Tracing an elusive killer parasite in Peru

September 27 2011

This is a triatomine insect vector of parasite that causes Chagas disease. Credit: Victor Quispe-Machaca

Despite what Hollywood would have you believe, not all epidemics involve people suffering from zombie-like symptoms--some can only be uncovered through door-to-door epidemiology and advanced mathematics.

Michael Levy, PhD, assistant professor of Biostatistics and Epidemiology, at the Perelman School of Medicine, University of Pennsylvania, along with other collaborators from Penn, Johns Hopkins University, the Centers for Disease Control and Prevention, and Universidad Peruana Cayetano Heredia in Peru, are in the trenches combining tried-and-true epidemiological approaches with new statistical methods to learn more about the course of a dangerous,

contagious disease epidemic. Their research was published last week in *PLoS* Computational Biology.

Chagas disease, primarily seen in South America, Central America, and Mexico, is the most deadly parasitic disease in the Americas. Caused by the protozoan parasite, Trypanosoma cruzi, it is spread chiefly via several species of blood-sucking triatomine insects. After an initial acute phase, the disease continues to lurk in the body and can eventually cause a variety of chronic life-threatening problems, particularly in the heart. Although there are some drugs to treat Chagas disease, they become less effective the longer a person is infected. The lack of a vaccine also means that the only effective way to control the disease is to control the disease vectors.

Because the chronic effects of Chagas disease can take decades to manifest themselves, tracking the development and progression of epidemics has been a challenging problem. In the past, Chagas disease was known mostly in rural regions, but has been spreading into more urbanized areas over the last 40 years. Levy's team has been focusing on one of those areas in the city of Arequipa, Peru.

"There is an assumption that Chagas disease is not a problem in Peru because statistics don't show that more people are dying of cardiac disease in the areas with Chagas transmission compared to the rest of the country," Levy said. "What we've shown calls into question the assumption that the particular parasite that's circulating in Arequipa is somehow less virulent. We show that there's really nothing to back that assumption."

Epicenter Regression

The researchers used epicenter regression, which takes a statistical "snapshot" of disease infection in a particular population to track the

history of how an infection takes hold and spreads. Epicenter regression considers the duration of an individual's exposure to infection as a function of distance from their home to an unknown site, or sites, where disease has been introduced, and combines that measure with other known risks to estimate the probability of infection. From this data, the course of infection can be traced backward to infer where and when a disease first struck a community.

Levy's team has been collecting data in Peru since 2004. "We do all the fieldwork, we gather all our data, which is very much door-to-door, old-fashioned epidemiology," said Levy. That involves both entering households to search for infected insects and collecting blood samples from residents. The team's survey work led to the observation of spatial clusters of parasites in insects such that "it looked like there were isolated clusters of transmission, or 'micro-epidemics.' It was really observation, then hypothesis, then testing."

According to their findings, the Chagas parasite was introduced into the region about twenty years ago, and most infections occurred over the last ten years. Spread of the disease is being disrupted in Arequipa through insecticide application, but up to 5 percent of the population was infected before their houses were sprayed with insecticide. Levy and his colleagues conclude that the lack of chronic disease symptoms among these infected individuals could be due to the relatively short time of transmission: Most individuals may have yet to pass from the long asymptomatic period to symptomatic Chagas disease.

Inevitable Increase

The finding has crucial implications for the future management of the disease. Because the lack of late-stage Chagas disease in Arequipa is not an indication of a weakened parasite, the researchers believe that preparations should be made for a potential increase in chronic Chagas

cases in coming years. As they have throughout their research, Levy's team is working in close collaboration with the Peruvian government to ensure that the warning provided by their work does not go unheeded. "Everything we do in Arequipa is with the local Ministry of Health," Levy said. "We're very much integrated with the government's Chagas disease control program. We started diagnosing people who are asymptomatic and the Ministry of Health is treating the individuals who are diagnosed to increase the probability they don't progress to later-stage disease."

Levy and his collaborators, including Eleazar Cordova-Benzaquen and Cesar Naquira in Peru, plan to expand their epicenter regression modeling techniques to study other infectious diseases, including the West Nile virus in New York City. The method can even be applied to fighting the spread of pesky insects such as bedbugs. "We're trying to work in parallel to improve control of Chagas vectors and bedbugs," he noted. "The idea is if you find a house with bedbugs, where do you go next? Same thing with the Chagas bugs. When they come back after the insecticide campaigns, you get a report and you have to figure out how to react to those reports, which are pretty scattered." Levy and his team have found a way to find patterns, and thus more predictability, in the chaos of infectious disease transmission.

Provided by University of Pennsylvania School of Medicine