Preventing Meningococcal Infection in College Students

Lee H. Harrison

From the Infectious Diseases Epidemiology Research Unit, Departments of Medicine and Epidemiology, University of Pittsburgh School of Medicine and Graduate School of Public Health, Pennsylvania

The incidence of invasive meningococcal disease in adolescents and young adults of high school and college age has recently increased in the United States. Recent studies indicate that certain groups of college students are at increased risk. This has led to the recent Advisory Committee Immunization Practices recommendation that college freshman dormitory residents be provided information about meningococcal infection and the benefits of vaccination. Future studies will need to focus on the potential vaccine prevention of the increased risk of meningococcal infection in persons of high school age, particularly as new conjugate meningococcal vaccines become available.

Neisseria meningitidis is a leading cause of meningitis and other invasive bacterial infections worldwide [1, 2]. In recent years, the annual incidence of meningococcal infection in the United States has been 0.8–1 per 100,000 population, with infants, the elderly, and immunocompromised persons having the highest risk [3]. Mortality due to N. meningitidis is nearly equivalent to the mortality due to Streptococcus pneumoniae during the first 22 years of life, despite the substantially higher incidence of pneumococcal infection [4]. The case fatality ratio is ~10%, and 11%–19% of survivors suffer permanent sequelae, including hearing loss, other neurologic damage, or loss of limb [5–7]. Persons of college age typically have had a low risk of invasive meningococcal infection [3].

There have been several striking changes in the epidemiology of meningococcal infection during the 1990s. First, there has been an increase in the number of outbreaks caused by serogroup C N. meningitidis in the community and on college campuses [8–10]. Second, there has been an impressive increase in the incidence of meningococcal disease among adolescents and young adults, including persons of both high-school and college age [5, 11]. Third, the serogroup distribution of invasive meningococcal isolates in the United States continues to change, such that an increasing proportion of infections are potentially vaccine preventable [5]. Finally, recent studies indicate that certain behaviors, such as bar patronage, binge drinking, and cigarette smoking, are important risk factors for meningococcal infection during outbreaks, but whether these factors play a role in the increased incidence among adolescents and young adults is not clear [12–15].

A tetravalent serogroup A/C/Y/W-135, purified polysaccharide product was licensed in 1981 and is the sole meningococcal vaccine available in the United States [16]. This vaccine has not been universally used, because of the poor immunogenicity of polysaccharide vaccines in infants and the lack of a serogroup B component. Serogroup B polysaccharide is poorly immunogenic in humans, which has led to efforts to develop non–polysaccharide-based vaccines to prevent serogroup B infection [17]. In the United States, the tetravalent polysaccharide vaccine is administered to all military recruits, recommended for travelers to selected countries and for persons with certain medical conditions, and used for the control of outbreaks due to vaccine preventable strains [16, 18]. Immunization has been highly successful for controlling meningococcal infection in the military. In 1964 (the preimmunization era), the annual incidence was 30.1 per 100,000 active duty Army service members. After the initiation of routine immunization of enlisted soldiers in 1971, the annual incidence of meningococcal infection in the Army has decreased to 1.4 per 100,000, and the large outbreaks that plagued the military have disappeared [19].

In 1997, the American College Health Association (ACHA) recommended that college students “consider vaccination to reduce their risk for potentially fatal meningococcal disease” [20]. This was, in large part, a result of the outbreaks of meningococcal infection that had occurred on college campuses and the associated disruption that they brought, which included
panic on the part of students, staff, and parents, as well as mass antibiotic chemoprophylaxis and immunization campaigns. Unfortunately, there were no data on the risk of meningococcal infection among college students, whether the risk of meningococcal infection was higher than that among the general population of the same age, and whether there were subgroups of college students at highest risk.

Several recent studies have provided new information about these issues. During the 1998–1999 academic year, 88 cases of meningococcal infection that resulted in 8 deaths were identified among college students (N. Rosenstein, personal communication). In a study conducted in Maryland, college students did not have a higher risk, although the rates both among college students and among noncollege adults aged 18–22 years—which were 1.74 and 1.44 per 100,000 population, respectively—were higher than historical levels [11]. Among 4-year college students, on-campus residents had an annual incidence of 3.24 per 100,000 population, a 3.3-fold higher risk than off-campus residents. Interestingly, the highest incidence in this age group was among persons aged 17 years, the vast majority of whom were high-school students (none were college students). A survey found a >10-fold higher incidence among college students who resided in dormitories than in the rest of the college population [21]. A study conducted by the Centers for Disease Control and Prevention (CDC) in collaboration with the ACHA and the Council of State and Territorial Epidemiologist showed that first-year college students living in dormitories had an annual meningococcal incidence of 5.4 per 100,000, the highest rate except that for children aged <2 years [22]. In both the Maryland and CDC studies, the majority of meningococcal cases for which serogroup information was available were caused by serogroups that are included in the available meningococcal vaccine (71% in the CDC/ACHA study and 86% in the Maryland study). In the 2 studies combined, 8 (88%) of the 9 cases that caused death, for which serogroup information was available, were potentially vaccine preventable.

In contrast to the experience in the United States, college students in the United Kingdom had a higher annual incidence of meningococcal infection than did the general population of the same age (13.2 and 5.5 cases per 100,000 population, respectively [23]). Among college students, the increased risk was associated with catered halls (annual incidence of 15.3 per 100,000 population), which are analogous to dormitories at US colleges. Serogroup C polysaccharide-protein conjugate vaccines for preventing meningococcal disease were recently licensed for use in the United Kingdom. A recently initiated immunization program will focus on immunizing children aged 0–18 years, as well as first-year college and university students [24].

What are the reasons for the increasing incidence of meningococcal infection in adolescents and the higher risk among dormitory residents in the United States? In Oregon, the increase appears to be due to the emergence of a clone of serogroup B N. meningitidis [25]; a shift to older ages is a recognized, but not fully understood, feature of meningococcal epidemics, which typically are clonal in nature [26]. In other parts of the country, however, the increase does not appear to be clonal and is mostly due to serogroups C and Y [5]. It is intriguing to think that some of the increase may be due to the high prevalence of binge drinking [27] and the increasing prevalence of smoking among adolescents [28, 29], but insufficient data are available to determine whether this is the case. Thus, the increasing incidents among adolescents and the higher risk among college dormitory residents remain largely unexplained.

On the basis of studies of meningococcal infection in US college students, the Advisory Committee on Immunization Practices (ACIP) met on 20 October 1999 and modified its recommendations for meningococcal immunization, indicating that “those who provide medical care to [freshman dormitory residents] give information to students and their parents about meningococcal disease and the benefits of vaccination.... Other undergraduate students wishing to reduce their risk of meningococcal disease can also choose to be vaccinated” [30]. Some have questioned focusing public health resources on the prevention of meningococcal infection in college students, because of questions of cost-effectiveness [31]. However, the published cost-effectiveness analysis on immunization of college students did not take into account the recent increase in meningococcal incidence, the costs of permanent sequelae, the cost of the mass chemoprophylaxis and immunization efforts that often occur as a result of case clusters, and the costs of litigation [32]. The alternative approach to universal vaccination of college students is to initiate immunization campaigns in response to meningococcal outbreaks. This approach is problematic because, despite being necessary, it is not a particularly effective public health strategy since outbreaks are often on the wane by the time immunization activities are initiated [8, 9].

Furthermore, the issue is more complex than can be conveyed in a cost-benefit analysis. For example, one might argue that it is objectionable for one of the world’s wealthiest nations to allow young healthy adults to develop a devastating, often-fatal illness that can be prevented by a safe and efficacious vaccine. The focus on meningococcal infection has also been questioned on the basis that there are more important causes of serious illness and death among college students, such as binge drinking and suicide [33]. In response to such criticism, Dr. James Turner, chairman of a committee on vaccine-preventable diseases for ACHA, recently commented that “if we had a vaccine for those things, we’d give it” [33] thereby underscoring that the existence of more common public health problems among college students for which there are no highly efficacious interventions does not preclude the use of a safe and efficacious intervention for a less common problem. This debate underscores the complexity of the issue of vaccine prevention of meningococcal infection.

So, where are we with the vaccine prevention of meningocolic infection?
coccal infection in college students? First, it is reasonable to promote the use of meningococcal vaccine in college students because of the seriousness of the illness and the safety and efficacy of the available vaccine. However, it may be unwise to focus only on first-year college students living in dormitories. In the Maryland and CDC studies, 72% and 56% of cases, respectively, occurred among non-first-year college students [11, 22]. Although the risk among off-campus residents is lower than that among on-campus residents, a substantial proportion of cases occurs among the former group [11]. Therefore, it is conceivable that a college that focuses on the immunization of only first-year college students residing in dormitories could have cases occurring among nonimmunized students not included in this group, making the position politically difficult to explain and defend. However, after 4 years of a program to immunize first-year college students, essentially all undergraduate students could have the opportunity to be immunized and have some degree of protection. Also, given the wide variety of living arrangements available to college students, defining in what type of housing a student resides is not always straightforward, which could lead to arbitrary decisions about to whom immunization should be recommended. Given these and other limitations associated with focusing on specific risk groups, the most rational strategy might be to make meningococcal vaccine available to all college undergraduate students. The military experience suggests that this approach could have a substantial impact on the problem of meningococcal infection among college students if high rates of immunization can be achieved.

Although the recent recommendation regarding college students is a laudable first step to controlling meningococcal infection in the United States, the overall public health impact is not likely to be substantial [11]. Furthermore, the incidence of meningococcal infection among noncollege adults aged 18–22 years and among persons of high-school age also has recently increased, indicating that a more comprehensive approach to prevention is needed. Fortunately, the recent ACIP recommendations on vaccination for college students is an interim measure. It should eventually be possible to have a substantial impact on meningococcal incidence in the United States through the use of improved vaccines administered to all groups at high risk, not just college students. Conjugate meningococcal vaccines may be available in the United States in the next few years and should offer major advantages over the current meningococcal vaccine, including efficacy in young infants, herd immunity, and immunologic memory. A recent analysis of strategies for using a bivalent serogroup C-Y meningococcal conjugate vaccine suggested that the highest impact could be achieved by immunizing infants, adolescents, and college students [4]. This approach could eventually lead to a 53% reduction in meningococcal incidence and a 65% reduction in meningococcal deaths among persons aged 0–22 years. Further reductions could be expected if effective serogroup B and W-135 components could be included, although the development of a satisfactory B component remains problematic [17]. The development of improved vaccines could eventually lead to the near elimination of meningococcal infection in this country, as the Haemophilus influenzae type b (Hib) vaccines have done for invasive Hib infection [34, 35].

What are areas that require further study? First, it is important to understand the reasons for the recent increase in meningococcal infection among adolescents, including the role, if any, of potentially modifiable risk factors. In addition to specifically providing insight about meningococcal infection, such studies could increase our understanding of the epidemiology of other infectious diseases. Second, cost-benefit analyses of the vaccine prevention of N. meningitidis infection that take into account the complexity of this disease are clearly required. An aggressive approach for developing a serogroup B vaccine is warranted, particularly given the importance of this serogroup in young children. A way must be found to make serogroup A conjugate vaccines available to developing countries that still are experiencing devastating meningococcal epidemics [36]. Finally, continued population- and laboratory-based active surveillance will be required in order to monitor the constantly changing epidemiology of meningococcal infection so that optimal immunization policy can be formulated.

Acknowledgments

I thank Nancy Rosenstein and Bruce Gellin for their thoughtful review of the manuscript.

References


