Has Haiti's cholera epidemic become a permanent problem?

April 11 2016, by Alex Weppelmann, University Of Florida

Patients and companions at the Cholera Treatment Center in Haiti, April 2015. Credit: Andres Martinez Casares

On January 12, 2010 a 7.0 magnitude earthquake struck Haiti, killing thousands of people and displacing millions more.

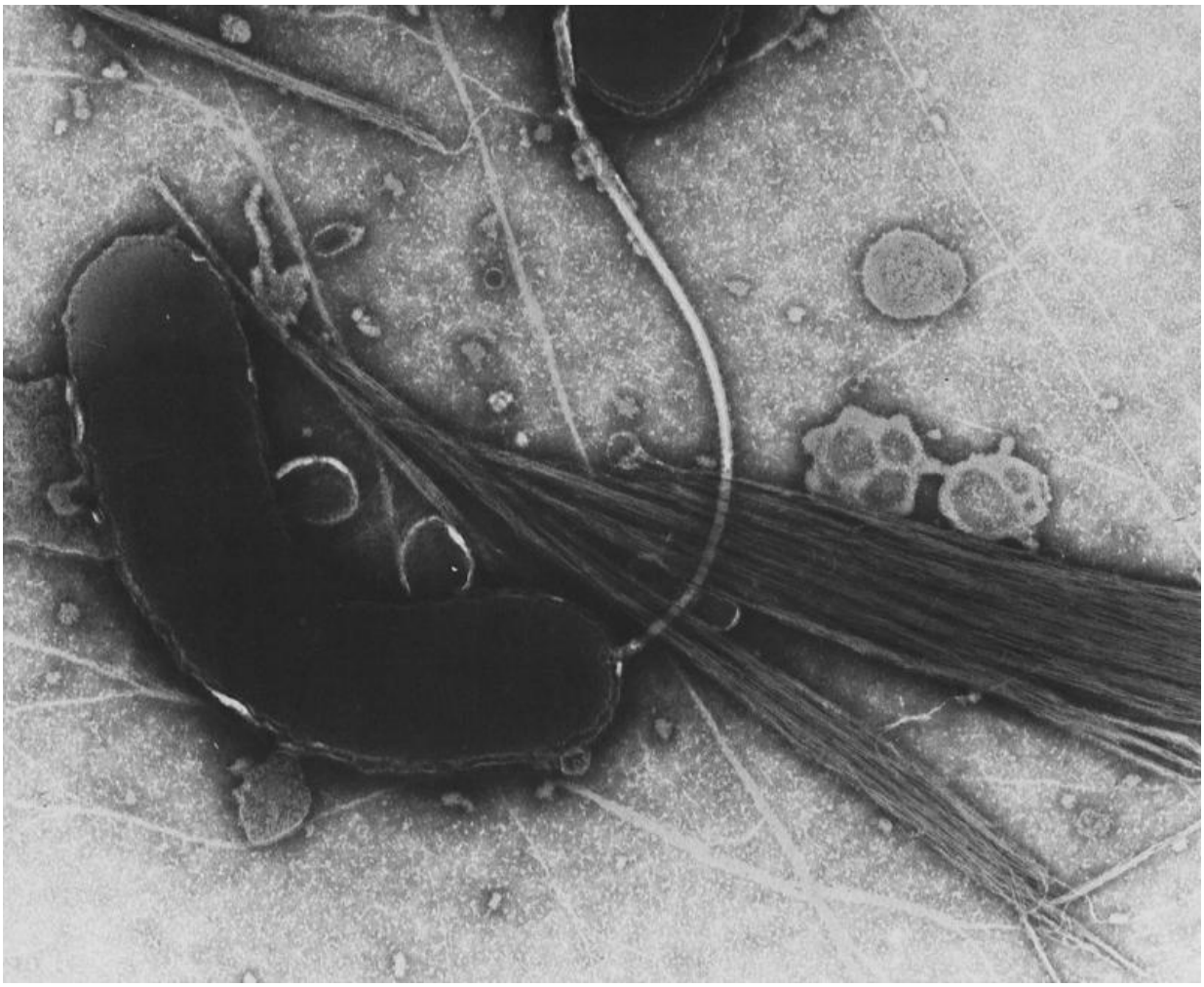
Ten months later the country was stricken with an outbreak of cholera, a deadly diarrheal disease. Though the number of cholera cases has decreased from a peak of approximately 25,000 cases per month, it is likely that thousands of people are still falling ill with the disease.

Moreover, there are now worrying signs that cholera has transitioned from an outbreak to an endemic disease. This means that cholera could join the list of infectious diseases that regularly occur in Haiti.

My colleagues and I at the University of Florida have developed mathematical models to help understand cholera transmission in Haiti and provide insights into how it might be stopped. Unless drinking water and sanitation infrastructure are improved, cholera could remain in Haiti indefinitely, an unwelcome development for the poorest country in the Western Hemisphere.

What is cholera?

Cholera is a waterborne disease, caused by the bacterium *Vibrio cholerae*. People become infected when they consume food or water contaminated by this pathogen. Once ingested, the bacteria colonize the small intestine, releasing a toxin that disrupts the movement of water.



Vibrio cholerae. Credit: Tom Kirn, Ron Taylor, Louisa Howard, Dartmouth Electron Microscope Facility, via Wikimedia Commons

The results are devastating: acute, watery diarrhea that can result in the loss of one liter of fluid per hour and death by dehydration in less than a day. However, lifesaving treatment in the form of oral rehydration salts, a simple mixture of electrolytes and water, can prevent death in up to 80 percent of cases.

Though largely a forgotten disease in most developed countries, cholera

was once a major source of illness and death. Before the advent of modern water and sanitation practices, cholera was found in much of the world and remains endemic in Bangladesh, India and parts of Africa. It is estimated that 1 to 4 million people become infected per year worldwide, and between 28,000 and 140,000 will die from this disease.

The earthquake created ideal conditions for water-borne diseases

After the earthquake in Haiti, millions of people were living in temporary camps without access to improved water or sewage systems, and crowded into very unhygienic circumstances. These are ideal conditions for the transmission of cholera.

In October 2010, a cluster of cholera cases was detected along the Artibonite River, the longest and most important waterway in Haiti. The cases were traced back to a tributary of the river, bordered by a garrison of Nepalese soldiers that were sent by the United Nations (U.N.) to help keep the peace in the aftermath of the earthquake. Like the majority of people infected with cholera, the soldiers were asymptomatic and unaware that they carried the bacteria.

The garrison discharged untreated sewage directly into a river that many people were relying on for drinking water. Once the river was contaminated, the spread of cholera was explosive.

By December 2010, cholera had spread throughout all 10 departments of Haiti, causing over 100,000 cases and thousands of deaths.

The outbreak continued to grow

In the year that followed, over 350,000 cases were reported, making

Haiti the scene of the largest national cholera outbreak in recent history. The international community was, once again, mobilized to help Haiti with this new crisis.

By early 2014 it seemed as if the cholera epidemic was coming under control. The number of cases dropped to approximately 200 cases per week, with signs that the increase in access to cholera treatment centers, along with interventions in sanitation and hygiene, were working.

After a few consecutive weeks during the summer of 2014 when no new cholera cases were reported in Haiti, it appeared that the epidemic was finally finished and the international community started to close many of the cholera treatment centers in Haiti.

Cholera returns – and lingers

But in the fall of 2014, cholera transmission returned at a rate of around 2,000 cases per week and remains elevated at approximately 1,000 cases per week. Perhaps the disease returned because fewer treatment centers were available for those infected to receive treatment. Or maybe the acquired immunity in people who survived the infection started to wane.

However, it is also possible that the underlying dynamics of cholera transmission in Haiti had changed. Cholera is transmitted via two main routes. The first is person-to-person transmission within households by food, water or surfaces directly contaminated by fecal material from infected people. The second is environment-to-person transmission from the consumption of surface water that contains free-living populations of the bacteria in the absence of fecal contamination.

Cholera outbreaks and epidemics are typically characterized by person-to-person transmission. But if the causative bacterium, *V. cholerae*, has established reservoirs in the environment, then the disease may have

become endemic.

Epidemiologists often use mathematical models to predict the course that outbreaks will take. For cholera, these models typically incorporate the number of people who have acquired temporary immunity after being infected and how long the bacterium can survive in the environment. Most models of cholera outbreaks assume that *V. cholerae* only survives in the environment for up to a few weeks and then dies.

Based on this reasoning, if all of the active cases can be treated and enough time passes for the *V. cholerae* in the environment to become noninfectious, no new infections occur and the epidemic will become extinct. This is likely why cholera treatment centers began to close when the cases approached zero.

However, given the right conditions, such as the warm tropical waters of Haiti, *V. cholerae* originally shed in the feces of cholera patients can survive for months or years in surface water. Environmental reservoirs of *V. cholera* can lead to recurrent seasonal outbreaks even after years without reported cases. This natural phenomenon is commonly observed in countries such as India or Bangladesh, where cholera remains endemic.

A growing body of evidence now suggests that this has happened in Haiti. My research group at the University of Florida noticed that despite a decrease in cholera cases in the summer of 2014, the isolation frequency of *V. cholerae* in the surface waters of the Ouest Department, Haiti's largest administrative area, was actually increasing. This suggested that reservoirs had been established and cholera could have gained a permanent foothold in Haiti.

Can Haiti eliminate cholera?

If *V. cholerae* has established reservoirs in the environment, what will it take for Haiti to stop cholera transmission? We developed a new model to shed some light on this.

Like traditional models for cholera transmission, we considered the number of people who have acquired temporary immunity because they survived the infection. But instead of assuming that *V. cholerae* decays in the environment after a few weeks, our model assumes that it can not only survive for prolonged periods, but can proliferate in response to environmental factors.

Combined with information about recent pilot vaccinations trials in Haiti, we can estimate the effects that these interventions, as well as any improvements to drinking water and sanitation, will have.

Unfortunately, there is little evidence that sanitation systems or access to clean drinking water have improved in Haiti since 2010. Given these conditions, we believe that mass vaccination with oral cholera vaccines might be the only intervention available to stop transmission of the disease.

We are currently investigating how many people would need to be vaccinated, how quickly oral cholera vaccines would need to be administered and how effective the vaccine would need to be in order to halt cholera transmission in Haiti. Our preliminary results suggest that controlling cholera transmission with oral vaccines could be possible in Haiti, but would require significant financial and logistical support from the international community.

The World Health Organization considers cholera endemic in countries that have had confirmed cases in three of the last five years. By that definition cholera is now endemic in Haiti. The question is, how long will it remain that way?

Source: The Conversation