-ordination at a Regional level. Responsibility for the co-ordination of the response to the outbreak was therefore transferred to the Regional Epidemiologist of Trent Regional Health Authority.

**Implementation**

North Nottinghamshire Health co-ordinated the ordering and delivery of vaccine supplies for both Health Authorities. Although the strategy on the target group for the community prophylactic antibiotic and immunization programme was adhered to by both District Health Authorities, local logistic factors led to differences in the implementation of the programme within each district.

**Rotherham Health Authorities**

Rotherham Health Authorities opted to arrange the administration of prophylactic antibiotics to the school considered a priority group on Friday, 12 January 1996. Vaccine was administered to the school the following day. The remainder of the community programme was provided in a phased approach over the week commencing 15 January 1996, using school facilities and a local community health services clinic. This approach was adopted for three reasons:

1. To ensure supplies of antibiotics, vaccine, needles and syringes would be available for the programme. After discussion with the local Community Pharmacist, it became evident that large supplies, especially of rifampicin, would be required, which needed to be individually packaged for dispensing to children. This would take most of the weekend to achieve.

2. RHA could not secure a large, single, accessible, health service facility in the three target wards. Owing to the close working relationships between RHA, community health services and Rotherham Metropolitan Borough Council Department of Education, the use of school facilities was offered for the programme. The headteachers of the schools within the target area were informed of this decision during the afternoon of Friday, 12 January 1996, and pupils were informed before the end of the school day.

3. This would be the best way of ensuring that the target population alone received prophylactic antibiotics and immunization. The target population could be identified through the use of school registers and child health surveillance records.

Press enquiries were jointly handled by RHA Press Officer and the Department of Public Health. Rotherham Health Authorities established a helpline which began taking calls at 5.00 p.m. on Friday, 12 January 1996. The helpline was manned by staff from all directorates in the Health Authority. The helpline was manned over the weekend and the following week.

**North Nottinghamshire Health**

North Nottinghamshire Health opted to arrange for prophylactic antibiotics and vaccine to be administered to as many children and young people as possible in the target group on
Saturday, 13 January 1996, using a small community hospital not normally open at weekends. Those people who could not be treated at the weekend (owing to illness or being away over the weekend) would be treated in small sessions organized in local secondary schools during the following week. This approach was adopted for three reasons:

1. A rapid response would quickly reduce the carriage of N. meningitidis in the target group, thus reducing the risk of further cases occurring within the next five to seven days.6

2. The geographical nature of the area meant that Retford town centre was an obvious focus for people to attend.

3. A small community hospital in the town was available at weekends, providing good clinical facilities.

Headmasters of schools within the target area were informed of these arrangements during the afternoon of Friday, 12 January 1996, and most pupils were informed before the end of the school day. A ten-line help line was established by 3 p.m. on 12 January, staffed by non-medical volunteers from all NNH departments. This remained staffed over the weekend and the following week. All volunteers were briefed regularly. If medical input was required, a public health physician either took over the call or telephoned back later. All calls requiring action were logged and action taken was recorded.

Both Health Authorities publicized the arrangements for their individual programmes through the local media and schools. The issue of informed consent was addressed differently by the two Health Authorities, within national guidance.8

Coverage

By the end of the RHA programme, 8320 doses of vaccine had been given (coverage 92.5 per cent for the estimated target group of 8900). At the end of the NNH programme, 8110 doses had been given, 7660 to people within the target population (coverage 95.7 per cent for a revised target population of 8000, see below). These compare favourably with the coverage rate in a mass, phased, community immunization programme carried out in Canada.2

Costs

The costs of this exercise were considerable; the extra resources which had to be found by both Health Authorities amounted to around £250 000. This included staff overtime, drug and vaccine costs, and consumables. For Rotherham supply and preparation of drugs cost around £20,000, and administration, distribution and clinical staff time cost £102,000. The opportunity cost to local services will have been much greater in terms of disruption to the routine work of Health Authorities, trusts, local authorities and schools.

Efficacy

Whether the prophylaxis and vaccination exercise halted the outbreak is not possible to know. There was one subsequent case of meningitis in a vaccinated individual owing to the outbreak strain of N. meningitidis. However, investigation revealed a suboptimal response to the vaccine. Rates of nasopharyngeal carriage post vaccination are being compared with a non-immunized group in a separate study.

Problems

Microbiological confirmation

The interval between onset of illness and laboratory confirmation of diagnosis was four and two weeks in cases A and B, respectively (Table 1). In case A no isolate had been obtained and the diagnosis relied upon serological testing of sequential blood specimens. In case B delays occurred owing to the holiday period and the increased workload at the Meningococcal Reference Unit (MRU) as a result of the high incidence of meningococcal disease at that time. Once the outbreak had been identified and reported to the MRU, the process of obtaining specimens and laboratory confirmation was given high priority. The time interval between onset of illness and laboratory typing was reduced to five days for each of cases F–H.

The organism was identified from a throat swab culture in six of the cases. In most of these cases this investigation had not been done until requested by the Consultant in Communicable Disease Control (CCDC). The recommendation to take throat swabs from cases has been stressed in the latest national guidance to CsCDC and Microbiologists.5,8

Programme logistics

The logistics of supplying vaccine and antibiotics was a problem (only 16300 doses of vaccine were in the United Kingdom at the time). This was experienced more acutely in the rapid response programme instituted by NNH, where limits were placed by the manufacturer on the amount of antibiotics released to the district for use in this programme. In addition, antibiotic supplies promised by the manufacturer for 9.00 a.m. on Saturday, 13 January 1996, did not arrive until lunchtime. Because of these difficulties the NNH programme had to be extended over two days. Fresh supplies of antibiotics and vaccine were obtained for the second phase of the NNH programme. The remainder of the programme was held in secondary schools and a local health centre, and was completed on Friday, 19 January 1996.

One of the problems in estimating the amount of prophylactic antibiotics and vaccine needed by NNH was the inadequacy of information available on the size of the target population — which was cautiously estimated at 25 per cent
greater than the known general practitioner list size. There was also an unexpectedly large private school population (approximately 700), all of whom fell within the definition of the target group. In addition, simple everyday activities, such as reconstituting the single dose ampoule of vaccine, when translated into the scale of this exercise, led to some wastage of vaccine and significant delays in administration.

One of the most difficult aspects of the programme in both Health Authorities was containing the programme to the target population. At a practical level, this presented a particular problem in NNH, where, owing to the scale of the exercise, it was difficult to turn away people outside the target group. However, at most 450 people outside the intended target group were immunized. In RHA, difficulties were also experienced but at a level which meant that non-target group individuals could be refused immunization.

The helplines of both Health Authorities were inundated with calls. In Rotherham this hampered the effective management of the outbreak by public health staff.

Acute reactions to intervention

Two potentially serious angioedemic reactions occurred among those given prophylactic antibiotics and vaccine in North Nottinghamshire. The first happened on Saturday, 13 January 1996. The second occurred on Friday, 19 January 1996, during the catch-up programme in a local health centre, with the patient describing symptoms suggestive of laryngeal oedema. Both cases occurred at least 30 minutes after administration of ciprofloxacin and vaccine, when the individuals were on their way home (both returned to the programme location). These serve to illustrate that such community based programmes are not without risks from the intervention, which must be set against the unknown likelihood of future cases. An assessment of side effects and antibiotic resistance is being addressed through follow-up studies.

Communications

Misunderstandings arose between the agencies involved in the response in Rotherham. One particular concern arose around the definition of the boundaries of the area affected, owing to two villages having similar sounding names. This led to great public anxiety in one of the villages where the programme was not taking place.10,11

Media relations

Difficulties were experienced in handling press and public enquiries regarding the perceived difference in implementation in the two districts. Although there was little difference in the strategy being followed, differences in the presentation and organization of the Health Authorities' responses were highlighted by the media.12-14

Public misconceptions

It has become evident since the end of the community antibiotic and immunization programme that many of the people vaccinated now believe they are safe from meningitis. This view was shared by parents in a village outside the target area, who saw immunization as a means of allowing them to relax from the fear of their children developing meningitis.11 This occurred despite strenuous efforts by both Health Authorities, including using regional television news broadcasts to strongly advise the public to continue to be vigilant regarding the symptoms of meningitis. These broadcasts stressed that immunization would only protect against the organism causing the outbreak, and that many other organisms could cause meningitis. Information leaflets on meningococcal disease were given to everyone receiving prophylactic antibiotics and vaccination.

Lessons learned

Microbiological confirmation

Microbiological confirmation of invasive meningococcal infection should be as rapid as possible. Specimens for polymerase chain reaction should be obtained at the earliest opportunity and not after standard culture techniques have failed.9 Communication between CsCDC, Consultant Microbiologists and the Meningococcal Reference Laboratory needs to be enhanced. The value of taking a throat swab in a case of suspected invasive N. meningitidis disease should be stressed by CsCDC and Consultant Microbiologists to clinical staff in hospitals.

Programme logistics

There is no perfect way to respond to such a community outbreak. Decisions must be made in the light of local circumstances and revisited as additional information becomes available. Each of the responses chosen by the Health Authorities had different benefits and disadvantages, which we have illustrated, and these should be given due consideration.

The rapid response initiated by NNH should have had the advantage of rapidly allaying public anxiety. Unfortunately, owing to logistical problems, the programme had to be extended over two days. The follow-up programme was somewhat larger than originally planned. This was completed on Friday, 19 January 1996. The result of this was a degree of public inconvenience and bad publicity. This was recognized as a potential risk at the outset of the programme but was deemed to be acceptable. The potential difficulties should be borne in mind by any Health Authority undertaking such an exercise.

The phased approach of RHA reduced concerns over adequate prophylactic antibiotic and vaccine supplies. However, during the phased approach the potential risk of further cases occurring had to be accepted. There could have been an
increase in public anxiety, if they had perceived the response to the outbreak was not rapid enough.

During an urgent community immunization programme, attention needs to be given to the method of vaccine preparation being used (either ready-to-use liquid or dried powder for reconstitution). Staff may have to draw up liquid or reconstitute and draw up dried vaccines for administration by other staff. Despite being both tedious and labour intensive, such an activity is nevertheless unavoidable.

It is vital for any Health Authority undertaking such an exercise to hold fast to the defined target group, in the face of intense public pressure. Any Health Authority which suspects a potentially significant outbreak should contact the CDSC at an early stage. The assistance offered by local and national meningitis charities to any Health Authority should be welcomed. Throughout this exercise, both Health Authorities received a large amount of support from charities, including handling helpline queries overnight. Issues concerning informed consent must be given careful consideration by any Health Authority before embarking on a community health intervention, irrespective of the reasons for this intervention.

Acute reactions to intervention

The fact that there can be reactions to any health intervention must be borne in mind. These potential risks have to be balanced against the unknown risk of further cases of invasive *N. meningitidis* disease. It is important to have paramedical staff available to deal with an acutely ill patient without interrupting the programme.

Communications

Clear communications between Health Authorities and other agencies involved in an outbreak are essential if perceived differences are not to lead to public anxiety. Early co-ordination by the Regional Epidemiologist may be the best means of achieving this. Written communication, involving the greater use of facsimile machines for confirmation of important details would have reduced misunderstandings in Rotherham.

Media relations

The media will be very interested in the photogenic opportunity of any helpline and this should be borne in mind when one is being planned. The security of confidential information, not least of any of the cases involved in the outbreak, and staff manning the helpline needs to be given serious consideration at the planning stage.15

Public misconceptions

The general public may become complacent about meningitis and meningococcal septicaemia following such a programme. Both Health Authorities have, through the media and through dispensing literature to the parents of those vaccinated, reminded the public that:

1. protection has been afforded against only one of many infective agents which may cause meningitis or meningococcal septicaemia in the United Kingdom;
2. immunity may last for a variable period of time (between two and five years);
3. the best defence against meningitis and meningococcal septicaemia is awareness of the important symptoms and seeking prompt medical attention if symptoms arise.

Conclusion

Any major incident such as this is a complex undertaking, involving the close co-operation of many agencies. The potential difficulties with such a situation are legion, some of which can never possibly be foreseen. The experience of this outbreak and the programmes instituted in response to it, emphasize the value of giving serious consideration to these issues in advance.

Districts should incorporate their response to major outbreaks in a detailed, local multiagency incident plan. This should include arrangements for: information gathering; decision-making; defining roles and responsibilities of the various agencies; the provision of a helpline or counselling; the co-ordination of a possible large-scale response (e.g. an immunization–decontamination–evacuation exercise); record keeping; media and public relations; and the management of supra-district incidents.

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