Responsibility for follow-up must not be transferred back to the parents lightly, but routine follow-up implies more consultations, and further research is needed to establish whether our definition of major symptoms would result in many extra consultations or admissions to hospital.

This study was supported by grants from the Department of Health. We are grateful to Dr M Downham for advice; Dr W Kell, Mrs J Herdman, and Mrs C Ruddick for help with the Gateshead interviews; the families, doctors, and ward staff for co-operating with the study; and Mrs W Scott and Mrs A Jowett for secretarial help.

References

- 1 Stanton AN, Downham MAPS, Oakley JR, Emery JL, Knowelden J. Terminal symptoms in children dying suddenly and unexpectedly at home. *Br Med J* 1978;iii:1249-51.
- 2 Richards IDG, McIntosh HT. Confidential inquiry into 226 consecutive infant deaths. *Arch Dis Child* 1972;47:697-706.
- 3 Wynne J, Hull D. Why are children admitted to hospital? *Br Med J* 1977;ii:1140-2.
- 4 Oakley JR, Stanton AN. Meningococcal infections during infancy: confidential inquiries into 10 deaths. *Br Med J* 1979;iii:468-9.

(Accepted 15 January 1980)

Haemophilus influenzae type B meningitis: a contagious disease of children

MARY P GLODE, ROBERT S DAUM, DONALD A GOLDMANN, JEANNE LECLAIR, ARNOLD SMITH

Summary and conclusions

The families of 126 consecutive patients with *Haemophilus influenzae* type B meningitis were surveyed for secondary invasive *H influenzae* disease among household contacts. A total of 120 of the families were contacted. In six cases no contact was possible and the medical record was reviewed. Some 555 household contacts were found; 31% (171) were under 5 years of age. A secondary case was defined as a household contact with *H influenzae* type B isolated from blood or cerebrospinal fluid more than 24 hours, but less than 30 days, after admission to hospital of the index case. Four secondary cases were identified, all in children aged under 5 years. The secondary attack rate in children under 5 years or less in the month after exposure to an index case was thus 2.3%, 800 times the endemic attack rate for *H influenzae* meningitis. This is a conservative estimate since five additional contact cases were documented, but not included in the secondary attack rate.

Young contacts of a child with *H influenzae* meningitis are thus at significant risk of life-threatening secondary disease.

Introduction

Haemophilus influenzae type B remains the major cause of bacterial meningitis in infants and children in the United States: it is estimated that 10 000 cases occur yearly.¹ Unlike meningococcal disease, *H influenzae* is generally not considered to be sufficiently contagious to warrant prophylaxis of contacts. Nevertheless, several lines of evidence suggest a need to re-evaluate this recommendation. A high rate of carriage of

H influenzae type B has been recognised for many years in families of index cases, and temporally related familial cases have been noted sporadically since 1909.²⁻¹¹ Several clusters of cases of invasive *H influenzae* type B disease have also been reported in day care centres.¹²⁻¹⁷ A secondary attack rate in families of 4% to 5% was recently suggested on the basis of a retrospective study,¹⁸ but only 220 families of 546 index cases were available for review and there was only one secondary case of *H influenzae* type B disease proved by culture.

To determine the secondary attack rate more accurately we reviewed all cases of *H influenzae* type B meningitis seen at the Children's Hospital Medical Centre, Boston, Massachusetts, over three years.

Patients and methods

All medical records of children admitted to the Children's Hospital Medical Centre from January 1975 to January 1978 and discharged with a diagnosis of *H influenzae* type B meningitis were reviewed. One hundred and twenty-six records representing 127 cases were reviewed.

In the index cases *H influenzae* type B meningitis had been established by isolating the organism on cerebrospinal fluid culture or by detecting type B capsular polysaccharide in cerebrospinal fluid by latex agglutination¹⁹ in patients with clinical and laboratory data compatible with bacterial meningitis, but in whom antibiotic treatment had been started before the diagnosis of meningitis.

We aimed to identify any cases of *H influenzae* type B meningitis that occurred among household or day care centre contacts of the index children. Secondary cases of invasive *H influenzae* disease were those diagnosed (by isolation from blood or cerebrospinal, joint, or pleural fluid) in a contact of the index case more than 24 hours but less than 30 days after the index patient was admitted to hospital. Household contacts were defined as those people who spent four or more hours a day with the index patient in the week before the illness. Contacts from day care centres (any child care organisation catering for 10 or more children) were not counted as household contacts when calculating the secondary attack rate.

Approval for this study was obtained from the centre's committee on human investigation at Children's Hospital Medical Centre.

All charts were reviewed by one of the authors, who completed a questionnaire on clinical and bacteriological data. If the patient had a private physician we obtained his permission to contact the family. One of the authors contacted an adult in the family by telephone or letter and obtained the following information: (a) names, ages, and sex of all people who normally lived in the house or who spent more than four hours a day with the index patient in the week preceding his or her admission to hospital; (b) whether index patient regularly attended a nursery, day care centre, or went to a babysitter's house;

Division of Infectious Disease, Children's Hospital Medical Centre, Boston, Massachusetts

MARY P GLODE, MD, research fellow (now associate director of infectious disease, the Children's Hospital, Denver, Colorado)

ROBERT S DAUM, MD, research fellow (now assistant professor of paediatrics, Tulane University School of Medicine, New Orleans)

DONALD A GOLDMANN, MD, hospital epidemiologist and director of bacteriology

JEANNE LECLAIR, MPH, infection control practitioner

ARNOLD SMITH, MD, professor of paediatrics (now chief, Division of Infectious Disease, Children's Orthopaedic Hospital and Medical Centre, Seattle, Washington)

(c) the names and ages of any contacts of the index patient known to be seriously ill (either visit to hospital emergency room or admission in the three months before or after the index patient's admission; (d) whether prophylaxis was given to contacts when the index patient was ill.

Data were evaluated using χ^2 analysis comparing expected and observed cases of secondary disease.²⁰

Results

One hundred and twenty-seven cases (126 children) of *H influenzae* type B meningitis were listed by medical records from January 1975 to January 1978; all charts were available for review. One hundred and twenty families were contacted and volunteered the information requested. In six cases no contact was possible by phone or letter and information was limited to that available in the medical chart.

Secondary cases—Four secondary cases were identified (table). There were also five additional cases among contacts that did not meet our criteria for inclusion as secondary cases. In one case (case 5) the contact case occurred before the index case, in two (cases 6B and 7B) the number of close contacts at a day care centre were not known, and in two (cases 8B and 9B) more than 30 days elapsed between the cases. Eight of the nine contact cases had meningitis. One had otitis media and *H influenzae* bacteraemia. In three of the nine contact cases the disease was due to ampicillin-resistant organisms; in all three the isolate from the index case was also ampicillin resistant. Four contact cases occurred in siblings, two in playmates living in the same house as the index patient, one in a cousin, and two in contacts from a day care centre. In seven of the nine cases the contact case was initially detected only by the telephone survey and would not have been detected by chart review alone.

Interval to onset of disease—The interval between admission to hospital of the index case and admission of the contact case ranged from three days to 11 months. Seven of the nine cases occurred in the first month after admission of the index case.

Age distribution—The mean age of the contact cases was 18.7 months (range 7 months to 3 years 9 months). In six of the nine cases disease occurred first in the older child and then spread to the younger contact.

Secondary attack rate—One hundred and twenty-six cases of *H influenzae* meningitis were reviewed and 122 were determined to be index cases. Four cases (2B, 4B, 5B, 7B) actually represented contact cases of meningitis. Three were contacts of index cases included among the original 126 and one case of meningitis was secondary to *H influenzae* pneumonia and bacteraemia occurring in a sibling 12 days previously. In the households of these 122 index cases there were 555 contacts. These included family members, babysitters, and other children who spent more than four hours a day with the index case in the week before his illness. Altogether 171 of the contacts were 5 years old or less. The secondary attack rate for all individuals in a household was 0.72% (4/555). The secondary

attack rate for children in the household aged 5 years old or less was 2.3% (4/171).

Prophylaxis—In six of the families antibiotic prophylaxis had been attempted. In two families oral ampicillin had been given to siblings; in three rifampicin had been given to contacts and family members because the initial presentation of the child suggested meningococcal disease; and in one a child cared for by the same babysitter as the index case had received an unknown medication. One contact who developed meningitis (case 1B) had received chemoprophylaxis. The clinical course of the index case (case 1A) suggested meningococcal disease and the family received rifampicin as prophylaxis. The 10-month-old sibling (case 1B) received two doses of rifampicin (10 mg/kg/dose)—one dose on the evening of admission of his brother, and the second the next morning. Rifampicin prophylaxis was then discontinued as the index patient did not have meningococcaemia. The contact case became symptomatic 72 hours later.

Discussion

These data strongly suggest that *H influenzae* meningitis is a contagious disease in age-susceptible household contacts. The combined data from two previous epidemiological studies suggest that the overall annual attack rate for *H influenzae* meningitis is 35 cases per 100 000 age-susceptible children.^{1 21} Assuming that this attack rate applies to the Boston area, we would thus have expected 0.005 cases in our 171 age-susceptible household contacts in the month after exposure. Four cases were actually observed, giving an attack rate of 2.3%, which is 800 times greater than expected ($p < 0.0001$).

Although the 2.3% attack rate documented in this study is substantial, it probably underestimates the risk to a child who is intimately exposed to a case of *H influenzae* meningitis. Two day care centre contacts developed meningitis within one month of exposure to an index case, but they were not included in the secondary attack rate since we could not determine the number of day care centre contacts who were at risk. One household contact developed meningitis two and a half months after the index case and was thus not counted as a secondary case. Nevertheless, these children (cases 8A and 8B) were cousins with frequent contact; both developed meningitis due to ampicillin-resistant *H influenzae* type B. In the course of our telephone interviews we learnt of another household contact who developed meningitis 11 months after exposure. This sibling was only 3 weeks old at the time the index case became ill. Since families often harbour an *H influenzae* type B carrier for as long as 12 months after a case of meningitis, the sibling may have been exposed to *H influenzae* type B and developed

Secondary cases of *haemophilus influenzae* meningitis

Case No	Age and sex	Interval to onset of secondary case	Disease	Ampicillin sensitivity	Prophylaxis	Type of contact
Secondary cases						
1A 1B	2 yr 9 mnth, M 10 mnth, M	4 days	Meningitis Otitis media, sepsis	Sensitive „	Rifampicin x2 doses	Siblings
2A 2B	9 mnth, M 3 yr 9 mnth, F	3 days	Meningitis Meningitis	Resistant „	None	Siblings
3A 3B	8 mnth, F 2 yr, M	3 days	Meningitis Meningitis	Resistant „	None	Playmates, lived in two-family house
4A 4B	11 mnth, M 23 mnth, M	3 days	Meningitis Meningitis	Sensitive „	None	Playmates, three-family house, one kitchen
Additional contact cases						
5A 5B	3 yr, M 1 yr, M	12 days	Pneumonia, bacteraemia Meningitis	Sensitive „	None	Siblings
6A 6B	3 yr 3 mnth, M 2 yr, M	9 days	Meningitis Meningitis	Sensitive „	None	Day care centre
7A 7B	11 mnth, M 7 mnth, F	24 days	Meningitis Meningitis	Sensitive „	None	Day care centre
8A 8B	4 yr, M 1 yr, M	2½ mnth	Meningitis Meningitis	Resistant „	None	Cousins, frequent contact
9A 9B	4 yr, F 1 yr, M	11 mnth	Meningitis Meningitis	Sensitive „	None	Siblings

meningitis at a time when passively acquired maternal antibody concentrations would be expected to be at their lowest.²² In addition to these culture-documented contact cases, one household contact was admitted with probable bacterial meningitis but no organism could be isolated. Since this child had received previous antibiotic treatment, he may have represented another contact case.

Five of the nine contact cases were intrafamilial, raising the issue of genetic susceptibility to disease. An association of HLA type with *H influenzae* epiglottitis and meningitis has been reported.²³ Four of the nine cases occurred in close contacts who were not related to the index case. In addition, the reports of clusters of *H influenzae* disease in day care centres also emphasise the fact that secondary cases need not be intrafamilial.

It is difficult to compare our data on *H influenzae* type B meningitis with the position in meningococcal disease since the calculated secondary attack rate for meningococcal disease includes all age groups and the secondary attack rate in children aged 5 years or less is not known. Only one secondary case occurred in a child less than 5 in the Centre for Disease Control meningococcal disease surveillance study of 326 primary cases.²⁴ The total number of secondary cases of invasive *H influenzae* disease seen in the United States each year probably exceeds the number of secondary cases of meningococcal disease.

Our findings corroborate the results of a recent CDC study of secondary spread of *H influenzae* meningitis in household contacts.²⁵ Our secondary attack rate, however, was 2.3% in children aged under 6 years compared with a rate of 0.5% in the CDC study. One major difference in the design of the studies was our expanded definition of household contact, which included all individuals spending four or more hours a day with the index case in the week before admission. Thus, we carefully investigated all child care arrangements in our families. In contrast to the CDC study, over half of our contact cases (5/9) occurred in non-sibling contacts. We believe that this finding of non-familial contact cases has important epidemiological implications regarding both the risk of secondary disease and the identification of individuals who may benefit from chemoprophylaxis.

Effective chemoprophylaxis for eradicating *H influenzae* type B carriage and preventing secondary cases has not been identified. Ampicillin and co-trimoxazole have not been successful in eradicating *H influenzae* type B carriage in day care centres.^{16 17} Rifampicin eradicated carriage in 22 out of 25 children in two different studies, and further trials with this drug seem warranted.^{15 16}

Doctors have traditionally been taught that *H influenzae* type B meningitis is a sporadic disease of children that is not contagious. Our results strongly suggest the need to reassess this tenet. *H influenzae* type B disease should be recognised as potentially contagious in young children. A careful history of contacts of the index case should be obtained and parents should be instructed that any contact who becomes ill should be seen immediately by a doctor. Pending the development of an effective vaccine, controlled trials of chemoprophylaxis in household contacts are now indicated.

We acknowledge the excellent secretarial assistance of Ms Lynda Gregory and the statistical advice of Mr Dennis Luckey.

References

- Parke JC Jr, Schneerson R, Robbins JB. The attack rate, age incidence, racial distribution, and case fatality rate of *Haemophilus influenzae* type b meningitis in Mecklenburg County, North Carolina. *J Pediatr* 1972;**81**:765-9.
- David DJ. Influenzal meningitis. *Arch Intern Med* 1909;**4**:323-9.
- Hertzog AS, Cameron IL, Karlstrom AE. Influenzal meningitis in brothers. *JAMA* 1944;**124**:502-3.
- Cooperstock M. Influenzal meningitis in siblings. *Am J Dis Child* 1944;**68**:269-70.
- Rothman M, Nahil FJ. Prophylaxis in meningitis due to type b *Haemophilus influenzae*. *N Engl J Med* 1955;**253**:653.
- Tejani A, Dobias B, Nangia BS, et al. Intrafamily spread of *Haemophilus influenzae* type b infections. *Am J Dis Child* 1977;**131**:778-81.
- Kloss LJ. *Haemophilus influenzae* meningitis in siblings. *Clin Pediatr* 1967;**6**:580-1.
- Coulter D, Whisnant JK, Marks MI. *Haemophilus influenzae* b meningitis in identical twins of a triplet sibship. *Pediatrics* 1974;**54**:502-4.
- Ginsburg CM. Epiglottitis, meningitis, and arthritis due to *Haemophilus influenzae* type b presenting almost simultaneously in siblings. *J Pediatr* 1975;**87**:492-3.
- Kline AH. *Haemophilus influenzae* meningitis. *Am J Dis Child* 1962;**104**:595-7.
- Addy MG, Ellis PDM, Turk DC. *Haemophilus epiglottitis*: nine recent cases in Oxford. *Br Med J* 1972;**ii**:40-1.
- Schiffer MS, Schneerson R, MacLowry J, et al. Clinical, bacteriological, and immunological characterisations of ampicillin-resistant *Haemophilus influenzae* type b. *Lancet* 1974;**ii**:257-9.
- Glode MP, Schiffer MS, Robbins JB, et al. An outbreak of *Haemophilus influenzae* type b meningitis in an enclosed hospital population. *J Pediatr* 1976;**88**:36-40.
- Melish ME, Nelson AJ, Martin TE, et al. Epidemic spread of *Haemophilus influenzae* type b (HIB) in a day care center. *Pediatr Res* 1976;**10**:348.
- Ward JI, Gorman G, Phillips C, et al. *Haemophilus influenzae* type b disease in a day care center. *J Pediatr* 1978;**92**:713-7.
- Gilsdorf J, Granoff D, Gessert C, et al. *Haemophilus influenzae* type b (HIB) infection in a day care center (DCC): eradication of carrier state by rifampin. *Pediatr Res* 1978;**12**:491.
- Ginsburg CM, McCracken GH, Rae S, et al. *Haemophilus influenzae* type b disease. Incidence in a day care center. *JAMA* 1977;**238**:604-7.
- Filice GA, Andrews JS Jr, Hudgins MP, et al. Spread of *Haemophilus influenzae*. Secondary illness in household contacts of patients with *H. influenzae* meningitis. *Am J Dis Child* 1978;**132**:757-9.
- Ward JI, Siber GR, Scheifele DW, et al. Rapid diagnosis of *Haemophilus influenzae* type b infections by latex particle agglutination and counter-immunoelectrophoresis. *J Pediatr* 1978;**93**:37-42.
- Armitage P. *Statistical methods in medical research*. New York: John Wiley and Sons, 1971:99-146.
- Smith DWP Jr, Haynes RE. Changing incidence of *Haemophilus influenzae* meningitis. *Pediatrics* 1972;**50**:723-7.
- Michaels RH, Norden CW. Pharyngeal colonization with *Haemophilus influenzae* type b: a longitudinal study of families with a child with meningitis or epiglottitis due to *H influenzae* type b. *J Infect Dis* 1977;**136**:222-8.
- Whisnant JK, Rogentine GN, Gralnick MA, et al. Host factors and antibody response in *Haemophilus influenzae* type b meningitis and epiglottitis. *J Infect Dis* 1976;**133**:448-55.
- The Meningococcal Disease Surveillance Group. Meningococcal disease: secondary attack rate and chemoprophylaxis in the United States, 1974. *JAMA* 1976;**235**:261-5.
- Ward JI, Fraser DW, Baraff LJ, et al. *Haemophilus influenzae* meningitis. A national study of secondary spread in household contacts. *N Engl J Med* 1979;**301**:122-6.

(Accepted 17 December 1979)

ONE HUNDRED YEARS AGO Medical men of all nations will (says the *Daily Telegraph*) learn with interest, upon the authority of no less exalted a personage than the Princess Bismarck, that magpie-dust is an infallible panacea for the falling-sickness. The most confirmed epileptic may achieve a radical cure of his distressing malady if he will only swallow a sufficient quantity of the dried and pulverised flesh of this furtive fowl: at any rate, so we should infer from the following circular, addressed by the President of the Eckenfoerd Shooting Club to the members of that association:—"M... 2nd January, 1880. Her Highness Princess Bismarck wishes to receive, before the 18th instant, as many magpies as possible, from the burnt remains of which an antiepileptic powder may be manufactured. I permit myself, therefore, high and well born sir, to express to you the entreaty that you will forthwith shoot as many magpies as you can in your preserves, and forward the same either to the Chief Forester Lange at Friedrichruhe or hither, without paying for their carriage, down to the 18th of this month. Teeming with exalted respect, I am, etc., J L L."—We have no reason to believe that the indisposition from which the German Chancellor has recently been suffering is one in the slightest degree complicated by epileptic symptoms. It may, therefore, be hoped that he is not the patient whom Princess Bismarck has been treating with burnt magpie. Perhaps an epidemic of fits has broken out among the Prince's tenants on his estates in Lauenburg and Pomerania. If so, we sincerely wish them well through a cure which, however beneficial it may prove to epileptic farmers, seems likely to result unfavourably to the health of the Eckenfoerd magpies. (*British Medical Journal*, 1880.)