Complications of Meningococcal Disease in College Students

Lonny J. Erickson,1 Philippe De Wals,2 Joan McMahon,3 and Shirley Heim3

1Regional Health Board of Montérégie, and 2Department of Community Health Sciences, University of Sherbrooke, Quebec, Canada; and 3Allegheny County Health Department, Pittsburgh

A retrospective study was conducted to provide a description of the risk, complications, fatality, and sequelae associated with invasive meningococcal disease in college students admitted in the Allegheny county (Pennsylvania) hospital system from January 1990 to May 1999.

Recent studies have found an increased risk of invasive meningococcal disease (IMD) among college students, particularly among those staying in campus dormitories [1, 2]. A high fatality rate and high frequency and gravity of sequelae in survivors of IMD due to serogroup C Neisseria meningitidis were documented in Canada [3], but no survey has specifically addressed this question in the United States. The present study aims to provide a picture of complications of IMD in college students in Allegheny County, Pennsylvania, from 1990 to 1999.

Methods. A total of 26 patients with IMD who had documented college or university enrollment during the period of January 1990 through May 1999 were notified to the Allegheny County Health Department, and 2 additional patients were identified through contact with regional hospitals and university health services during the course of this project. Outcome assessment was based on review of medical records and telephone interviews. For 3 fatal cases, families were not contacted; instead, medical records were reviewed. Twenty survivors were contacted by phone, of which 3 declined to participate in the interview. Two additional case-patients were located, but no contact could be made, and the remaining case-patient could not be located. The medical records from the last 5 patients were reviewed. The severity of permanent physical impairment was determined by means of the Annotated Scale of Bodily Injuries Regulation, which is the evaluation system of the Quebec Occupational Health and Safety Commission for work-related injuries [4]. The EuroQol EQ5D questionnaire was used for quality-of-life evaluation [5]. Figures for enrollment at colleges and universities in Allegheny County were obtained for academic years that ended in 1991–1999 [6].

Results. Fourteen of the total of 28 IMD cases occurred in students who attended 1 of the 9 Allegheny County colleges during 9 successive academic years (total, 598,144 person-years), giving an average annual attack rate of 2.3 cases per 100,000 students (95% CI, 1.3–4.0 cases per 100,000 students). Diagnosis was made by identification of N. meningitidis in culture of blood and/or CSF specimens, in 24 cases; latex agglutination test of CSF, in 3 cases; and by the findings of a Gram stain of CSF specimens, in 1 case. Serogroup identification was done for 17 cases; 2 cases due to serogroup B; 9 cases due to serogroup C; 2 cases due to serogroup C or W135; 1 case due to serogroup C, Y, W135, or A; 2 cases due to serogroup Y; and 1 case that was not groupable. Fourteen (82%) of these 17 cases were due to known serogroups were thus vaccine-preventable.

The overall case-fatality rate was 11% (3 of 28 cases). All 3 deaths occurred among vaccine-preventable cases. The first fatal case (due to serogroup C or W135) was in an 18-year-old man who presented to student health service for headache and fever, and who was given penicillin and sent home. The following night, he was admitted to the emergency department while incoherent and with meningeal signs. The patient’s condition rapidly deteriorated, and he developed cerebral hypertension with cerebellar herniation, diabetes insipidus, and disseminated intravascular coagulation. Brain death was declared, and the patient died <1 day after hospital admission.

The second fatal case (due to serogroup C) was in a 19-year-old woman who presented with complaints suggestive of respiratory infection, who had pneumonia visible on a chest radiograph, and who received a prescription for oral antibiotics. Soon thereafter, she developed signs of severe infection and was admitted to a local hospital at 1 p.m., where parenteral antibiotic therapy was initiated. Signs of meningitis appeared within a few hours, and the patient became lethargic and comatose. The diagnosis of meningitis was made after lumbar puncture, and the patient was flown to a tertiary-care hospital. On ad-
mission, at 8 p.m., the patient was unresponsive and had no spontaneous respiration. Maculopapular lesions appeared on arms and legs. CT revealed moderate cerebral edema but no evidence of herniation. Brain death was declared at midnight.

The third fatal case (due to serogroup Y) was in a 21-year-old man with history of coarctation of the aorta and mitral valve regurgitation, who developed fulminant meningococcemia with meningitis, intravascular coagulation, septic shock, multiple-organ failure, and coma before death, which occurred only 18 h after hospital admission.

Permanent physical sequelae were noted in 5 patients (20% of survivors; table 1). The majority of physical sequelae occurred in patients with vaccine-preventable IMD, and none were observed in the 2 patients with cases due to serogroup B. Physical sequelae were due mainly to complications of septicemia and tissue necrosis and led to significant reduction in functional ability and quality of life.

Beyond the clinical and epidemiological parameters are profound and permanent psychological and social scars, as reported by survivors and their families. A young man stated that “Psychologically, I find this disease hard to understand or accept … there is no warning … it is so disabling! Maybe the fact that I am a diabetic made me more susceptible … I don’t know … I still have a lot of questions.” Even though it has been 4 years since her illness, this young woman began crying during the interview; she recalled, “I just don’t know how it happened to me … or why … I was under a psychiatrist’s care for 6 weeks for depression … I’m studying at another school now … I just couldn’t bear to return to the college where I got sick.” Another survivor mentioned, “I was in the hospital for more than 3 months, one thing after another … profound respiratory distress, renal insufficiency, liver involvement … amputation of both legs below the knees … I will never play football again.” Another student obtained a full football scholarship as a linebacker at the university of his choice, but then, 1 month before transferring from his present college to the university, IMD destroyed all his plans. His father reported, “His life has been a series of long hospitalizations, treatments, surgeries, amputations of both forefeet and digits on both hands … he lives with constant physical and emotional unresolved grief … and he is consumed with anger.” Finally, a female student who had planned on an acting career said, “Imagine that [an acting career] now—with a prosthesis on both hands because of amputations.”

Discussion. This is the first study on the long-term impact of IMD in college students in the United States, and results are important for making decisions regarding immunization. Allegheny County hospitals serve a large number of colleges and universities in the Pittsburgh area, and efforts were made to achieve complete ascertainment of culture-confirmed IMD during a 9-year period. However, the relatively low number of cases remains a limitation.

Sporadic and small outbreaks of IMD, mainly caused by serogroup C organisms, have been reported with increasing frequency in colleges and universities during the past 10 years [7]. The estimated attack rate for IMD among college students in Allegheny county (2.3 cases per 100,000 students per year) was higher than the rate observed in the general population in the United States. In 7 areas that have an active surveillance system, the average annual incidence of IMD was 1.8 cases per 100,000 persons, for persons aged 15–19 years, and 1.0 cases per 100,000 persons, for persons aged 20–24 years, for the period of 1992–1996 [7]. Indeed, the gathering of young adults in an environment where transmission of airborne pathogens is facilitated by shared living and sleeping accommodations is a well-established risk factor for meningococcal disease [8].

In the present study, septicemia was diagnosed in all cases of vaccine-preventable IMD and was associated with a very high rate of complications, deaths, and sequelae. The same observation was made in a comprehensive study of serogroup C IMD in Quebec [3]. For patients in the age group of 17–24 years, the case-fatality rate was 19% (10 of 57 cases), and 23% of survivors (11 of 47 patients) had permanent physical sequelae. The factors that contributed to the extreme severity of

Table 1. Description of sequelae in survivors of meningococcal disease among college students in Allegheny County, Pennsylvania, January 1990–May 1999.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Neisseria meningitidis serogroup</th>
<th>OHSC physical impairment scorea</th>
<th>EuroQol quality of life scoreb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amputation of fingers in both hands and bilateral amputation forefeet</td>
<td>C</td>
<td>87%</td>
<td>0.69</td>
</tr>
<tr>
<td>Amputation of fingers in both hands</td>
<td>C</td>
<td>24%</td>
<td>0.80</td>
</tr>
<tr>
<td>Hearing loss and decreased knee mobility</td>
<td>Y</td>
<td>5%</td>
<td>0.73</td>
</tr>
<tr>
<td>Bilateral amputation forefeet</td>
<td>Unknown</td>
<td>42%</td>
<td>0.73</td>
</tr>
<tr>
<td>Extensive skin scarring</td>
<td>Unknown</td>
<td>0%</td>
<td>Not assessed</td>
</tr>
</tbody>
</table>

NOTE. OHSC, Quebec Occupational Health and Safety Commission.

a Score of 100% means complete inability to work.
b Score of 1.0 represents best and 0.0 worst imaginable health state.
IMD in young adults are not known. Proliferation and dissemination of meningococci in the bloodstream are facilitated by bacterial capsular characteristics and deficiencies in the innate host defense, in which complement-mediated bacteriolysis and opsonophagocytosis play a prominent role [9]. There is growing evidence that stress and fatigue can alter different components of the immune response and the outcome of many bacterial infections [10], but the lack of a suitable animal model for meningococcal infection hampers research in this area.

Meningococcal disease remains relatively rare among college students in the United States, but it has very serious consequences. Improving treatment may be difficult, and prevention remains the best option. Decisions regarding immunization should be based not only on disease risk, but also on fatality risk and on the risk of permanent and severe physical sequelae. Even in the absence of physical sequelae, survivors and families are affected by the dramatic course of the disease and often mention increased anxiety and reduced energy [3]. Our results support the recent recommendation of the Advisory Committee on Immunization Practices, which is to inform parents and college freshmen on the risk and consequence of IMD and the availability of a safe and effective vaccine [11].

**Acknowledgments**

We thank the following for their participation in this project: Bruce W. Dixon, Allegheny County Health Department, Pittsburgh; Anita Barkin, Carnegie Mellon University Health Service, Pittsburgh; Barbara Galderise, Duquesne University Health Service, Pittsburgh; Rose Bruich and Robert Morris, College Health Service, Coraopolis, Pennsylvania; and Nancy Evans, Indiana University of Pennsylvania Health Service, Indiana, Pennsylvania.

**References**