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Data Gold Mine: Building a National Wastewater Surveillance System

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Researchers and governments alike have sampled wastewater for varied uses, from estimating population socioeconomics[1] to assessing vaccination rates.[2,3] But with more than 16,000 wastewater treatment plants across the United States, the country faces unique challenges in leveraging these data for research or policy. A new commentary in *Environmental Health Perspectives* proposes a road map for adapting wastewater surveillance—traditionally an academic exercise in the United States—to a policy tool that can respond to current and future public health crises.[4]

Traditionally, wastewater surveillance has been used to detect health indicators, such as stress hormones, illicit drugs, chronic disease biomarkers, and pathogens.[5] This surveillance enables public health officials to identify, at a population level, disease outbreaks, previously undetected health problems, and changes in health-related behavior. Officials can also estimate the seriousness of such problems and assess the effectiveness of interventions and control measures.[6]

For the new article, a team of health policy analysts at Mathematica applied their expertise in wastewater surveillance to the COVID-19 pandemic. Springboarding off a 2017 symposium—which positioned some communities to launch wastewater surveillance for the SARS-CoV-2 virus as soon as the first clinical cases of COVID-19 were detected—the team curated a data hub[7] that collected credible resources on different aspects related to pandemic management. They then built a dynamic reporting tool to evaluate wastewater data alongside other public health data and worked with communities to help them implement wastewater surveillance.

"Thanks to COVID-19, there's been unprecedented attention paid to wastewater surveillance," says lead author Aparna Keshaviah, a senior biostatistician at Mathematica. "As federal agencies now work to build a national surveillance system, we wanted to help them think through ways to bring a systematic approach that works not just for the current pandemic but for future threats as well."

At the state level, surveillance varies from routine sampling by public health departments across the state to a smattering of pilot studies.[8] At a federal level, the U.S. Centers for Disease Control and Prevention and the Department of Health and Human Services are working with other federal agencies to develop a National Wastewater Surveillance System (NWSS).[9] Eight states were initially selected to pilot this system: California, North Carolina,

Ryan Dupont, a professor of civil and environmental engineering at Utah State University, collects sewage samples from dormitories on 2 September 2020. Utah State later quarantined hundreds of students after wastewater tests detected the SARS-CoV-2 virus. Image: © AP Photo/Rick Bowmer.

Ohio, South Carolina, Virginia, Utah, Washington, and Wisconsin. In addition, researchers worldwide have coordinated to share best practices for wastewater sample processing and testing.

However, with so many different states and authorities, challenges have arisen, particularly standardizing data and sampling techniques. "Each state has its own approach, and sometimes state health departments are not coordinating with local health departments on wastewater surveillance," says Keshaviah. "Our conversations with leadership in [federal, state, and local] agencies have made clear that, for the NWSS to serve multiple purposes, more interagency coordination and cooperation is needed."

The new commentary focused on tips and lessons learned. The authors emphasized that techniques should be tailored to community needs and the phase of the health threat. For example, they wrote, "As transmission accelerates, testing might shift from detection to quantification, and sampling might shift to target vulnerable populations where the need for care could outweigh capacity." They discussed the costs and benefits of the two main sampling techniques: composite and grab sampling. Grab samples capture wastewater at a single point in time, whereas composite samples combine multiple grab samples taken over a period of time. Composite sampling improves the detectability of SARS-CoV-2, but it is more expensive and may not always be feasible because the autosamplers used sometimes do not fit into the maintenance holes of specific facilities.

Collecting samples that accurately represent a population requires considering properties of both the population and the biomarker, such as how rapidly it breaks down. For example, sampling wastewater in the morning captures larger flows of SARS-CoV-2 but likely misses effluent from shift workers, who may be at greater risk of the disease.

"This is clearly a topic of much interest in many of the countries that have adapted wastewater surveillance techniques over the past year as well as those that are currently considering this. I think it is very important to share experiences and learnings globally," says Kevin Thomas, a professor of environmental health sciences at the University of Queensland, who was not involved in the commentary. "An area that might have been examined in more detail is the research needs around effective sampling." He adds that commercial autosamplers are not the only solution and that other technologies need to be developed and adopted to collect representative samples. Finally, he says that grab sampling for early warning can, in many cases, lead to false negatives, which diminishes the value of the approach.

"The paper makes a good point about the need to fill the gap between innovation and implementation," says Sandra McLellan, a professor of environmental health at the University of Wisconsin–Milwaukee, who was not involved in the commentary. "We need to remember that the method development and science behind these measurements are very young: It has been just over a year since researchers started intensively tackling the technology, and the leap to implementation might be an iterative process."

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