Insights into seasonal dynamics of bacterial meningitis

Despite remarkable progress in prevention via vaccines, bacterial meningitis remains a major global infectious disease challenge with high morbidity and mortality. In this issue of *The Lancet Global Health*, Juliette Paireau and colleagues present a global meta-analytical study of the seasonal dynamics of three major pathogens that cause bacterial meningitis worldwide: *Streptococcus pneumoniae*, *Neisseria meningitidis*, and *Haemophilus influenzae*. The study compiled a comprehensive global database of national meningitis surveillance data from 66 countries and analysed country-level data using innovative wavelet analysis. A distinct 12-month seasonal incidence pattern was detected in a remarkably consistent 96% of 38 countries that had sufficient data for analysis. Also, the study found a consistent relationship between the timing of peak bacterial meningitis incidence and latitude. Peak meningitis incidence was in February to March for countries in the meningitis belt of sub-Saharan Africa, with remaining countries having peaks in respective winter months in the northern and southern hemispheres. The same seasonal pattern persisted when meningitis surveillance data were broken down for all three species.

The study did not find a difference in seasonality after introduction of new vaccines, despite a reduction in incidence. This is important because, although capsular group A epidemics seem to have been eliminated by introduction of the group A meningococcal conjugate vaccine in the meningitis belt, epidemics caused by group C, W, and X continue to occur there. Since strain distribution undergoes frequent changes both because and independent of the impact of vaccination programmes, future analysis will be needed to assess whether changes in infecting strain affect the onset and peak meningitis incidence.

Interestingly, there were some differences between seasonal peaks for the three pathogens in countries with such data. For example, in the four countries with both *H influenzae* and *N meningitidis* data, the *N meningitidis* peak preceded that of *H influenzae* by 3–6 weeks. Unexpectedly, the peak incidence of bacterial meningitis in Lebanon, a country with a Mediterranean climate, is in the hot and dry month of May, suggesting that some countries outside of sub-Saharan Africa may also have peak meningitis incidence associated with hot, dry weather.

All three of these bacterial pathogens are transmitted via airborne respiratory droplets, colonise the pharyngeal mucosa, and reach the meninges through haematogenous spread. Bacterial meningitis arises from an intricate interplay between host, pathogen, and environmental factors. On the bacterial side, recent studies applying high-resolution genomics have identified genetic factors that lead to the emergence of virulent pneumococcal and meningococcal strains predominantly through homologous recombination and phase variation within capsule-encoding and major antigen genes. Much is also known about host genetic and behavioural risk factors for bacterial meningitis. Even though the seasonal nature of meningitis has been known since at least the 1960s, the exact mechanisms by which environmental factors exert a seasonal influence on incidence remain unclear. The majority of the meningitis belt lies within an area with 300–1100 mm annual rainfall that experiences large meningococcal epidemics in the dry and dusty months of February to April. Meningococcal cases typically show a precipitous decline with the onset of the rainy season. Physical damage to pharyngeal mucosa, concomitant viral infections, and changes in normal pharyngeal flora have been proposed, although not yet established, as the cause of these dramatic changes in incidence.

What are the public health implications of Paireau and colleagues’ study? First, it demonstrates the utility of large global databases to address fundamental questions about infectious diseases epidemiology. In this case, the data are from national surveillance systems, which further underscores the value of public health surveillance. In that regard, the study highlights the need for strengthened meningitis surveillance in countries with limited data such as India, parts of the Middle East, and central Asia, primarily to measure disease burden and formulate vaccination policy. Second, an improved understanding of the complex interplay of environmental forces in the pathogenesis of bacterial meningitis could help in public health preparedness, especially for the 19 meningitis belt countries in Africa that experience meningococcal epidemics. Third, it will be important to determine whether the seasonal dynamics demonstrated in this study will change in the setting of ongoing climate change.

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In summary, Paireau and colleagues present important groundwork on global seasonal dynamics of bacterial meningitis. How complex environmental variables, the natural dynamics of bacterial meningitis, and immunisation programmes will affect seasonal and long-term temporal changes in bacterial meningitis epidemiology warrants additional investigation.

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We declare no competing interests.

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