

No Water, No Life

[Announcer] This program is presented by the Centers for Disease Control and Prevention.

[Sarah Gregory] Today, I'm talking with Byron Breedlove, Managing Editor of the EID journal, and also Dr. Todd Weber, a medical officer at CDC, about the April EID cover essay that they cowrote.

[Byron Breedlove] Glad to be here, Sarah.

[Todd Weber] Thank you for inviting me to the podcast.

[Sarah Gregory] Byron, you've written many cover essays now. Some you write on your own and some with a coauthor. How are these two types of experiences different?

[Byron Breedlove] That's a good question, and every essay's a bit different, because as you know, the theme for every issue varies—the type of art, the period of the art, and of course, the artist—so you've got all these variables. And so, when I write an essay on my own, I kind of use a formula where I want to offer a little bit of information and background on the artist, but not too much, but the key points, then describe the artwork in a noninterpretive way. And, what I mean is, I don't want to be telling viewers or readers what they should see, but I want to describe it to them in a way that gives them a picture of what it's about, and sort of directs them towards that elusive science-art connection.

That's the hard part and I like the fact that, when I work with another writer or coauthor, that as I'm writing, I don't feel like I have to nail down every loose end or fact right away, and I can share those ideas with a coauthor knowing that some will pass muster and others will be discarded because of the feedback and interaction of working with somebody else. It's actually kind of liberating, in a way, knowing that the coauthor will be scrutinizing what I've written and bringing a different point-of-view to the essay. So, in the case of this essay about water and about antimicrobial resistance, Todd was able to frame the scientific viewpoints about the importance of water and how it's used as a cleaning agent, how it can be used to spread disease, in ways that had just not occurred to me, and it really made for a more rounded, solid essay.

[Sarah Gregory] Todd, how was your experience as a coauthor different from your usual one of writing scientific articles?

[Todd Weber] It was different. We were starting with a work of art, rather than a scientific question or a discovery, and this was a metaphor, rather than fact. But, the theme evoked by the artwork isn't distant from many concepts that are directly related to the biological sciences, to health care, in particular, and to people, in general. Water, needless to say, is fundamental to our existence and the work that we do here at CDC. So, we had enormous creative options for discussing the artwork itself and tying thoughts about it to numerous infectious diseases and conditions of interest to the readers of the Emerging Infectious Diseases journal. Working together with someone else on an article is nothing new. Scientific work is very much a collaborative endeavor, and this was no different.

[Sarah Gregory] As a scientist, talk to us a little bit about water, the good and the bad.

[Todd Weber] Sure. As we wrote in the essay, water is essential for life and for preserving health, but under certain circumstances, it can be the reservoir for pathogens that can lead to disease and death. So, starting with the good... As related to health and preventing the spread of disease, water is used to maintain hygiene, with handwashing being the most critical and most well-known worldwide for preventing the spread of diseases. These diseases are as diverse as influenza and other respiratory infections, diarrheal disease, and healthcare-associated infections in hospitals. In addition, water is critical for sterilization. As most people probably know, for a very long time we have used steam under pressure to sterilize instruments to prevent the spread of infections when these instruments are reused for surgery and other purposes.

But, there is bad news with water and infections. Starting with some infections that are probably known to most listeners, there's *Vibrio cholerae*, that's the bacteria that causes cholera, which preys on areas without adequate access to clean water and sanitation systems. Cholera has been responsible for seven pandemics since the nineteenth century, killing millions of people across the globe. Unfortunately, this organism remains endemic in many countries. *Legionella pneumophila*, the bacteria that causes Legionnaire's Disease, is transmitted by inhalation of contaminated water aerosols, from cooling towers, decorative fountains, hot water tanks, large plumbing systems, and the like—cooling towers being the ones that are probably most familiar to people, since those often get headlines for their far-reaching effect.

In the past several years, epidemiological investigations and scientific studies have demonstrated other ways water is related to infection, particularly in healthcare settings. Water associated with these infections has been found in healthcare settings—drinking water, sinks, ice machines, flowers vases, and unsurprisingly, toilets, among other places. The infections associated with water sources can cause significant morbidity and mortality, especially among vulnerable patients in healthcare, who are critically ill or have compromised immune systems. So, for example, complex devices that use water and water drains have been identified as the site of biofilms harboring the pathogens. Biofilms can form on a variety of water-associated surfaces, including living tissues, indwelling medical devices, industrial and potable water system piping, and other places. There have been numerous articles published recently that describe drainpipes in sinks that have become colonized with multidrug resistant bacteria, which lead to hospital-acquired infections. There's significant research in progress to figure out precisely how bacteria are dispersed from the sink to patients, as well as research on how to effectively remove or reduce the dangerous bacteria lurking in these hospital drains.

And then there's surgical site infections, also related to biofilms, caused by nontuberculous mycobacteria associated with heater-cooler devices used during cardiac surgery, that have been reported internationally. Nontuberculous mycobacteria, also called NTMs, are bacteria related to tuberculosis, but which cause different kinds of infections. To give you a sense of the scope of this problem, more than 250,000 heart bypass procedures using heater-cooler devices are performed in the United States every year. Heater-cooler units are an essential part of these lifesaving surgeries because they help keep a patient's circulating blood and organs at a specific temperature during the procedure. In addition to heater-cooler devices, infections with NTMs have been associated with hospital water systems, including showers, ice machines, and faucets. Other bacteria, such as *Pseudomonas aeruginosa* and other highly resistant bacterial organisms, including gram-negative organisms, have been responsible for outbreaks associated with the waste- and tap water systems in healthcare institutions.

Outside of the healthcare environment, as we mention in the essay, antibiotics themselves can contaminate water. In addition, genetic materials have been found in river sediments that could potentially confer resistance to ciprofloxacin and other antibiotics. It's possible that waste water from our hospitals could serve as bioreactors for antibiotic resistance and a source for human infection. This would be through a combination of the genetic resistance elements found in waste water from humans and animals, combined with antibiotics in the same environment, along with other environmental selective pressures that may be man-made.

[Sarah Gregory] Would you read us the essay you and Byron wrote, "No Water, No Life, No Blue, No Green."

[Todd Weber] Yeah, I'd be happy to. The essay starts with a quote from W. H. Auden's "First Things First":

"Thousands have lived without love, not one without water."

Water is the most precious and essential natural resource. If unadulterated and at room temperature, it is tasteless, odorless (to humans), and transparent. Water sustains life, reshapes topography, provides passage and conveyance, and delineates and destroys geopolitical boundaries. Water comprises about 71 percent of Earth's surface, and the United States Geological Survey estimates that Earth is covered by more than 332,500,000 cubic miles of water. Archaeology, history, and anthropology corroborate that most civilizations originated near water. American marine biologist Sylvia Earl offers this perspective: "No water, no life. No blue, no green."

Vivid blues and greens interspersed with layers of white splash across this month's cover art, "Water Prayer I," one of a series of water-related pieces from the portfolio of artist Patricia Goslee, who lives in Washington, DC, United States. Her abstract work points to the possibility of mutability and transformation in water. A hazy hatch work sweeps across the top of the painting and repeats in the lower right. Green and pale blue spheres of color float above the patterns. Dominating the image, a dense V-shaped amalgamation of speckled shapes—some uniform and others elongated—streaks diagonally across the center of the canvas while a column of undulating forms juts up along the left side.

Goslee's water-themed painting can be viewed from divergent perspectives. It might be perceived as capturing a teeming collection of microorganisms inhabiting a drop of water. Conversely, it could suggest the proverbial 10,000-foot view, the stretched convergence of a city and river delta, interlaced with roads, canals, and lakes, and dotted with buildings, fields, forests, and towns as viewed from an airplane window.

It may be a viewer's choice, for Goslee, who favors a style that is colorful and intuitive, approaches her painting without a preconceived plan. In her words, "It's a blank slate every time I start. I make marks, move and pour paint on the canvas. Sometimes I use spray paint, and sometimes I draw on the surface of the paintings. It all evolves and is ultimately a practice that allows me to process my experience of the world."

"Flow" was an exhibition of Goslee's work displayed at the District of Columbia Arts Center in 2009 and 2010. Notes from this exhibition also offer perspective into her style of painting, "The most obvious unifying element in Goslee's mixed media work is pattern: layers of color and

form operate as a visual metaphor for layers of awareness. The results achieved often depict isolated moments, visualizations.”

Water is essential for life and for preserving health, but under certain circumstances, it can be the reservoir and conduit for pathogens that can lead to disease and death. Water is used in myriad ways to maintain hygiene, arguably handwashing being the most critical for preventing the spread of organisms responsible for diseases as diverse as influenza and other respiratory infections, diarrheal disease, and healthcare-associated infections in hospitals. Water is critical for sterilization. Steam under pressure has a long history of use for sterilization to prevent the spread of infections by reusable surgical instruments.

Water has been the source for infections of international and local importance. *Vibrio cholerae*, which preys on areas without adequate access to clean water and sanitation systems, has been responsible for seven pandemics since the nineteenth century, killing millions of people across the globe. This organism remains endemic to many countries. *Legionella pneumophila* is transmitted by inhalation of contaminated aerosols from cooling towers, decorative fountains and hot water tanks, large plumbing systems, and the like. More recently, complex devices that use water and water drains have been identified as the site of biofilms harboring pathogens. Biofilms may form on a variety of water-associated surfaces, including living tissues, indwelling medical devices, industrial or potable water system piping, and natural aquatic systems. Surgical site infections caused by nontuberculous mycobacteria associated with the heater-cooler devices used during cardiac surgery have been reported internationally. *Pseudomonas aeruginosa* and other highly resistant organisms have been responsible for outbreaks associated with the water and tap systems in healthcare institutions.

Antibiotics themselves can contaminate water. A group of researchers discovered concentrations of pharmaceuticals, including levels of ciprofloxacin greater than those found in the blood of humans taking this antibiotic, in effluent from a water treatment plant that served around 90 drug manufacturers in India. They studied bacteria in river sediments and found genetic materials that could potentially confer resistance to ciprofloxacin and other antibiotics.

One of the most abundant and indispensable compounds, water courses through art, literature, history, and science. A multitude of different names exist for water, and cataloguing these would prove an arduous, complicated endeavor. Spending a few minutes reflecting on Goslee’s “Water Prayer I” enables us to move beyond words and simply appreciate how important water is to life and health.

[Sarah Gregory] Listeners can read the April 2018 cover essay, No Water, No Life, No Blue, No Green, online at cdc.gov/eid.

I’m Sarah Gregory for *Emerging Infectious Diseases*.

[Announcer] For the most accurate health information, visit cdc.gov or call 1-800-CDC-INFO.