Medical Xpress

Scientists chase deadly MRSA bacteria with new models

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Argonne scientists are creating a virtual network to model the movement of the deadly bacterium MRSA, or methicillin-resistant Staphylococcus aureus. (Photo: Dr. Kari Lounatmaa / Science Photo Libary).

(PhysOrg.com) -- Ten years ago, Chicago hospitals were at ground zero when the deadly MRSA bacterium, till then confined to hospitals, learned some new tricks and spilled out into the community. This year, researchers from Argonne National Laboratory and the University of Chicago are teaming up to develop a unique new computer model to understand how the bacteria spread across Chicago -- and how it might be prevented from spreading further.

Argonne senior systems scientist Charles Macal and U of Chicago associate professor Diane Lauderdale received a grant from the Models of Infectious Disease Agent Study (MIDAS), funded by the National Institutes of Health, to begin a five-year study to mathematically model MRSA outbreaks.

Sometimes called “the flesh-eating bacterium,” MRSA, or methicillin-resistant Staphylococcus aureus, is a new antibiotic-resistant strain of bacteria that kills more people annually in the U.S. than AIDS. MRSA is spread by close contact and by touching contaminated surfaces, and can often live harmlessly on the skin for years before infecting an open wound.

To capture MRSA’s travels more accurately, Macal and Lauderdale will use a new technique called agent-based modeling (ABM). Traditional epidemiological models do not take individual actor choices into account—each virtual person in the model is assumed to behave the same way.

Instead, agent-based models use data from surveys to draw a picture of a virtual actor in a model neighborhood. Demographic factors such as age, ethnicity and location are likely to determine the virtual person’s risk as well as his or her individual response to the outbreak. Each actor has the potential to react differently, which presents a more accurate picture of MRSA travelling through a real city.

Macal and Lauderdale's study has two components. The first models the physical movements of virtual people through a neighborhood, tracking the simulated path of the bacteria itself as it is transmitted from person to person.

“How people move around creates sites of contact with other people, and that changes how the bacteria migrate through a population,” Macal said. “We find the spots where people gather: large employers, schools, hospitals, or the county jail, for example, and we sketch patterns of movement that could spread the bacteria.”

The other component is less tangible; it models the community’s social response to infection. In order to test which public health measures could slow the rate of transmission, officials need to know what information the simulated actors are getting about how to respond to MRSA.

“Social networks transmit both disease and information,” Macal said. “Do people go to the hospital? Do they stay home? Do they even have access to health care? Most importantly, who do people listen to when they actually decide what to do?”

According to Macal, the actors in the model can “learn”—changing their behavior as public awareness rises or other factors change. Lauderdale and Macal will simulate how populations respond to various public health measures, such as screenings, public announcements, treatment, isolation or promoting hand-washing and better wound hygiene.

And as Macal's virtual patients "learn," so can the bacteria. “One of the best things about ABM is that we can even model the disease itself as an agent,” Macal said. As it travels, changes to its genome can allow MRSA to modify its own structure and behaviors to adapt to new conditions created by the public response.

“MRSA has evolved into a serious public health concern, most recently in cities like Baltimore and Chicago,” said Irene Eckstrand of the National Institutes of Health’s National Institute of General Medical Sciences. “Dr. Macal brings considerable experience in building computational models of complex processes to this important problem. We hope that his contributions lead to a better understanding of how MRSA is transmitted and reveals public health practices that limit the spread of the disease.“

In their study, Macal and Lauderdale will run thousands of different simulations on Argonne’s high-performance computers. In the long term, the scientists hope to create a versatile framework model for disease transmission. In the ideal model, researchers from any city could plug in their own demographic and disease data and find the most effective ways to slow

"We want to make a tool that provides the technical information policymakers need to know for making difficult decisions," Macal said.

Provided by Argonne National Laboratory (news : web)