Pneumococcal Meningitis Epidemics in Africa

Brian Greenwood
London School of Hygiene and Tropical Medicine, London, United Kingdom

(See the article by Yaro et al. on pages 693–700)

Outbreaks of meningococcal meningitis are not uncommon. In industrialized countries, epidemics increase and decrease in severity slowly over a number of years and rarely achieve very high incidence rates of disease. In sub-Saharan Africa, the situation is different. Within the African meningitis belt, which extends across the Sahel and sub-Saharan from Ethiopia in the east to The Gambia in the west, major epidemics of meningococcal disease occur every few years [1]. These epidemics show a characteristic association with season. They almost always start early in the dry season, build to a peak at the hottest and driest time of the year, and then abate rapidly with the onset of the rains [2]. The reason for this remarkable seasonality is unknown, but climatic factors—in particular, a low absolute humidity—almost certainly play a central role [3].

In contrast, pneumococci are not usually considered to be a cause of meningitis epidemics. Outbreaks of invasive pneumococcal disease are reported from time to time in industrialized countries among people living in poor social circumstances, such as centers for the indigent, prisons, and military camps, but these outbreaks usually involve only a handful of cases. Thus, the recent reports of major outbreaks of pneumococcal meningitis in countries located in the African meningitis belt that have many of the epidemiological features of classic meningococcal epidemics are of concern [4, 5].

Surveillance of cases of meningitis and longitudinal surveys of nasopharyngeal carriage of pneumococci have been underway in the Kassena-Nankana region of northern Ghana since 1998. Carriage studies have shown fluctuations in the prevalence of meningococci of different serogroups and sequence types over time, including a wave of infections caused by meningococci belonging to serogroup X [6, 7]. Surveillance of admissions to the district hospital showed a marked increase in the number of cases of pneumococcal meningitis in 2002 and 2003; >100 patients were seen during this 2-year period [4]. All age groups were affected, and the case fatality rate of 44% was high. A strong association with season was observed; an increase in the number of cases of pneumococcal meningitis occurred approximately a month before there was an increase in the number of cases of meningococcal meningitis. Examination of the pneumococci responsible for this outbreak showed that 76% of isolates belonged to serogroup 1. On multilocus sequence typing, most isolates belonged to a single sequence type, ST217, and its 2 single-locus variants ST303 and ST612. Recently, the number of cases of meningitis caused by pneumococci of this serotype has decreased in the study area (G. Plutschke, personal communication), which suggests a natural cycle of penetration of a susceptible population by a new strain of bacteria and its subsequent elimination as a result of naturally acquired immunity; no pneumococcal vaccination has been undertaken.

Unusual events have also been taking place in the neighboring country of Burkina Faso. In 2002, a major epidemic of meningococcal meningitis occurred that was caused by serogroup W-135 meningococci [8]. This is the first time that this bacterium has been implicated as a cause of a major outbreak of illness in Africa. In addition, since 2002, there has been an increase in the proportion of cases of meningitis seen during seasonal outbreaks caused by a pneumococcus. A description of some of these cases and of the bacteria that caused them are presented in the paper by Yaro et al. [5] in this issue of Clinical Infectious Diseases.

Surveillance of cases of meningitis was undertaken in 3 districts near to the town of Bobo-Dioulasso, Burkina Faso, during the period 2002–2005. During this period, 249 (44%) of 571 cases of proven bacterial meningitis were caused by a pneumococcus. Cases of illness occurred across all ages and, as in Ghana, the case fatality rate of 46% was high. The seasonal distribution of cases paralleled the distribution that was observed in Ghana; there was an
increase in the number of cases early in the dry season, before an increase in the number of cases of meningococcal disease. Although the clinical and epidemiological features of the 2 outbreaks were similar, there were microbiological differences between them. Only 48 isolates from the outbreak in Burkina Faso were serotyped. Twenty-one of these isolates were serotype 1, which is a lower proportion than that which was observed in Ghana. Multilocus sequence typing was done on only 3 isolates. Two were sequence type 618, and 1 was a newly described sequence type related to 618; these were different sequence types than those of the epidemic strains found in Ghana. Thus, although only a small number of bacteria were characterized in Burkina Faso, it appears that the propensity to cause epidemic disease is not restricted to the dominant clone isolated in Ghana.

Are there any general lessons that can be learned about the epidemiology of meningitis in Africa from these recent, unusual events in Ghana and Burkina Faso? The observation that an upsurge in cases of pneumococcal meningitis can occur during African epidemics of meningococcal meningitis is not new. It was reported in northern Nigeria 30 years ago [9] and was almost certainly known to physicians who practiced in the area before that time. What are new are the scale of the pneumococcal outbreak in Burkina Faso and the demonstration that, in the right circumstances, a virulent clone of pneumococci can behave epidemiologically like meningococci.

The outbreaks of pneumococcal meningitis in Ghana and Burkina Faso both showed a similar seasonal pattern to that of classical meningococcal epidemics in Africa, although the increase in the number of cases began a little earlier. This suggests that the environmental factors responsible for setting off outbreaks of these 2 infections are similar but not identical. Perhaps the weather early in the dry season—the nights are cold early in the dry season but hot at its peak—is more advantageous to pneumococci, allowing the spread of infection. I have suggested previously [2] that an important factor underlying the seasonality of epidemics of meningococcal disease in Africa is an increase in the ratio of case patients to carriers, rather than an increase in the incidence of infection, when infections are acquired during the dry season; perhaps this is a consequence of damage to the mucosal defenses by the adverse environmental conditions prevalent at that time of year. If this is true, it would not be surprising if pneumococcal disease, normally characterized by a low case-to-carrier ratio, behaved in a similar way. However, there are a number of observations that suggest that the situation is more complex than this. Although previous studies of invasive pneumococcal disease conducted in countries of the African meningitis belt have shown seasonality [10, 11], the effect has not been very marked, and major outbreaks have not been described previously, even though serotype 1 pneumococci are a common cause of invasive pneumococcal disease in some of these countries [12, 13]. Furthermore, Haemophilus influenzae type b infection, which might be expected to behave in the same way, is not seasonal in meningitis belt countries [14]. These observations suggest that, for a major outbreak of meningitis to occur, a combination of environmental and microbiological factors must occur at the same time and that the latter, whatever they are, may occur either in meningococci or, more rarely, in pneumococci. Whether the microbiological features necessary for an epidemic relate to an ability to transmit, establish colonization, or invade is uncertain.

The fact that pneumococci can cause epidemic disease in Africa raises important issues in relation to the introduction of pneumococcal conjugate vaccines into countries of the African meningitis belt. At present, the only licensed vaccine is a 7-valent vaccine which lacks conjugates of serotypes 1 and 5. The results of trials in South Africa [15] and The Gambia [16] indicate that the introduction of this vaccine would save many young lives, but if this vaccine is used widely in meningitis belt countries, sustained surveillance will be necessary to ensure that vaccination does not select for a serotype 1 pneumococci with the potential to cause an epidemic.

Acknowledgments

Potential conflicts of interest. B.G.: no conflicts.

References


