How best to describe the risk of meningococcal B infection?

Manish Sadarangani BM BCh MRCPCH DPhil[1,2], Julie A Bettinger PhD MPH[1], David W Scheifele MD[1]

QUESTION

With a meningococcal B vaccine soon available, how can I best describe the risk of this infection to colleagues and interested parents?

ANSWER

Septicemia and meningitis caused by *Neisseria meningitidis* are devastating infections with the potential for death within hours of symptom onset. Such infections are relatively uncommon in Canada, partly due to the success of the conjugate meningococcal vaccines (1). These vaccines target serogroups A, C, Y and W, but not serogroup B, which now causes the majority of disease in Canada (2). The use of serogroup C vaccines since 2001 has led to a significant decrease in serogroup C disease across Canada, from approximately 40% of all cases to 5% to 10% of all cases (3). Whether the quadrivalent ACYW conjugate vaccine will have a similar impact on serogroup Y disease remains to be determined. A new serogroup B vaccine (4CMenB) has been licensed in Europe and will likely be available in Canada in the near future. Unlike the conjugate vaccines that target the polysaccharide capsule surrounding the bacteria, 4CMenB is based on subcapsular proteins found within the bacterial outer membrane. These proteins can vary slightly among bacteria; therefore, the vaccine will not be effective against all serogroup B strains. This will raise questions not only for public health organizations at the provincial and national levels, but also for parents as to whether to use the vaccine. Epidemiological data, such as incidence rates per 100,000 population, can be difficult to translate into tangible risks for health care professionals and parents. The present article addresses the common questions regarding meningococcal disease risk and prevention using statistics that should be more comprehensible to these groups.

The information below is based on data from the National Enhanced Invasive Meningococcal Disease Surveillance System (Public Health Agency of Canada) (www.phac-aspc.gc.ca/im/vpd-mev/meningococcal-eng.php, accessed January 21, 2013) and the Canadian Immunization Monitoring Program ACTive (IMPACT) surveillance network. The latter is a population-based network based around 12 centres in eight provinces and includes approximately 50% of the Canadian population (1). Data from between January 2006 and December 2011 were used because all provinces and territories had introduced routine meningococcal conjugate vaccine programs by 2005, except Nunavut, where it was introduced in 2007.

How common is meningococcal disease in Canada?

On average, 195 cases of invasive meningococcal disease (meningitis or septicemia) occur every year in Canada, which equates to approximately 16 cases per month. Overall, 60% of cases are caused by serogroup B, but this figure rises to 85% in infants (3) (Table 1).

TABLE 1
Average number of cases of invasive meningococcal disease per month in Canada between 2006 and 2011 (all serogroups and serogroup B disease) and disease incidence rates (all serogroups)

	Average number of cases of invasive meningococcal disease per month		
Age, years	All serogroups	Serogroup B (% of total)	Actual incidence rate (per 100,000 population per year), all serogroups
<2	3.2	2.7 (84)	5.18
2–14	2.5	1.7 (68)	0.62
15–24	3.6	2.3 (63)	0.95
≥25	6.9	2.8 (41)	0.35
All ages	16.3	9.8 (61)	0.58

TABLE 2
Total risk of invasive meningococcal disease in Canada in different age groups based on rates between 2006 and 2011, for any serogroup and serogroup B

	Age-specific risk of invasive meningococcal disease	
Age, years	Any serogroup	Serogroup B
<2	1 in 10,000	1 in 11,900
2–14	1 in 12,400	1 in 18,500
15–24	1 in 8700	1 in 13,900
≥25	1 in 4600	1 in 11,200
Childhood (0–18)	1 in 4200	1 in 6200
Lifetime risk	1 in 1900	1 in 3200

The risks of developing invasive meningococcal disease in Canada in different age groups at current rates are shown in Table 2.

What are the outcomes of meningococcal disease?

Approximately 17 individuals (five children and 12 adults) die from meningococcal disease every year in Canada, with an additional 35 (19 children and 16 adults) experiencing significant sequelae, most commonly deafness, skin scarring and limb amputation (4). Every week in Canada, on average, one individual dies or develops a new significant disability as a result of invasive meningococcal disease. Among infected children, one in 24 die and one in five experience significant sequelae. Among adults, one in eight die and one in seven develop sequelae. For serogroup B disease, the case-fatality rate appears to be slightly lower in adults compared with the overall rate, with death occurring in one in 12 infected individuals, but rates of sequelae in adults and adverse outcomes in children are similar to the overall rate. This translates to the death of approximately three children and three adults per year related to serogroup B disease, with 14 children and six adults experiencing significant sequelae.

[1]*Division of Infectious & Immunological Diseases, Department of Pediatrics, University of British Columbia and British Columbia Children's Hospital, Vancouver, British Columbia;* [2]*Department of Paediatrics, University of Oxford and the National Institute of Health Research Oxford Biomedical Research Centre, Oxford, United Kingdom*

Correspondence: Dr Manish Sadarangani, Department of Pediatric Infectious Diseases, British Columbia Children's Hospital, 4480 Oak Street, Vancouver, British Columbia V6H 3V4. Telephone 604-875-2345, fax 604-875-2226, e-mail manish.sadarangani@paediatrics.ox.ac.uk

Accepted for publication March 7, 2013

TABLE 3
Estimated number of preventable cases of serogroup B meningococcal disease and 'number needed to vaccinate' calculations for 4CMenB

	Age, months	
	6–11	6–23
Estimated number of serogroup B cases per year	7.7	16.9
Estimated number of cases preventable with the 4CMenB vaccine*	5.1	11.2
Number of doses of vaccine required†	3	4
Estimated 'number needed to vaccinate' to prevent one case of invasive serogroup B meningococcal disease	75,706	34,412

**Assuming that 66% of strains in Canada will be covered by the vaccine (7); †According to the immunization schedule used in recent clinical trials of meningococcal serogroup B vaccine (4CMenB) (5,6), with three doses in early infancy and a booster dose at 12 months of age*

How effective is the new vaccine 4CMenB for preventing meningococcal disease?

The new meningococcal vaccine is aimed at preventing serogroup B disease, but will not be effective against all serogroup B strains. In phase 3 clinical trials, the vaccine was administered with other routine immunizations at two, four and six months of age; therefore, it is possible that there will be little or no protection in infants before six to seven months of age (5). The achievable rate and duration of protection are also unknown. A recent study showed waning of protection by 12 months of age, although some children did retain significant immunity against some vaccine antigens (6). In this study, an additional dose at 12 months resulted in higher levels of antibody than after the primary series.

Based on the data from the Public Health Agency of Canada and IMPACT, seven to eight cases of serogroup B disease in six- to 11-month-old children and 17 cases in six- to 23-month-old children can be expected every year in Canada. Overall, two of every three of these would theoretically be preventable with the 4CMenB vaccine, based on in vitro analysis of the proteins targeted by the vaccine in a recent collection of strains from across Canada (7). With an annual birth cohort in Canada of nearly 400,000 (8), approximatly 75,000 children would need to be vaccinated to prevent one case of invasive serogroup B meningococcal disease in six- to 11-month-olds, in the absence of herd immunity. If the booster dose is included, this number is 34,000, assuming the booster would protect children until at least two years of age (Table 3).

If 4CMenB is approved in Canada, it will provide an exciting opportunity to significantly reduce the burden of meningococcal disease, but will also raise several challenging issues given the relatively low incidence of invasive meningococcal disease in this country. The decision to introduce the vaccine into routine provincial schedules will depend on cost, incidence of local disease and estimated coverage of local strains. Provinces with a relatively high incidence of serogroup B disease may be more likely to introduce the vaccine. In Quebec, for example, the incidence rate of serogroup B disease in children younger than two years of age from 2009 to 2011 was approximately eight times higher than other provinces, although it was only two times higher during 2006 to 2008 (3). Policy decisions at the national and provincial level have a different basis than individual decisions. If the 4CMenB vaccine is approved for use in Canada, but does not become part of the routine childhood immunization schedule, it will be the responsibility of family doctors, paediatricians and public health officials to educate parents about the vaccine, enabling them to make an informed decision regarding immunization of their children. The present article highlights the key facts and figures and presents them in a way that will be accessible to the general public, to facilitate such a decision-making process.

DISCLOSURES: The Canadian Immunization Monitoring Program (IMPACT) surveillance network was funded by grants to the Canadian Paediatric Society from Sanofi Pasteur and Novartis. MS is a co-investigator on Investigator-Initiated Research grants from Pfizer. JAB is supported by a Career Investigator Award from the Michael Smith Foundation for Health Research. JAB has contributed to ad-hoc advisory boards for Novartis and received speaker honoraria from Novartis, Pfizer and Baxter.

REFERENCES

1. Bettinger JA, Scheifele DW, Le Saux N, Halperin SA, Vaudry W, Tsang R. The impact of childhood meningococcal serogroup C conjugate vaccine programs in Canada. Pediatr Infect Dis J 2009;28:220-4.
2. Halperin SA, Bettinger JA, Greenwood B, et al. The changing and dynamic epidemiology of meningococcal disease. Vaccine 2012;30(Suppl 2):B26-36.
3. Sadarangani M, Halperin SA, Vaudry W, et al, eds. A decade of serogroup C *Neisseria* meningitidis surveillance in Canada. 10th Canadian Immunization Conference. Vancouver, December 3 to 5, 2012.
4. Sadarangani M, Halperin SA, Vaudry W, et al, eds. Outcomes of invasive meningococcal disease in Canadian children and adults between 2002 and 2011. 10th Canadian Immunization Conference. Vancouver, December 3 to 5, 2012.
5. Gossger N, Snape MD, Yu LM, et al. Immunogenicity and tolerability of recombinant serogroup B meningococcal vaccine administered with or without routine infant vaccinations according to different immunization schedules: A randomized controlled trial. JAMA 2012;307:573-82.
6. Vesikari T, Esposito S, Prymula R, et al; for the EU Meningococcal B Infant Vaccine Study group. Immunogenicity and safety of an investigational multicomponent, recombinant, meningococcal serogroup B vaccine (4CMenB) administered concomitantly with routine infant and child vaccinations: Results of two randomised trials. Lancet 2013 [Epub online ahead of print].
7. Bettinger JA, Scheifele DW, Halperin SA, et al, eds. Estimated coverage of Canadian meningococcal serogroup B isolates by an investigational meningococcal serogroup B vaccine (4CMenB). 10th Canadian Immunization Conference. Vancouver, December 3 to 5, 2012.
8. Statistics Canada. Births, estimates, by province and territory. Table 051-0004. Catalogue number 91-215-X. 2012. <http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/demo04a-eng.htm> (Accesssed January 21, 2013).