Researchers fight cholera with computer forecasting

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AUSTIN, Texas – Just as the rainy season is driving a new surge of cholera cases in Haiti, a new computational model could forecast where outbreaks are likely to occur.

Researchers at Ohio State University are working with the Centers for Disease Control and Prevention (CDC) on the project, in the hopes of targeting anti-cholera efforts where they are most needed in the earthquake-ravaged country.

Just back from a 10-day trip to the Artibonite Valley in Haiti, Ohio State researcher Marisa Eisenberg described the model's early results at the Ecological Society of America annual meeting in Austin.

One question was whether the deadly disease is spreading primarily through contaminated environmental water or through human contact – for example, through contaminated food. That knowledge would enable the CDC and relief agencies to focus limited resources on counteracting one means of transmission or the other.

"According to our preliminary findings, it's both," said Eisenberg, who is a postdoctoral fellow in the Mathematical Biosciences Institute at Ohio State. "We can't neglect either source of transmission."

As they continue to process the data, the researchers hope to identify typical patterns of cholera outbreaks, and identify "hotspots" – regions that are key to controlling the spread of the disease.

The CDC approached computer modelers about the problem in November 2010. Among them was Eisenberg's collaborator, Joseph Tien, professor of mathematics at Ohio State, who had previously identified patterns in data from the 19th Century cholera epidemics in London.

The resulting study, which he and Eisenberg published with Canadian collaborators in the Annals of Internal Medicine in May 2011, revealed the disease's cyclical nature: When a new strain of cholera invades a country, the epidemic typically starts with an initial wave of cases in the fall, then erupts into much larger outbreaks the following summer.

That pattern has thus far held true for Haiti.

"Before the earthquake, cholera hadn't been reported in Haiti in decades, so we're in new territory as far as what the disease will do there in the coming months and years," Tien said. "There are lots of different factors to consider -- environmental conditions affecting the ability of the cholera bacteria to persist in water bodies, variation in water quality and sanitation in different locales, infection-derived immunity, seasonal drivers such as rainfall. We're hoping to use mathematics to help piece the puzzle together."

Cholera is a bacterial infection of the intestines that causes vomiting and severe diarrhea. Without help, victims die of dehydration. According to the CDC, an estimated 3-5 million cases and 100,000 deaths occur around the world every year due to cholera.

The disease is primarily spread through fecal contamination of water and food. In much of Haiti, where large portions of the population still remain homeless since the 2010 earthquake, sanitation simply doesn't exist.

Tien, Eisenberg, and the Ohio State team traveled to Haiti to make connections with local health officials and to begin to gather cholera data from hospitals – in particular, the Hôpital Albert Schweitzer, the main hospital for a population of nearly 350,000 in the island's central valley.

Several trips to Haiti will follow, but Eisenberg describes the first one as intense and eye-opening.

"Part of the difficulty in getting accurate data, particularly during the first wave of the outbreak, is that the hospitals fill up and not everyone reaches a treatment center. Treatment center staff keep as detailed records as they can, though different agencies use different reporting methods. But cholera treatment centers are often short on funds and space, and even hospitals have many people staying in tents outside, because there isn't enough space," she said.

Other facts make tracking the disease more difficult. One village may get its water from multiple sources – a nearby river, spring on the hillside, or well dug along a road. Families travel many times a day to gather water in buckets and carry it home.

"Two neighbors may both get cholera, but they didn't necessarily get it from the same source," Eisenberg explained.

Modeling the Haiti outbreak on computer presents its own unique challenge, as hospitals, the United Nations, and UNICEF are all providing data at different spatial scales. Some have data at only the village level, or the department (state) level, or the country level. The telecommunications company Digicel is providing customers' location data, so the researchers can track where populations are moving within the country.

Eisenberg is busy constructing algorithms to fit all this diverse data

together. It may take time before the researchers have a complete model for the CDC and other agencies to use, but she hopes to get more initial results soon.

Non-Government Organizations (NGOs) have aided Haiti since the earthquake. They distribute chlorine tablets, and educate people on how to decontaminate their water. They build latrines to encourage people not to defecate in the river or in a field of crops.

But, as the Ohio State researchers learned on their trip, those same NGOs are running out of money, and preparing to leave the country. Yet the current rainy season, which began in June, has brought a surge of new cases.

According to the Haitian government, the population experienced 1,000 new cases of cholera per day in June.

To make the best use of aid that remains, the researchers would like to be able to know where exactly on the island new outbreaks are going to occur. They are assembling maps of cholera transmission, and creating software that will forecast the likelihood of new cases based on many factors such as population, water sources, travel, and weather.

They hope to have more results in the fall. What they learn could be of use not just in Haiti, but in Southeast Asia and in the Democratic Republic of the Congo, where the disease is common today.

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