Epidemiologic Characteristics of an Outbreak of Serogroup C Meningococcal Disease and the Public Health Response

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Synopsis

An outbreak of serogroup C meningococcal disease occurred in six counties in the State of Washington from January 1989 through mid-1991. This report describes epidemiologic data collected from hospitals and health departments, the results of multilocus enzyme electrophoresis of isolates, and the vaccination of high-risk populations in one county.

A total of 45 confirmed or probable cases (10 per 100,000 population) occurred. Infants younger than age 1, Hispanics and American Indians, and low-income populations had high attack rates. Nine (20 percent) patients died. The predominant enzyme type, ET-22, had not been detected previously in Washington. More than 22,000 persons were vaccinated in one of the counties.

Major challenges to health care personnel included deciding when and where to employ vaccination, obtaining sufficient vaccine, and responding to public anxiety.

AN OUTBREAK OF SEROGROUP C meningococcal disease (SCMD) occurred in six counties in the State of Washington from January 1989 through mid-1991. With 45 cases, this was one of the largest outbreaks of meningococcal disease to occur in the United States since 1945 (*1,2*). At the time, it was one of the few outbreaks in this country for which vaccine was used widely.

Outbreaks of SCMD have become more common in the United States (*2*), but formal recommendations for controlling them are limited (*3*). We describe this outbreak because the additional experience with vaccination might be valuable as a supplement to published recommendations.

Background

The outbreak involved six counties with a total 1990 population of 451,212—Benton, 112,560; Chelan, 52,250; Douglas, 26,205; Grant, 54,758; Klickitat, 16,616; and Yakima, 188,823 (fig. 1) (*4*). A total of 11,128 American Indians, including 8,405 in Yakima County, and 71,600 Hispanics, including 45,414 in Yakima County, were affected minority groups. Yakima County, the most severely affected, has three distinct geographic regions (fig. 1)—the rural upper valley (population 13,018); the central valley (population 108,175), which includes the city of Yakima (population 54,827); and the lower valley (population 67,630), which is rural with small communities and the Yakama Indian Reservation. All cases in Chelan and Douglas Counties occurred in residents of an urban area with a population of 24,540.

The estimated annual incidence of serogroup C meningococcal infection in the United States was 0.5 per 100,000 population from 1989 through 1991, with an incidence of 3.1 per 100,000 among children younger than age 3 years (*5*). The annual incidence in Washington State increased from 0.1 per 100,000 in 1980 to 0.4 per 100,000 in 1988 (unpublished data, Washington State Department of Health). Eleven serogroup C meningococcal infections were reported in the six outbreak counties from 1980 through 1988 (eight in Yakima County, two in Benton County, and one in Chelan County). The first case in this outbreak

Table 1. Confirmed and probable serogroup C meningococcal disease cases, by time period and county, central Washington State, 1989–91

Country	Period 1 Jan.–Aug. 1989		Period 2 Sept. 1989–Aug. 1990		Period 3 Sept. 1990–Aug. 1991		Total	
	Number	Attack rate[1]	Number	Attack rate[1]	Number	Attack rate[1]	Number	Attack rate[1]
Yakima	21	11	8	4	1	<1	30	16
Benton	3	3	0	0	1	1	4	4
Grant	3	6	0	0	0	0	3	6
Klickitat	1	6	0	0	0	0	1	6
Chelan	0	0	4	8	2	4	6	12
Douglas	0	0	0	0	1	4	1	4
Totals	28	6	12	3	5	1	45	10

[1]Cases per 100,000 population.

Table 2. Confirmed and probable serogroup C meningococcal disease cases, by age, and time period, distinguishing Yakima County alone and all 6 counties in central Washington State, 1989-91

Age (years)	Period 1 Jan.–Aug. 1989				Period 2 Sept. 1989–Aug. 1990				Period 3 Sept. 1990–Aug. 1991			
	Yakima		6 counties		Yakima		6 counties		Yakima		6 counties	
	Number	Attack rate[1]	Number	Attack rate[1]	Number	Attack rate[1]	Number	Attack rate[1]	Number	Attack rate[1]	Number	Attack rate[1]
Younger than 1	6	221	6	95	2	73	2	32	0	0	1	16
1–4	9	65	14	44	3	22	4	13	1	7	2	6
5–9	3	18	3	13	1	6	1	4	0	0	0	0
10–14	1	7	1	3	1	7	3	8	0	0	0	0
15–19	1	7	2	6	0	0	0	0	0	0	0	0
20–24	1	8	2	7	0	0	0	0	0	0	1	4
Older than 24	0	0	0	0	1	1	2	1	0	0	1	<1
Totals	21	11	28	6	8	4	12	3	1	<1	5	1

[1]Cases per 100,000 population.

Table 3. Confirmed and probable serogroup C meningococcal disease cases, by per capita income of patient's census tract and time period, Yakima County, WA, 1989–91

Per capita income range of census tract residents	Income quartile	Period 1 Jan.–Aug. 1989		Period 2 Sept. 1989–Aug. 1990		Period 3 Sept. 1990–Aug. 1991		Total	
		Number	Attack rate[1]	Number	Attack rate[1]	Number	Attack rate[1]	Number	Attack rate[1]
$12,422–$25,039	4th	2	4	2	4	0	0	4	7
$9,909–$12,237	3rd	1	2	2	4	0	0	3	7
$7,851–$9,808	2nd	2	4	1	2	1	2	4	9
Less than $6,921	1st	16	37	3	7	0	0	19	44
Totals		21	11	8	4	1	<1	30	16

[1]Cases per 100,000 population.

was reported to the Yakima Health District (YHD) on January 12, 1989.

Methods

Demographic and socioeconomic data are from the 1990 U.S. census (*4*). Three periods based on case onsets were defined for this report—period 1, January-August 1989; period 2, September 1989-August 1990; and period 3, September 1990-August 1991 (fig. 2).

A confirmed case of SCMD was defined as an acute illness of a resident of the six counties from January 1989 through March 1992, with recovery of

serogroup C *Neisseria meningitidis* from a normally sterile body fluid. A probable case was defined as an acute illness accompanied by a depressed level of consciousness, temperature greater than 38.5 Centigrade, and petechial rash, but without laboratory confirmation.

Serogroup C *N. meningitidis* was identified at the Washington State Public Health Laboratories by using standard biochemical techniques (*6*) and serogrouping with group-specific antisera. Multilocus enzyme electrophoresis (MEE) was used to characterize the enzyme types (ET) of 21 of 23 isolates recovered during period 1, and two isolates recovered in Chelan and Yakima Counties during period 2. MEE was performed at the Centers for Disease Control and Prevention (CDC), Atlanta, GA, and the Laboratory Centre for Disease Control (LCDC), Ottawa, Ontario, Canada, using the techniques of Selander and coworkers (*7*) and Bibb and coworkers (*8*).

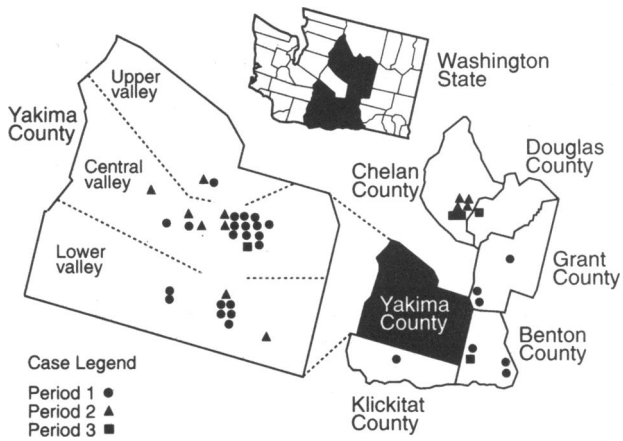
Results

Epidemiologic findings. Forty-five cases (40 confirmed and 5 probable) occurred in the six counties during the entire outbreak for an attack rate (AR) of 10 per 100,000 population; 28 during period 1 (AR 6 per 100,000), 12 during period 2 (AR 3 per 100,000), and 5 during period 3 (AR 1 per 100,000) (table 1 and fig. 2). No case occurred after June 1991. Secondary spread was not documented. Nine (20 percent) patients died. Among confirmed cases, *N. meningitidis* was recovered from only the blood of 23 persons (58 percent), only the cerebrospinal fluid (CSF) from 10 (25 percent), from the blood and CSF of 6 (15 percent), and joint fluid only from 1 (2 percent).

The median age of patients was 3 years (range 2 months to 77 years), with 9 (20 percent) younger than 1 year, 18 (40 percent) younger than 2 years, and 42 (93 percent) younger than 25 years. Infants younger than age 1 year had the highest age-group-specific AR for each period (table 2). Four (44 percent) of the 9 deaths were of children younger than age 2 years. The AR for the entire outbreak was higher for American Indians (54 per 100,000) and Hispanics (41 per 100,000) than for non-Hispanic whites (3 per 100,000).

Thirty (67 percent) cases occurred in Yakima County (AR = 16 per 100,000, including 21 cases during period 1 (fig. 1 and table 1). Sixteen (76 percent) of the 21 cases in Yakima County during period 1 were among residents of those census tracts at or below the first (lowest) quartile for per capita income, compared with three (33 percent) of the nine cases in the county during periods 2 and 3 (table 3). The other 15 outbreak cases occurred in Chelan (AR 12 per 100,000), Benton (AR 4 per 100,000), Grant (AR 6 per 100,000), Klickitat (AR 6 per 100,000), and Douglas (AR 4 per 100,000) Counties (fig. 1 and table 1). The AR in the single urban area where cases occurred in Chelan and Douglas Counties was 16 per 100,000 (4 cases) during period 2 and 12 per 100,000 (3 cases) during period 3.

Figure 1. Location of serogroup C meningococcal disease cases, by period, central Washington, 1989–91



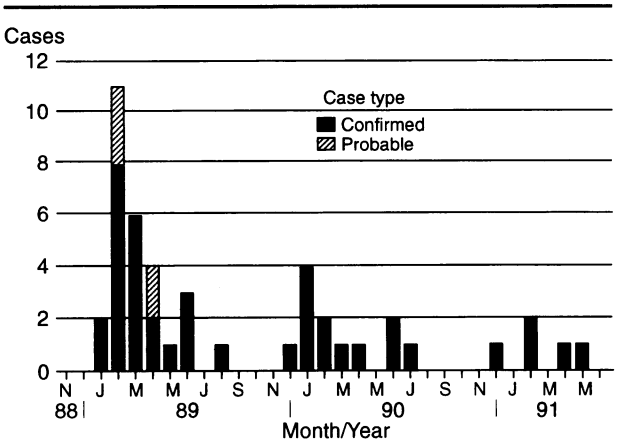
'. . . the news media learned of cases from other sources; the resulting controversy (charges of a public health "coverup" and an attempt to dismiss the health officer) and intense public anxiety complicated response to the rapidly evolving outbreak.'

Enzyme typing. The electrophoretic patterns of 18 of the 21 period 1 isolates and both of the period 2 isolates that were tested were similar to the ET-22 pattern of isolates collected in Tennessee and California during 1986 (*9*).

Public Health Response

Public information. The earliest cases were not publicized by the YHD because a high risk population had not yet been identified, and an announcement was felt to offer no public health benefit. However, the news media learned of cases

Figure 2. Serogroup C meningococcal disease cases, by month and year of onset, central Washington, 1989–91



from other sources; the resulting controversy (charges of a public health "coverup" and an attempt to dismiss the health officer) and intense public anxiety complicated response to the rapidly evolving outbreak (*10*). Subsequently, daily press conferences, telephone information lines, and a facsimile-based system were used to inform the public and health care providers.

Chemoprophylaxis. Rifampin was offered to all contacts of patients. Distribution initially exceeded that recommended by CDC (*3*) when its use was extended beyond intimate case-contacts to include 4,100 residents of selected parts of Yakima County during period 1. Reports of poor compliance were common early in the outbreak, in part because of cultural and linguistic factors. For example, American Indian and Hispanic community leaders were not initially involved in the prophylaxis education program and information printed in Spanish was not immediately available.

Vaccination. The YHD and Indian Health Service (IHS) first used vaccine in early March 1989 because cases and deaths continued to occur in spite of aggressive contact tracing and chemoprophylaxis. They offered vaccine to residents of selected parts of Yakima County ranging in age from 1 to 24 years during periods 1 and 2. During period 1, the YHD targeted residents of school districts where cases continued to occur, while the IHS attempted to vaccinate all 1–24-year-old American Indians in Yakima County. From March 10 through April 14, 1989, 1,838 residents of selected parts of the upper valley (approximately 38 percent of the target group) and 13,060 residents of selected parts of the lower valley (approximately 73 percent of the target group) received vaccine. Vaccine was not used in the central valley during period 1 because cases were no longer occurring there when the decision to vaccinate was made, and sufficient vaccine was not available.

In August 1989, YHD and IHS developed contingency plans for additional vaccinations. The YHD focused its plans on residents of low-income census tracts because they had been at highest risk (table 3) and because 69 percent of the 16 period 1 cases from these tracts had been in persons who would have been age-eligible for vaccination. Vaccination was not performed at that time because neither the geographic spread nor the persistence of the outbreak could be predicted, and there were insufficient funds and vaccine to cover all low-income census tracts in the county.

However, if a single subsequent confirmed case occurred in any census tract at or below the first quartile for per capita income (an average AR in those tracts of 19 cases per 100,000 residents), vaccine would be offered to 1–24-year-old residents of census block groups surrounding and including the residence of the case patient. The same approach would be used in a census tract with higher per capita income if two unrelated cases occurred (an average AR in those tracts of 33 cases per 100,000 residents).

The YHD purchased 8,000 doses of vaccine and arranged locations, staffing, and operational details for potential vaccine clinics. If any additional cases occurred in Yakima County, the IHS would offer vaccine to all 1–24-year-old American Indians in Yakima County who had not yet been vaccinated or who had been younger than age 2 years when vaccinated earlier. These plans were first implemented when a case occurred in the central valley on December 23, 1989. Ultimately, 5,828 persons in the central valley and 2,075 persons in the lower valley were vaccinated during period 2.

No vaccinated resident developed SCMD. Cases occurred in four unvaccinated residents of census tracts where vaccine had already been distributed, but none of the four had been age-eligible for vaccination. The ARs for all age groups dropped sharply from period 1 through period 3, including that for the unvaccinated younger-than-1-year group (table 2); this trend was seen in Yakima County as a whole, in low-income census tracts, in tracts where vaccine was used during period 1 only, and in tracts where vaccine was used during periods 1 and 2. No cases occurred among American Indians in Yakima County after the initial IHS vaccine campaign was completed during period 1.

Problems with the vaccine program included a delay in implementation caused in part by an initial

lack of consensus among consulted experts, the shifting focus of the outbreak, and inadequate supplies of vaccine. While staffing vaccination clinics, the YHD also was educating the public, investigating contacts, distributing rifampin, and maintaining other essential public health services. The plans already described simplified the decision to vaccinate during period 2. The extent of vaccination during period 1 was possible only because the U.S. Army supplied much of the vaccine. Vaccine purchased during the summer of 1989 was adequate for period 2, although supply would have been a problem had requirements been greater. More than 900 local volunteers supervised by personnel from county, State, and Federal agencies staffed most clinics. Other counties did not use vaccine because cases stopped occurring or distinct high-risk target populations could not be identified.

Cost. The true cost of responding to this outbreak is unknown because many services and supplies were provided without charge or were funded out of regular operating budgets. The estimated cost of administering vaccine was $20 per dose.

Discussion

This meningococcal disease outbreak was unusual among those occurring in the United States because it involved a regional population, and vaccine was used extensively. Vaccine had not been used widely in this country because most cases are sporadic or caused by serogroup B *N. meningitidis*, for which there is no vaccine (*1*). In addition, serogroup C vaccine produces a relatively poor and transient immune response in infants younger than age 24 months (*11*), the age group with the highest incidence of disease (*5*). One-year-olds in Yakima County were vaccinated because some short-term protection is possible.

Since 1945, community meningococcal disease outbreaks in the United States had tended to occur in low socioeconomic groups (*1*). In this outbreak, low income probably indicated other risk factors; the Yakima County census tracts with the lowest per-capita income also had the highest mean number of residents per housing unit room (*4*). Crowded housing may also have contributed to the high risk of SCMD for Hispanics and American Indians. These ethnic and racial groups have no known biological predilection for SCMD (*12*) but reported the highest average number of residents per housing unit in all six counties (*4*).

Enzyme typing documented persistence of the ET 22-like strain in Yakima County from one period to the next, and its appearance in Chelan County—100 miles distant—as the outbreak progressed. Active laboratory-based surveillance in Washington State during 1986 did not detect this ET, but it predominated during a period of increased SCMD activity in Los Angeles County that began in 1986 (*9,13*). There is no evidence that the Washington ET-22 strain originated in California, although such importation cannot be ruled out.

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Serogroup C meningococcal vaccine is known to be effective for preventing disease in adults (*14*) and children older than 23 months (*15*) but does not eradicate nasopharyngeal carriage and therefore does not prevent transmission of epidemic strains. The absence of disease in vaccinated Yakima County residents at a time when SCMD activity continued in the county suggests that vaccination prevented some cases. However, an effect of vaccination on the overall course of the outbreak there cannot be demonstrated statistically because ARs dropped sharply over time for the unvaccinated as well as vaccinated age groups.

The IHS objective of high vaccine coverage among all age-eligible American Indians in Yakima County during period 1 may have been responsible for the early termination of the outbreak in that population. Vaccination might have had a greater effect on the course of the outbreak throughout the county if resources had permitted its early extension to all age-eligible, low-income residents as soon as that population's high risk was recognized, rather than waiting for additional cases to direct distribution. Investigators of outbreaks of serogroup A disease in the northwest United States (*16*) and SCMD in Denmark (*17*) previously recognized the limitations of case-directed vaccination. However, since community-wide vaccination is very expensive and the persistence and geographic spread of an outbreak are uncertain, this case-directed approach coupled

with intense active surveillance may be the most practical, albeit suboptimal, option available when vaccine supplies are limited.

The SCMD outbreak in central Washington was the first of several in North America for which vaccine was used widely. Vaccine was administered to more than 235,000 persons in four Canadian provinces during the winters of 1988–89 and 1991–92 (*18–22*) and more than 52,000 residents of two counties in Georgia during early 1993 (personal communication, Kathleen Toomey, MD, Georgia Division of Public Health). The intense public anxiety, lack of specific guidelines, and insufficient vaccine supply experienced in Washington State also complicated the initial decision to vaccinate in several Canadian Provinces (*20–23*).

The Immunization Practices Advisory Committee (ACIP) recommends that vaccination be used in outbreaks for populations at risk that are delineated by neighborhood, school, dormitory, or other reasonable boundary (*3*). In 1994, the Canadian LCDC released new recommendations that stress identification of vaccine target groups based on defined risk of disease, community characteristics, and the epidemiology of the disease (*24*). Although experiences with past outbreaks should not be overgeneralized, they can be helpful as supplements to these formal recommendations. Public health officials in central Washington offer the following suggestions based on their experience:

1. Health agencies should have objective and explainable policies for announcing cases of meningococcal disease and plans for responding to the public anxiety that often follows announcements.
2. Contingency plans for vaccination programs should be made before outbreaks occur and include vaccine sources, demographic data, operational details, and funding mechanisms. Plans can be generic; for example, the YHD's meningococcal plan was adapted for measles vaccination in 1990.
3. Public information programs should be linguistically and culturally specific for their target population and should involve community leaders early.
4. The serogroup of all *N. meningitidis* isolated from normally sterile sites should be determined.
5. Prior local consideration of the number of cases or incidence rates that would "trigger" vaccination can make the decision to vaccinate more objective if an outbreak actually occurs.
6. If an outbreak of vaccine-preventable meningococcal disease (that is, serogroups A, C, Y, or W-135) is suspected, the person, place, and time characteristics of cases should be used to identify the populations at highest risk for disease as potential target groups for vaccination.
7. If implemented, vaccination programs should include the largest possible portion of the target group that resources allow and should not be directed solely by the location of subsequent cases, if possible.
8. Health officials should anticipate persistence and regional spread of outbreaks for several years, although neither will necessarily occur.

Nationwide meningococcal disease epidemics have not occurred in the United States for 50 years, but this and subsequent local and regional outbreaks demonstrate that epidemic meningococcal disease continues to cause substantial morbidity and mortality in North America. Advance preparation can minimize the impact of outbreaks on the public health system and speed the delivery of vital health services.

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