Perspectives on Extreme Events: Epidemics

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In this presentation, I discuss epidemics of vector-borne disease (i.e., those diseases that are transmitted between hosts by insects, ticks, or other invertebrate). These are often zoonoses (diseases that occur normally in non-human vertebrates, but can "spill over" into the human population).

Vector-borne diseases tend to be complex, both in terms of their life cycles and in terms of their spatial and temporal distribution. For a given pathogen, the host(s) vector(s) and pathogen are each subjected to a variety of "pressures" within the ecosystem. For example, vertebrate hosts are affected by the quality of food quantity and quality, availability of nesting sites, and exposure to predators or parasites. The vector is affected by temperature, humidity, food resources (which may differ between adult and immature stages), and by predators and parasites. The pathogen is affected by host immune status, the frequency and timing of contact between vector and host. Temperature has a major impact on development rate of the pathogen when it is developing in the vector. All components of the system, pathogen, vector, and host, must occur together in time and space for epizootics or epidemics to occur. Variations in landscape structure create a patchwork of suitable and unsuitable habitats, leading to focal disease activity. Barriers, such as water bodies, deserts, or mountain ranges, may prevent the occurrence of a pathogen in an otherwise suitable location.

Vector-borne disease epidemics often seem to occur in conjunction with extreme climatic or weather events (flood, drought, hurricane, ENSO). For example, there appears to be a correlation between ENSO activity and malaria transmission in some parts of the world. In the United States, a severe drought in the summer of 1999 may have provided optimal conditions for the propagation of West Nile virus in New York City and surrounding areas. In the Red River Valley, North Dakota and Minnesota, heavy rains in the spring and summer of 1975 led to a large epidemic of St. Louis and western equine encephalitis. On the other hand, a study of vector-borne disease activity following a long series of floods and hurricanes failed to show any impact of severe weather events on disease transmission.

Current strategies for controlling epidemics of vector-borne disease are an example of "too little too late." For more effective prevention and control, we need better prediction and more effective detection systems. We would like to know which sets of environmental conditions, if any, are most likely to lead to epidemics, and which are least likely. We need more sensitive detection systems to tell us when and where outbreaks or epidemics are beginning. In the United States, for example, only a few states have sufficiently intensive surveillance systems to detect an epidemic in the earliest stage. Elsewhere in the world, surveillance systems are limited to a few areas within a small number of countries.

Suggested readings:

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