The Epidemiology Of Bacterial Meningitis

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Abstract: ***Background:*** **The incidence by age and causative organism of bacterial meningitis are not known on a community basis.**

Methods: **The epidemiology of bacterial meningitis in a metropolitan county was studied by identifying all cases admitted to a hospital from 1983 through 1987.**

Results: **The overall incidence of bacterial meningitis was 5 per 100,000 person-years, but numbers of cases ranged from 40 per 100,000 for children younger than 5 years to 1.0 per 100,000 in adults aged between 16 and 64 years. No significant excesses of cases were found in male patients or in blacks. The predominant causative organism varied with age. Overall, *Haemophilus influenzae* was the most common causative organism, but 32 percent of cases were due to *Streptococcus pneumoniae*. Case fatality rates were high for *S. pneumoniae* (12.5 percent) and very high for the small number of elderly patients suffering from bacterial meningitis.**

Conclusions: **Significant declines have occurred in the last decade in the incidence of bacterial meningitis in children, particularly in those younger than 5 years, and in disease caused by *H. influenzae* and group B streptococcus. (J Am Board Fam Pract 1991; 4:307-11.)**

Bacterial meningitis is a serious disease that causes approximately 2000 deaths each year in the United States and can leave up to 30 percent of survivors with permanent impairment.[1] Both morbidity and mortality are influenced by the age and previous health of the patient, the causative organism, and the time between onset of symptoms and initiation of treatment.[1] Family physicians frequently consider the diagnosis of meningitis, particularly in acutely ill children, and are forced to make critical diagnostic and treatment judgments based on perceptions of the likelihood of the diagnosis, the possible causative organism, and such patient-related factors as age and medical history. The importance of identifying the causative organism, even with the availability of broad-spectrum antibiotics, is emphasized by the variation in case fatality rates, which range from more than 20 percent in cases caused by *Streptococcus pneumoniae* and group B streptococci[1] to between 3 and 6.5 percent in those caused by *Haemophilus influenzae*.[2]

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Unfortunately, the available epidemiological information on the incidence of meningitis and the likely causative organism may not be appropriate for the current primary care setting. National statistics based on voluntary reporting systems are estimated from information received on less than 30 percent of cases.[3] In addition, both the national surveillance system and information from referral centers may be biased, providing information on only the most serious cases, as data are collected by neurologists rather than primary care physicians.

Several community-based studies[4-7] were conducted a decade ago to describe the incidence and pattern of bacterial meningitis likely to be encountered in primary care. These studies showed wide geographical variations in the incidence of bacterial meningitis, and their findings may no longer be valid because of the changes in the pattern of causative organisms over time. Substantial variations from year to year have been reported, particularly in the incidence of meningitis caused by *H. influenzae*, which is the most common causative bacterium.[8,9]

The purpose of our investigation was to describe the epidemiology of bacterial meningitis in Sedgwick County, Kansas. Sedgwick County is a stable metropolitan community with a population of 367,094 (1980 census). The county includes

Table 1. Population Characteristics: Sedgwick County and the United States.

Characteristics	Sedgwick County	United States
Age (years) (%)		
0–4	8.1	7.5
5–19	23.4	22.0
24–34	28.7	26.4
35–64	30.2	32.1
65+	9.6	12.0
Race (%)		
White	84.5	84.5
Black	10.8	12.2
Other	4.7	3.3
Average household size	2.49	2.76
Median family income	$20,893	$19,917
Adults with college education (%)	38.4	38.5
Family below poverty level (%)	7.2	9.6
Female head of household (%)	14.3	19.3

Wichita, the state's largest city. The population is in many respects representative of that of the United States (Table 1).

Our objective was to assist local physicians in their diagnosis and management of bacterial meningitis and the prognostic information provided to families. These data can be useful also to family physicians in other communities faced with the clinical challenges of bacterial meningitis. The following research questions were addressed:

1. What is the incidence of bacterial meningitis by age?
2. Are any groups (age, sex, race) at particular risk?
3. What is the most likely causative organism for each age group?
4. What is the mortality by age and causative organism?
5. What changes have occurred since a 1979–1982 study of bacterial meningitis was conducted in Sedgwick County?[7]

Methods

We assumed that all cases of bacterial meningitis would be identified by a search of hospital records and death certificates. Data were extracted on all Sedgwick County residents who at death or hospital discharge had a primary or secondary condition given an International Classification of Diseases (ICD) diagnosis code pertaining to bacterial meningitis for the years 1983 through 1987. Noncounty residents were excluded by Zip Code of usual residence. Because the nearest referral medical center is several hours from Wichita, any outflow of patients was considered unlikely. Data from the city-county Department of Health were checked for cases that could have been missed during the search of hospital records or for persons who died of bacterial meningitis in another locality. Only cases confirmed by culture of cerebrospinal fluid (CSF) were included in the study. No cases were encountered in which the CSF contained a high number of white cells and had a negative culture.

Denominator populations were provided by the Metropolitan Area Planning Department. They calculated midyear estimates for each year based on the 1980 census adjusted for birth, death, and migration. For several technical reasons, it was not possible to estimate the neonatal (younger than 28 days old) or the Hispanic population accurately. Patients were classified by their self-reported race; hence, the "other" category includes Hispanics, Asian, and native American patients.

Statistical comparisons between incidence rates were calculated using the hypothesis test.[10]

Results

Incidence

In the 5 years studied, 99 confirmed cases of bacterial meningitis were identified, which represented an overall incidence of 5 per 100,000 person-years (rounded). As reflected in Table 2, the number of cases and the age-specific incidence rate were highest in children aged 5 years and younger, but cases occurred in all age groups, including the elderly.

High-Risk Groups

Of the three variables measured (age, race, and sex), only young age appeared to be a significant risk. Seventy-three of the 99 cases occurred in children aged 5 years and younger. Their age-specific incidence was 40 times greater than that of children aged 6 to 16 and the adult population aged 16 to 64 years (Table 2).

No significant sex differences in the incidence of bacterial meningitis were found. The incidence in blacks was not significantly higher than that in whites (Table 3). All but two of the cases in blacks occurred in young children and were caused by *H. influenzae*. Cases with meningitis caused by *H.*

Table 2. Causative Organism of Bacterial Meningitis by Age Group.

Organism	< 28 d	28 d–5 y	6–15 y	16–64 y	65 y +	Total
Haemophilus influenzae	1	40	0	0	0	41
Streptococcus pneumoniae	0	19	0	6	7	32
Neisseria meningitidis	1	8	3	4	2	18
Group B streptococcus	2	2	0	0	0	4
Staphylococcus aureus	0	0	0	0	1	1
Other	0	0	0	2	1	3
Total	4	69	3	12	11	99
Age-specific incidence/100,000 (rounded)	40.0*		1.0	1.0	3.0	5.0
Population†	183,569*		262,793	1,279,183	204,824	1,932,300

*Both age groups, < 28 d and 28 d–5 y, included.

†Populations are estimates based on the 1980 census and information provided by the Metropolitan Area Planning Department. The population totals by age group were estimated by determining the percentage of the total population represented by each group. The sum of the population estimates approximates the total group population, because of rounding error.

influenzae were analyzed independently to determine racial differences in incidence, but no significant differences were found.[8]

Causative Organism

The most common causative organism was *H. influenzae*, which was cultured from 41 percent of cases but was limited to children aged 5 years and younger (Table 2). Almost one-third (32 percent) of all cases of bacterial meningitis were caused by *S. pneumoniae*, and of these, more than one-half occurred in children aged 5 years and younger. A similar pattern was evident for the 18 cases attributed to *Neisseria meningitidis*. Conversely, single cases in older patients were found for *Staphylococcus aureus*, *Escherichia coli*, *Listeria monocytogenes*, and *Pseudomonas*. Group B streptococci were implicated in four cases, all in children under 6 months of age.

Mortality

Nine patients died, giving an overall case fatality rate of 9 percent. Case fatality rates by age group are shown in Table 4. Five of the older patients died, resulting in a case fatality rate of 46 percent for patients aged 65 years and older. In addition, the two deaths in the 16-to-64-year age group occurred in patients older than 50 years, thus skewing the case fatality rates for the entire group. The deaths in the 16-to-64-year age group were attributed to *S. pneumoniae* and other organisms. Only one death occurred in cases attributed to *N. meningitidis*, two deaths each from *H. influenzae* and other infections, and four deaths from cases caused by *S. pneumoniae*.

Comparison of 1979–1982 and 1983–1987 Data

The overall incidence of bacterial meningitis found in the later study is one-half of that found in the same population between 1979 and 1982 (10 per 100,000 person-years).[7] The most significant changes were the dramatic decreases in incidence for the ≤ 5-year-old age group and in disease attributed to *H. influenzae* (Table 5). The highly significant decrease in neonatal disease caused by group B streptococci also contributed to the decline in incidence in young children. A smaller but statistically significant decline in incidence was found in children aged 6 to 15 years but not in the older age groups. A nonsignificant

Table 3. Cases of Bacterial Meningitis by Race and Age.

Race	< 28 d	28 d–5 y	6–15 y	16–64 y	65 y +	Total	Race-Specific Incidence (rounded)	Population*
White	2	59	1	12	10	84	5.0	1,681,101
Black	2	9	1	0	1	13	6.0	168,110
Other	0	1	1	0	0	2	2.0	83,089
Total	4	69	3	12	11	99	5.0	1,932,300

*Populations are estimates based on the 1980 census and information provided by the Metropolitan Area Planning Department. The population totals by race were estimated by determining the percentage of the total population represented by each group.

Table 4. Bacterial Meningitis Mortality by Age Group.

Outcome	< 28 d	28 d–5 y	6–15 y	16–64 y	65 y +	Total
Total cases	4	69	3	12	11	99
Deaths	0	2	0	2	5	9
Case fatality (%)	0	3	0	17	46	9

decline in disease attributed to *N. meningitidis* was measured as was a nonsignificant, but worrisome, increase in *S. pneumoniae*.

Discussion

To provide accurate incidence data, it was necessary to identify correctly all cases and obtain accurate population denominators. We insisted on bacteriological confirmation of disease and did not encounter any cases in which the clinical picture and CSF findings indicated bacterial meningitis but culture results were negative. Cases that could have been missed were those in persons not admitted to county hospitals, those misdiagnosed, or those miscoded. For both the number of cases and the denominator populations, our data were as accurate as could be obtained. The strengths of this study are its community base and its comprehensiveness.

The three earlier community-based studies,[4-6] plus our previous study in this population,[7] found an incidence of 7.3 to 10 per 100,000 person-years. The significant drop in incidence found in the current study might be a local phenomenon or reflect a more general trend over time. This study showed that most of the decline was due to a decrease in the incidence of meningitis caused by *H. influenzae* and group B streptococci in young children. Immunization against *H. influenzae* began in Sedgwick County in 1986, but this study was not designed to assess its impact. We cannot conclude that immunization can account for the decrease in disease incidence found in this current study. All of the cases of *H. influenzae* meningitis occurred in children who were younger than the age recommended for immunization, suggesting but not proving some community protection exists against *H. influenzae* in older children.

Although bacterial meningitis is predominantly a disease of young children, it occurs in all age groups. In the elderly, the case fatality was very high. We did not find evidence of delay in diagnosis in elderly patients, but 9 of the 11 patients were debilitated from other serious medical conditions. No cases associated with human immunodeficiency virus infection or the acquired immunodeficiency syndrome were found in this study.

One area of concern was the rise in the proportion of total cases attributed to *S. pneumoniae* from approximately 15 percent in the earlier study to 32 percent in the current study. If *H. influenzae* declines as a cause of meningitis, the proportion of cases attributable to *S. pneumoniae* can be expected to increase. Meningitis caused by *S. pneumoniae* is clinically significant because of its high case fatality rate.

Bacterial meningitis is an important disease, consuming considerable resources both in its treatment and in the steps taken to "rule out" the diagnosis, particularly in acutely ill young children. In the population studied, the incidence of bacterial meningitis has fallen significantly, particularly cases of *H. influenzae* meningitis in children younger than 5 years. The high case fatality rate in elderly patients and the rise in the proportion of cases attributable to *S. pneumoniae* are causes for concern.

Table 5. Comparison of 1979–1982 and 1983–1987 Studies of Bacterial Meningitis, by Age-Specific and Cause-Specific Incidence per 100,000.

Age and Cause	1979–1982	1983–1987	*P* Value
Age (years)			
≤ 5	70.00	40.00	< 0.00005*
6–15	3.55	1.14	< 0.05*
16–64	1.77	1.25	> 0.05
65 +	3.26	3.42	> 0.05
Organism			
Haemophilus influenzae	4.70	2.12	< 0.00005*
Streptococcus pneumoniae	1.31	1.66	> 0.05
Neisseria meningitidis	1.17	0.93	> 0.05
Group B streptococcus	1.17	0.21	< 0.0005*
Staphylococcus aureus	0.35	0.05	< 0.05*
Other	0.28	0.16	> 0.05

*Statistically significant difference.

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