New model uses public health statistics to signal when disease elimination is imminent

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Ecologists at the University of Georgia have developed a model showing that public health surveillance data can be used to signal when a disease is approaching eradication. Their research, just published in *Theoretical Ecology*, lays the groundwork for a potential new tool in the fight against infectious diseases.

Infectious diseases like malaria, which is spread by mosquitoes, take a serious toll worldwide. According to the World Health Organization, there were 214 million malaria cases and an estimated 438,000 malaria deaths in 2015, and 3.2 billion people—or roughly half the world's population—live in areas where they are at risk of contracting the disease.

"Billions of dollars are spent annually on various interventions to stop diseases like malaria, and the investments have made a difference," said the study's lead author Suzanne O'Regan, who was a postdoctoral fellow in the UGA Odum School of Ecology and is now at the National Institute for Mathematical and Biological Synthesis. "Government and public health agencies need the will to continue making these investments after the initial reduction of cases has occurred."

Malaria has been eradicated from 79 countries since 1945. Where it remains, mortality rates have been reduced by 60 percent since 2000 due to the increased use of prevention and control methods, according to the study authors.

But to sustain these gains, the interventions have to continue until the disease is eradicated, according to John Drake, associate professor in the UGA Odum School of Ecology and the study's senior author.

"If you push malaria almost all the way to elimination, and then you say, 'We don't have too many cases around here anymore,' and you let up, it's just going to come back," he said.

He likened the problem to individuals who stop taking antibiotics as soon as their symptoms disappear but before they've completed the prescribed course.

"That's why having a good way to monitor the path to elimination, and knowing when you're on the brink of elimination, is important," he said.

The researchers based their model on the theory of "critical slowing down," a term that describes telltale statistical patterns that appear when a system under stress is nearing a tipping point—the point after which it is doomed to eventual extinction.

Using public health surveillance data for malaria, they looked for evidence of critical slowing down with four commonly used prevention and control methods: using bed nets to reduce the number of mosquito bites, spraying indoor insecticides to shorten mosquito lifespans, administering human drug treatments to reduce the time a malaria patient remains infectious and eliminating mosquito habitat.

They found that while the strength of the signal varied depending on the control tactic and the statistical method used to analyze the data, their model did indeed reveal the patterns characteristic of approaching tipping points.

Drake described the model as the "scientific backbone" for producing

new algorithms and statistical methods for monitoring progress toward disease elimination.

"This theory suggests statistical procedures and algorithms that could be used for doing that monitoring," he said. "It doesn't produce those algorithms itself, but it suggests new information technologies or data science technologies or analytic technologies that could be developed for this purpose. I think it has commercialization potential."

More information: Suzanne M. O'Regan et al. Leading indicators of mosquito-borne disease elimination, *Theoretical Ecology* (2015). DOI: 10.1007/s12080-015-0285-5

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