Risk and prevention of meningococcal disease among education workers: A review


The aims of the present study were to review the risk of invasive meningococcal disease (IMD) among education workers, particularly pregnant women, and to evaluate preventive measures, in a context of endemicity, outbreak or epidemic as observed in the province of Quebec. The literature was reviewed and persons in charge of IMD surveillance in France, Quebec, the United Kingdom and the United States were interviewed. Surveys of asymptomatic carriage of Neisseria meningitidis show that transmission among students is higher than transmission between students and teachers. IMD incidence among education workers was analyzed in Cheshire (United Kingdom) in the period from 1997 to 1999, and the results indicated a risk six times higher than that in the general population. Overestimation of the magnitude of the risk is possible because the analysis focused on a cluster. None of the population-based studies of IMD mentioned a risk of secondary cases among education workers. Six IMD cases in education workers were identified in five clusters in schools in the United Kingdom, but not in the other countries. There is no epidemiological study on IMD risk among pregnant women, and this factor was not mentioned in any published review of IMD. Immunization of education workers at the beginning of their employment, using serogroup C glycoconjugate vaccine or a combined A, C, W-135, and Y conjugate vaccine (still under development), could reduce IMD risk, but the cost effectiveness of this measure should be evaluated. The societal benefit of excluding pregnant women from work place during an outbreak seems to be very low, even if the risk could be decreased for this specific group. When chemoprophylaxis is indicated for the control of an outbreak in an educational setting, treatment should be offered both to students and teachers in the group at risk.

Key Words: Disease risk; Education; Neisseria meningitidis; Occupational health; Prevention

An epidemic of invasive meningococcal disease (IMD) caused by a virulent clone of serogroup C was observed in Quebec in the early 1990s, and resulted in a mass immunization campaign with the polysaccharide vaccine during the winter of 1992 to 1993 (1). A recrudescence was detected at the beginning of 2001 and it was decided to offer the new serogroup C conjugate meningococcal vaccine to all Quebec persons up to 20 years of age (2). In this epidemiological context, the risk of transmission among education workers is a potential source of concern for the health authorities. This review aims to provide a comprehensive overview of the risk of IMD among education workers, taking into account the specific context of education, and to evaluate preventive measures in this setting.
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Risk of nasopharyngeal infection

The natural habitat of *N meningitidis* is the human nasopharynx and the bacterium is transmitted by direct mouth-to-mouth contact or by the excretion and inhalation of mucous particles during close contact (4). In a given community, the IMD risk depends on the acquisition rate of a pathogenic strain by susceptible individuals. For an individual, this risk is determined by the prevalence of carriers of pathogenic strains among the person’s contacts, and the frequency and closeness of interpersonal contacts.

To date, there has been no study specifically concerned with the asymptomatic carriage of *N meningitidis* among education workers. Generally, the prevalence of carriage is low among young children and higher among adolescents and young adults (5). The educational environment is conducive to the transmission of the bacterium. In England, a prospective study of first-year university students showed an increase in the proportion of carriers during the first term from 7% at admission to 23% a month later (6). Risk factors for acquisition were frequency of visits to bar halls, active smoking, visits to night clubs and intimate kissing.

In a situation of recrudescence caused by a virulent strain of serogroup C, the prevalence of asymptomatic carriage of the pathogenic strain is usually very low in the general population, with values below 1% (7-9). Higher prevalences may be observed among those in direct contact with a sick person. In England, the pathogenic strain was found in seven of the 34 classmates of a sick student (21%), but only in one of the 209 students in other classes (0.5%) and in none of the eight teachers at the elementary school (10). In another study, a high prevalence (50 of 572, or 9%) was found in students at a college in Devon, United Kingdom, following an outbreak caused by a serogroup C strain, while 3% (4 of 154) of the staff members were carriers (11).

Similar observations have been made in the context of an outbreak caused by serogroup B strains. Studies of asymptomatic nasopharyngeal carriage done in several high schools in Wales showed prevalences of the pathogenic strain of about 2% among the students (12,13). In a study of the contacts of sick people in Norway, the prevalence of the pathogenic strain was 1% among fellow day-care users (two of 220), 1% among classmates (four of 286), 0% among the teachers (zero of 44), and very low (0.7%) in the general population (14).

Risk of invasive infection

In Canada, as in other industrialized countries, most IMD occurs in people under age 20 and the risk is low among adults (15). Epidemiological surveillance data in Table 1 indicate that annual IMD incidence was about 4 per million in the adult population, during the endemic period of 1995 to 1998 (Health Canada, written communication). In the population aged 20 to 59 years, 43% of cases of known serogroup were of serogroup C, 11% of serogroup Y, 3% of serogroup W-135, and 2% of serogroup A. In the period 1990 to 1992, and in the period 1999 to 2001, outbreaks caused by virulent strains of serogroup C *N meningitidis* were observed in several Canadian provinces. During these outbreaks, an increased proportion of cases occurred in young adults (16). In the 25- to 44-year-old age group, in Quebec, the risk of serogroup C IMD was 3.0 per million person-years during the epidemic period (1990 to 1995), and was 0.4 per million during the endemic period.

### TABLE 1

Annual incidence rate per million of invasive meningococcal disease according to serogroup and age, in the endemic period from 1995 to 1998, in Canada

<table>
<thead>
<tr>
<th>Serogroup</th>
<th>0–9</th>
<th>10–19</th>
<th>20–29</th>
<th>30–39</th>
<th>40–49</th>
<th>50–59</th>
<th>60+</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>–</td>
<td>–</td>
<td>0.1</td>
<td>0.1</td>
<td>–</td>
<td>–</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>B</td>
<td>14.4</td>
<td>3.2</td>
<td>1.9</td>
<td>0.7</td>
<td>0.8</td>
<td>1.4</td>
<td>1.2</td>
<td>3.0</td>
</tr>
<tr>
<td>C</td>
<td>6.2</td>
<td>5.2</td>
<td>2.5</td>
<td>0.7</td>
<td>0.9</td>
<td>0.8</td>
<td>1.0</td>
<td>2.3</td>
</tr>
<tr>
<td>W-135</td>
<td>0.6</td>
<td>0.2</td>
<td>0.1</td>
<td>–</td>
<td>0.1</td>
<td>0.2</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Y</td>
<td>1.1</td>
<td>1.0</td>
<td>0.3</td>
<td>0.3</td>
<td>0.4</td>
<td>0.2</td>
<td>1.3</td>
<td>0.7</td>
</tr>
<tr>
<td>Others</td>
<td>–</td>
<td>0.1</td>
<td>0.1</td>
<td>–</td>
<td>0.1</td>
<td>–</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Unknown*</td>
<td>5.0</td>
<td>3.3</td>
<td>1.7</td>
<td>0.8</td>
<td>0.9</td>
<td>0.8</td>
<td>1.2</td>
<td>1.8</td>
</tr>
<tr>
<td>All</td>
<td>27.3</td>
<td>12.9</td>
<td>6.6</td>
<td>2.6</td>
<td>3.2</td>
<td>3.4</td>
<td>4.8</td>
<td>8.1</td>
</tr>
</tbody>
</table>

*Includes missing and nongroupable. Data from Health Canada (written communication)
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Risk for pregnant women
There are no epidemiological studies on the risk of IMD among pregnant women, but this factor is not mentioned in any of the literature reviews (3,39,40). In Quebec, we know of two IMD cases during pregnancy since 1990, and neither involved educators (Monique Douville-Fradet, written communication). Although there is no indication of an increased risk of IMD associated with pregnancy, it is logical to assume that the seriousness of the disease could affect the health of the fetus. In the first case observed in Quebec, a meningococcemia caused by a serogroup C strain occurred in the 38th week of pregnancy and brought on premature labour and the birth of a child who developed a cerebral palsy syndrome. In the second case, a febrile syndrome appeared in a woman who was 38 weeks pregnant. A blood hemoculture showed an infection by a serogroup B meningococcus. Antibiotic therapy resulted in a favourable outcome and a child in apparently good health was born after a 39 week pregnancy.

Immunization
Immunization is the best way to prevent IMD. Polysaccharide vaccines against serogroups A, C, Y and W-135 have existed for decades, but the protection is short-lived (41) and these vaccines are not recommended for routine immunization aiming to confer long-term protection (16). Serogroup C glycoconjugate vaccines are now available in Canada and their short-term effectiveness is approximately 90% in all age groups (42,43). This type of vaccine triggers the appearance of an immunological memory and it is likely that the protection will last a long time (44). Combined A, C, W-135 and Y glycoconjugate vaccines are presently under development, and may be available in the near future (44).

Assuming that education workers begin their professional careers at age 25 and at that time they receive a dose of serogroup C meningococcal conjugate vaccine, which will provide 90% protection against the disease for 20 years, it would be necessary to vaccinate between 8000 and 46,000 workers to prevent one IMD case (assuming the relative risk of the disease is 6 or 1 compared with the general population and annual incidence rates in the general population as reported in Table 1). Using a combined A, C, W-135 and Y conjugate vaccine and the same assumptions on disease incidence and vaccine efficacy, it would be necessary to vaccinate between 6000 and 34,000 workers to prevent one IMD case.

Protective work reassignment
There are no studies regarding the effectiveness of exclusion from work during a recrudescence or cluster, and this preventive measure is not mentioned in the guidelines for the control of IMD in the United States and Canada (45,46). The temporary reassignment of a pregnant teacher away from students in an epidemic situation or during a local outbreak could possibly reduce the risk of infection for this specific group, but the societal benefit would be virtually nil because the workers would have to be replaced and other individuals would be exposed.

Chemoprophylaxis
The effectiveness of chemoprophylaxis in preventing IMD in the close contacts of a sick person has been studied in noncontrolled epidemiological studies in families (47-49). The protection conferred by chemoprophylaxis is short-lived and the reduction in the risk may be effective in a given community,
also provided all the individuals are treated simultaneously. American and Canadian guidelines advocate chemoprophylaxis following a sporadic case in a day care centre (45,46), but not in institutions with older children. However, extended chemoprophylaxis is sometimes the only way to try to control an outbreak in an educational institution when the strain is not covered by a vaccine or when quick protection is the aim (50-52).

In February 2001, at the beginning of the serogroup C outbreak in the province of Quebec, four IMD cases occurred during a nine-day period, in 13- to 16-year-old adolescents attending the same large secondary school in the Montérégie area (Montérégie Regional Health Board, written communication). In two of these cases, the diagnosis was made on clinical grounds. The other two cases were confirmed by culture and the epidemic serogroup C 2a P1.2,5 ET15 clone was identified. Interestingly, the four affected adolescents had been immunized with one dose of polysaccharide vaccine during the 1992-1993 mass immunization campaign. To prevent any new cases possibly caused by transmission at the school, chemoprophylaxis and vaccination was immediately offered to all the students (approximately 2278) and adults (approximately 756) in the school. A total of 2700 individuals received one dose of polysaccharide vaccine (89% of target population), and a two-day rifampin regimen was prescribed to 2718 individuals (90% of target population). Among 541 students who responded to a survey, 89% fully complied with the prescribed chemoprophylaxis, 7% partially complied and 4% did not take the drug. No other IMD cases were observed in the school.

In such a situation, the objective is to interrupt the transmission of the pathogenic strain, before the immune response to the vaccine becomes effective. The treatment of all the individuals belonging to the target community is indicated, including teaching staff. Recommended drugs, regimens, indications and contraindications for chemoprophylaxis are provided in the Canadian guidelines for control of meningococcal disease (46).
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47. Analysis of endemic meningococcal disease by serogroup and epidemiology and a case-control analysis. JAMA 1997;277:389-95.