PNEUMOCOCCAL BACTEREMIA IN CHARLESTON COUNTY, SOUTH CAROLINA

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To describe the epidemiology of pneumococcal bacteremia in a large population, this study reviewed medical records for residents of Charleston County, South Carolina, who had pneumococci isolated from blood cultures during the period 1974–1976. The overall incidence of documented pneumococcal bacteremia was 8.5 cases per 100,000 population per year. It was highest for those in the first two years of life (35 per 100,000 per year) and those in their sixties (21 per 100,000 per year). The incidence was more than five times higher in blacks than in whites and within races appeared to be independent of socioeconomic status or population density. Seventy-three per cent of the cases occurred in persons with another medical problem. These data on the incidence of documented pneumococcal bacteremia underestimate the true incidence of bacteremia to the extent that blood cultures were not performed under optimal circumstances for all persons with compatible clinical syndromes. The data suggest that certain groups would benefit from vaccination against pneumococcal disease if the vaccines are shown to be safe and effective for these groups.

bacteremia; pneumococcal infections; race; socioeconomic factors; splenectomy; Streptococcus pneumoniae

The epidemiology of pneumococcal disease has recently assumed greater importance for two reasons: a relatively safe vaccine has been shown effective in limited trials (1–3) and it has recently been licensed. Data regarding risk for various segments of the population are needed for rational use of the vaccine in prevention of pneumococcal disease. Secondly, outbreaks caused by pneumococci resistant to penicillin and to several other antibiotics occurred recently in South Africa (4–6). Illness caused by these organisms was difficult to treat and prevention will be necessary should disease caused by them become widespread.

Accurate epidemiologic data for pneumococcal disease in the general population have been available only for pneumococcal meningitis (7–10). We conducted this study to estimate the incidence of pneumococcal bacteremia in a large general population and to determine risk factors associated with illness.

BACKGROUND

The Charleston metropolitan area is the largest in South Carolina and is the urban center for southeastern South Carolina. Like many other aspects of the region, hospital-based medical care is centered in Charleston County and few residents go elsewhere for this service (11). Charleston County had eight hospi-
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Tals during the study period: four private hospitals, the university hospital for South Carolina’s medical school, a Veterans Administration hospital, a US Navy Hospital, and a county hospital. A new private hospital was recently constructed just outside Charleston County.

The population of Charleston County in 1970 was 247,650 persons: including 168,414 white and 77,884 black. The median age was 23.5 compared with the national median of 28.1. The median family income was $8068 compared with the median for the nation of $9590. The median family income for blacks in Charleston County was $4635 and for blacks in the nation as a whole was $6067. Eighty-two per cent of Charleston County residents lived in urban areas (as defined by the US Bureau of Census) compared with 73 per cent of persons in the nation as a whole.

METHODS

This study was part of a larger study of bacteremia and fungemia. Records of all bacteriology laboratories serving inpatient or outpatient facilities in Charleston County and the hospital nearby were searched for all isolates of pneumococci (Streptococcus pneumoniae) from blood cultures obtained in the three-year period, 1974–1976. Charts of patients whose home address was in Charleston County and from whom positive cultures were obtained during life were reviewed by one of us.

Bacteriology records for one of the three study years, 1974, were not available from one hospital. Since the portion of the population served by this hospital in 1974 was not known, denominators could not be adjusted to calculate rates. Instead, it was assumed that the population served and their risk of bacteremia in 1974 were the same as in 1975 and 1976. All incidence figures reported in this paper are adjusted in this way. Five per cent of pneumococcal bacteremia cases in 1975 and 1976 were in patients cared for in that hospital.

Charleston County Health Department records were used to identify the census tracts of the patients’ homes. Information about Charleston County was obtained from the 1970 US Census.

To study the association between splenectomy and subsequent pneumococcal bacteremia, we attempted to identify all Charleston County residents who had splenectomy in the period 1967 to 1976 from hospital medical records of operations performed at each of the hospitals. Records of operations performed before 1973 were not available from one hospital. The number of patients undergoing splenectomy at that hospital before 1973 was estimated from the proportion of splenectomized patients in the later years who had splenectomies at that hospital (15 per cent). This estimate was used to arrive at a figure for person-years of risk for bacteremia in splenectomized patients.

Cases were considered nosocomial if the onset of symptoms or signs of septicemia occurred during hospitalization or within 30 days after a preceding hospitalization or invasive procedure which seemed likely to have given rise to the infection. Cases were considered community-acquired if there was no such association.

RESULTS

Sixty-two cases of pneumococcal bacteremia meeting our criteria were identified in Charleston County residents in the three-year period, giving an incidence of diagnosed pneumococcal bacteremia of 8.5 per 100,000 population per year. All patients with pneumococcal bacteremia had symptoms and signs consistent with septicemia. Since seven charts for patients with blood cultures positive for S. pneumoniae could not be found, it is estimated that the 62 cases reported represent 90 per cent of the cases actually diagnosed.
Two of the cases of pneumococcal bacteremia were clearly nosocomial; symptoms and signs of bacteremia began during hospitalization for other medical problems. In a third, the positive culture was obtained from a 53-year-old woman one day after admission for what was thought to be congestive heart failure. The other 59 cases were clearly community-acquired, giving a rate of 8.1 per 100,000 population per year. Among etiologies of community-acquired bacteremia found in the larger study, only Escherichia coli was more common (9.3 cases per 100,000 population per year, unpublished data). Fifty-seven per cent of pneumococcus cases occurred in the months October through January.

Documented pneumococcal bacteremia was much more common in blacks than in whites (19.7 compared with 3.6 cases per 100,000 population per year, respectively). The incidence in whites was highest in the very young and in those 60 years of age and older (figure 1). Among blacks, the incidence was also biphasic, but the incidence was equally high in adults in each decade of life over age 30 years. For children less than 10 years old with pneumococcal bacteremia, all nine black patients were under two years old, whereas only one of the five white patients was under two. The risk among males and females was similar.

To determine if the risk of pneumococcal bacteremia varied with socioeconomic status, we compared incidences of pneumococcal bacteremia with median family incomes of census tracts. Race-specific rates were used to avoid the confounding effect of race. Persons were classified as "black" or "other than black" because race-specific median family incomes of census tracts in the 1970 census were available only for the categories black and other than black. Ninety-eight and three tenths per cent of other than blacks in Charleston County were white. Incidences of pneumococcal bacteremia for blacks and other than blacks appeared to be independent of race-specific median family incomes of census tracts (figure 2).

**Figure 1.** Incidence of pneumococcal bacteremia, by age and race, Charleston County, South Carolina, 1974–1976.
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Fewer than 200 other than blacks lived in census tracts with median family incomes for other than blacks of less than $5000 and fewer than 2000 blacks lived in census tracts with median family incomes for blacks of $7000 or higher; these groups are excluded from figure 2 because of the small numbers. There was substantial overlap in the $5000 to $7000 range, and the incidences for the two groups in this range were quite different. Thus, the greater risk among blacks did not appear to be related to their lower socioeconomic status per se.

Focal sites of infection with pneumococcus in conjunction with bacteremia in these patients are listed in table 1. Cases of meningitis occurred in patients less than seven years old or greater than 35 years old; their age distribution was similar to that of all patients with bacteremias. During hospitalization for bacteremia, 13 patients died. It was not possible in this retrospective study to determine accurately how the bacteremias contributed to death in all cases. One fatal case was in a 26-day-old child with meningitis. The rest were in adults over the age of 38 years.

Forty-five (73 per cent) of the 62 cases of pneumococcal bacteremia occurred in persons with another medical problem. The commonest was alcoholism which was noted for 19 (42 per cent) of the 45 adult cases. It was impossible to know the criteria used for the diagnosis of alcoholism in all instances. Other problems listed for more than two patients were chronic liver disease (six patients), chronic obstructive lung disease (five patients), and hypertension (five patients).

Two cases occurred in blacks with sickle-cell trait and one case occurred in a black with sickle-C disease. The prevalence of diagnosed sickle-cell trait among blacks with pneumococcal bacteremia (3/44, 7 per cent) was not much different from the known prevalence (14.6 per cent) of this trait in Charleston County blacks (12). No cases were observed in persons known to have homozygous sickle-cell disease.

Hospital medical records indicated that 292 persons had splenectomies during
Table 1

| Foci of infection*                                                                                                                                 |
|---|---|---|---|---|---|---|---|---|
|    | <1 month | 1–11 months | 1–19 years | >=20 years | Total | CFR† |
|    | Alive | Dead | Alive | Dead | Alive | Dead | Alive | Dead | Alive | Dead | Alive | Dead |
| Pneumonia | -‡ | -‡ | 3 | - | 28 | 8 | 35 | 8 | 19 |
| Meningitis | - | 1 | - | - | 2 | 1 | 5 | 2 | 29 |
| Empyema | - | - | 1 | - | 2 | 1 | 3 | - | 0 |
| Lung abscess | - | - | - | - | 1 | - | 1 | - | 0 |
| Facial cellulitis | - | - | - | - | 1 | - | - | - | 0 |
| Bacteremia alone | - | - | - | - | 4 | 3 | - | 3 | - | 27 |
| Total | - | 1 | 5 | - | 9 | 35 | 12 | 49 | 13 | 21 |

* Two cases of empyema, one of lung abscess, and one of meningitis occurred in patients who also had pneumonia. These cases appear in each appropriate category.
† Case-fatality ratio.
‡ No cases.

1967–1976. Indications for splenectomy were traumatic injury to the spleen (127 persons), incidental to abdominal surgery (102 persons), idiopathic thrombocytopenic purpura (14 persons), non-Hodgkin's lymphoma (11 persons), Hodgkin's disease (nine persons), hereditary spherocytosis (five persons), and others (24 persons). Splenectomized persons tended to be older than the population as a whole; 81 per cent of splenectomized persons were 20 years of age or older during 1974–1976 compared with 59 per cent of the whole population. After adjustment for those known to have died and for the lack of records for one hospital before 1973, it was estimated that 337 persons had splenectomy in the 10–year period, with 648 person-years of risk during 1974–1976. One case of pneumococcal bacteremia occurred in a six-year-old boy whose spleen had been removed 31 months earlier. This occurrence in the estimated 648 person-years of exposure for splenectomized patients compares with the incidence of one case in 11,172 person-years for the population as a whole.

**DISCUSSION**

The incidence of most forms of pneumococcal disease is not well defined, and the potential impact of pneumococcal vaccine is therefore not known. The incidence of pneumococcal meningitis has been estimated as 1.4 to 2.2 cases per 100,000 population per year (7–10), but meningitis comprises a small proportion of cases of pneumococcal disease. Reliable estimates of the incidences of pneumococcal pneumonia and otitis media, perhaps the most common forms of pneumococcal disease, have not been made.

We chose to study bacteremia because it is accurately and easily defined. Because for most forms of pneumococcal disease a proportion of cases is bacteremic, the incidence of a particular form of pneumococcal disease in a population can be estimated if the proportion is known. For instance, the proportion of cases of pneumococcal pneumonia that are bacteremic has been variously estimated to be from 16 per cent to 51 per cent (13–16) based on series of hospitalized cases. The proportion may be lower and blood cultures are probably made less often for milder cases that do not result in hospitalization.

The incidence of diagnosed bacteremia found in this study underestimates the true incidence of bacteremia to the extent that blood cultures were not taken from persons with diseases compatible with bacteremia, that antimicrobial therapy prior to cultures may have sterilized the
blood, and that laboratory isolation techniques were not optimal. Pneumococcal bacteremia may present without a characteristic clinical syndrome, especially in children (17). If blood cultures are more likely to be taken from one subset of the population or at one hospital, differences in the risk of bacteremia for different subsets observed in this study may be inaccurate. Isolation methods were those commonly used and should have been adequate for the isolation of pneumococci from blood. The frequency of blood cultures taken from persons with compatible illnesses in Charleston County before antimicrobial treatment could not be accurately assessed.

As expected from clinical studies, pneumococcal bacteremia was common in young children and the elderly. Unexpected was the observation that above the age of 30 years the incidence among blacks was similar for persons in each decade of life.

The risk of documented pneumococcal bacteremia was more than five times higher for blacks than for whites. Although the median family income for blacks was lower than for whites, the higher risk for blacks appeared to be independent of income. This finding is similar to an observation made for pneumococcal meningitis (7).

A higher incidence of pneumococcal meningitis among blacks was found in a prior study in Charleston County and was in part due to an association between sickle-cell disease and pneumococcal meningitis (7). No association between sickle-cell disease and bacteremia was found in this study. The difference might reflect the fact that the meningitis study covered a longer period of time and that most cases of meningitis were in children, whereas most cases of bacteremia in this study were in adults. Since sickle-cell disease is predominantly a disease of childhood (29), the small numbers of cases in children in this study may have been insufficient to detect an increased risk for such patients.

That risk was not associated with population density suggests that risk is similar for persons in urban and rural environments. The measure of population density available to us is a crude one and this analysis must be considered only an estimate of the possible effects of population density.

Pneumococcal disease is thought to occur more frequently in persons with certain underlying diseases including alcoholism and cirrhosis than in persons without underlying disease (18). Although the proportion of patients in this study with alcoholism and the proportion with any underlying medical problem seemed high, the proportions of the county population with similar conditions were not known. Associations between these conditions and bacteremia cannot be proved with these data.

Clinical studies have shown that pneumococcal bacteremia is common in patients who have had splenectomy (19), especially in patients with diseases or treatments that compromise the immune system further (20). Although the case of bacteremia in the splenectomized patient in Charleston County would not have been expected from the incidence in the whole population, the occurrence of only one case makes large the possible error in the estimation of the relative risk associated with splenectomy.

A 14-valent pneumococcal polysaccharide vaccine has recently been licensed for use in the United States (20). It has been immunogenic for all groups studied so far except young children and persons treated intensively for Hodgkin's disease (1, 2, 22–24). It has been shown to be effective in young adult males employed in gold mines in South Africa (1–3), and a similar vaccine was similarly effective in young military recruits in this country in the 1940s (25). In both situations, the incidence of pneumococcal
disease for unvaccinated persons was extremely high (9 per cent per year in South African miners (1)). Studies in patients with sickle-cell disease and persons without spleens have demonstrated that pneumococcal vaccine is immunogenic and protective although the studies were not randomized or blind (26).

Studies of efficacy of the current vaccine for young children, older adults, or persons with chronic illnesses have not been published, although trials in some of these groups are in progress. A trial with earlier vaccines was conducted among elderly persons in the period 1937–1943 (27). Pneumonia and bacteremia with types I, II, and III pneumococci were approximately 8 per cent as common in persons vaccinated with these polysaccharides as they were in controls. However, the risks of pneumonia and bacteremia caused by pneumococci of other types and of pneumonia caused by other organisms were each less than half as common in vaccinees as in controls. The study was not randomized or blind and these unexplained differences in morbidity leave the results open to question.

The epidemiology of pneumococcal pneumonia is difficult to characterize because of the vagaries with which the diagnosis is usually made (28). Pneumococcal otitis media can be accurately diagnosed by myringotomy, but it is difficult to envision this procedure being applied to all persons with otitis media in a population large enough for an accurate epidemiologic study. The advantages of a study of pneumococcal bacteremia are that bacteremia occurs in most forms of pneumococcal disease and it is easily and accurately diagnosed. Although the documented incidence of pneumococcal bacteremia in a large population will be less than the true incidence, such data are at present the best available for estimating the potential impact of pneumococcal vaccines. The risks of bacteremia for the very young, the elderly, and middle-aged blacks observed in this study suggest that an effective pneumococcal vaccine would be useful for these groups. The data provide some support for the suggestion by others (30, 31) that vaccine would be useful for persons with certain chronic illnesses if it is effective in those persons.

REFERENCES


