Was Flint’s Deadly Legionnaires’ Epidemic Caused by Low Chlorine Levels in the Water Supply

By David Shultz | Feb. 5, 2018, 3:00 PM

From 2014 to 2017, thousands of people in Flint, Michigan, were exposed to dangerously high levels of lead after city officials began drawing water from a nearby river. But the dangers didn't stop there: Residents also suffered the third largest outbreak of Legionnaires' disease in U.S. history, with at least 87 people infected and 12 dead. Now, a new study adds support to the idea that a drop in chlorine levels in the water supply may have sparked the epidemic.

”It's a high-quality study,” says Nicholas Ashbolt, an environmental microbiologist at the University of Alberta in Edmonton, Canada, who was not involved in the work. He says it's “probably the first time” scientists have seen clear evidence of a relationship between chlorine levels and Legionnaires' disease. But not all experts are convinced the relationship is straightforward.

The water from the Flint River was more corrosive than the region's previous water sources thanks to a higher concentration of chloride, which can leach lead from pipes. But corrosive water can unleash other metals as well, including iron, which poses a double risk: It promotes the growth of bacteria, including Legionella pneumophila, which causes a severe and dangerous form of pneumonia, but also binds and inactivates chlorine, which is added to the water supply as a disinfectant.

To investigate the relationship between chlorine and Legionnaires' disease, researchers analyzed the levels of chlorine in the Flint water supply before, during, and after the water crisis. Utilities in the United States are required to record the level of disinfectant in the water supply, and these data were provided by municipal, state, and federal government sources. The scientists are careful to point out that the data do not prove that lower chlorine levels directly caused the outbreaks, but what they can show is that as the concentration of chlorine fell, the odds of Legionella infection increased.

Regulatory agencies recommend free chlorine be kept at concentrations between 0.2 and 0.5 milligrams per liter (mg/L). During the period when Flint drew its water from the river, for every mg/L of water that the concentration of chlorine dropped, the odds of seeing a case of Legionnaires' disease increased 80%, the authors report today in the Proceedings of the National Academy of Sciences.

However, experts say other factors may be more important than chlorine concentration. Both Ashbolt and Lok Pokhrel, a toxicologist at Temple University in Philadelphia, Pennsylvania, note that the study did not consider the temperature of the water, which plays an important role in fueling Legionella growth. River water can be warmer than lake or reservoir water, but the temperature of the water in the distribution system was not considered in the new study. Additionally, Pokhrel says, Legionella is actually highly tolerant of chlorine, especially when growing in a biofilm, a slick coating of bacteria that the chemical can't penetrate very well. “Their inference that a reduction in free chlorine in the water supply most likely caused [the Legionnaires'] outbreak seems spurious,” he says.

The data also don't make clear where each of the 87 the Legionnaires’ patients became infected. That makes it impossible to say for sure that a drop in chlorine levels was the culprit, Ashbolt says. For instance, a concentration of Legionella too small to be infectious could have found its way into the warm plumbing of a hospital or other large building where it grew to large numbers and subsequently infected many people. This is a common way outbreaks of the disease occur even in distribution systems that are functioning properly.

If chlorine is the problem, simply adding more of it during future water crises isn't a good idea, says Michele Swanson, a microbiologist at the University of Michigan in Ann Arbor. To overcome the influx of heavy metals and organic material from the corrosive river water, Swanson and her team calculated that the distribution center would've needed to add as much as 1.4 mg of chlorine per liter. But concentrations this high carry their own risks, she says. “It can generate disinfectant byproducts that are toxic, and it can also increase corrosion of pipes, so it could inadvertently increase lead release into the water.”

A better solution, says Pokhrel, would be to switch to polyvinyl chloride pipes—Flint hopes to do this by 2020—which don't release iron when exposed to corrosive water. In the meantime, he suggests managing water corrosiveness before it enters the larger distribution system and creating and enforcing standards for maximum Legionella concentrations in the water to help prevent another outbreak like the one in Flint.