Climate-Driven Changes in Vector-Borne Diseases

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Vector-borne diseases are infections transmitted by small blood-feeding organisms such as mosquitoes, fleas, or ticks. The infections can be caused by viruses, bacteria, protozoa, or parasitic worms. Their transmission depends on the biology, behavior, and geographic distribution of vectors and availability of suitable blood hosts, including humans. Environmental conditions such as outdoor temperature, humidity, and rainfall strongly influence vector survival, their reproduction, and rate of contact with human hosts.

Climate change is affecting vector distribution and abundance and altering patterns of pathogen transmission. This challenges long-standing assumptions about which vector-borne diseases are transmitted and where and when transmission occurs. Seasonal transmission windows are longer, and vectors are appearing in new habitats. Reported cases of vector-borne diseases have increased substantially in the United States, although these trends reflect multiple interacting factors and cannot be attributed to climate change alone.[1] For family physicians, these shifts have important implications for the diagnosis and prevention of vector-borne diseases.[1] The article in this issue by Shahbodaghi and Rathjen provides key updates on the presentation and management of emerging vector-borne diseases.[2]

Warmer temperatures accelerate mosquito development and can increase population sizes, although hot, dry conditions may reduce aquatic habitats. Warmer temperatures speed pathogen replication within mosquitoes, making it more likely for a mosquito that acquires a pathogen from an infected host to transmit it during a later bite.[3] The distributions of daytime-biting mosquitoes that transmit dengue, Zika, chikungunya, and yellow fever viruses are shifting due to warming. These changes are especially noticeable in temperate urban areas that, until recently, lacked aggressive daytime-biting mosquitoes. Winter cold impedes establishment, even for the cold-tolerant Asian tiger mosquito (*Aedes albopictus*), whose eggs can survive brief freezing temperatures but are unable to survive sustained subfreezing conditions. Because of milder winters, the Asian tiger mosquito has expanded northward from New Jersey into New York, Connecticut, and Massachusetts.[4]

Ticks, which transmit multiple viral, bacterial, and protozoal pathogens in North America, are also highly sensitive to changes in temperature and humidity. Warmer temperatures increase periods of host-seeking activity and accelerate development between life stages; they also increase overwinter survival.[5] Historically, Gulf Coast ticks (*Amblyomma maculatum*) were concentrated in the Southeastern United States. However, warmer winters have allowed them to expand into parts of the Northeast.[6] This expansion complicates interpretation of the growing number of reported cases of spotted fever because multiple tick species and rickettsial agents may be involved.

In the Eastern United States, abandonment of farmland and subsequent reforestation and recovery of some wildlife populations have increased suitable habitats and hosts for ticks, particularly mice and deer. Residential expansion into wooded areas and more opportunities for outdoor recreation can increase contact with ticks and mosquitoes.[5] Extreme weather events further increase the risk of transmission. Hurricanes and flooding can disrupt mosquito surveillance and control and create new water-holding habitats (eg, in damaged structures, debris, discarded containers).[7] With this changing landscape, family physicians are increasingly likely to encounter emerging and reemerging vector-borne diseases: those increasing in incidence, newly recognized, or expanding into new geographic areas.[8]

Public understanding of vectors, seasonal risk, and personal protective behaviors is uneven, particularly in regions where vector-borne diseases are emerging. Community participation can strengthen vector surveillance and control efforts. Neighborhood-based mosquito control can include mass trapping of adult mosquitoes and eliminating water-holding containers.[9] Individuals can reduce exposure by using repellents, managing vegetation and other vector habitats around homes, and performing tick checks after spending time outdoors. Citizen science programs can complement these efforts by helping residents recognize local vectors and changes in their distribution. Increasing tick-confidence (ie, the ability to recognize ticks, understand their habitats, and respond appropriately to bites) may be particularly important for reducing anxiety and promoting effective prevention behaviors.[10]

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Family physicians play an important role in communicating risks to patients, particularly those at increased risk of severe outcomes. Pregnancy warrants special attention because mosquito-borne infections such as Zika, dengue, and malaria and the tick-borne infection babesiosis can threaten maternal and fetal health.[11] Risk also varies with age. West Nile virus is substantially more likely to cause severe and fatal neuroinvasive disease in older adults, whereas La Crosse virus, also mosquito-borne, causes severe neurologic disease in children.[12]

As vector distributions shift, clinicians may increasingly encounter patients with exposures acquired close to home rather than during travel to historically endemic regions. Vector biologists, epidemiologists, and public health agencies can help recognize emerging risks, but these efforts will be most impactful if physicians act on this information while caring for their patients.

Understanding how environmental changes alter vector biology, seasonality, and geographic distribution will be important for anticipating future disease risk. A One Health approach integrates vector surveillance, environmental monitoring, community engagement, epidemiology, and clinical awareness. It offers a useful framework for responding to emerging vector-borne threats and protecting public health.[13] A One Health approach was useful for West Nile virus surveillance in New York, where integrated monitoring of mosquitoes, birds, horses, and human illness provided early warning of the risk of human transmission and guided mosquito-control efforts.[14] Because climate change alters where and when vector-borne diseases occur, this integrated surveillance is important for translating early warning into timely public health and clinical action.

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