Detecting COVID-19 in wastewater using real-time PCR to predict and contain outbreaks

Biogeochemist and Associate Professor of Plant and Wildlife Sciences, Zach Aanderud, Brigham Young University

BYU's Zach Aanderud depends on Quantabio's Q Cycler and qScript XLT 1-Step RT-qPCR ToughMix to deliver real-time high-quality data on SARS-CoV-2 viral loads

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"Wastewater never lies," says Brigham Young University (BYU) biogeochemist and Professor Zach Aanderud. That makes it a perfect diagnostic tool for a pandemic—particularly one such as COVID-19 that features large numbers of asymptomatic or untested carriers.

As the SARS-CoV-2 virus began to surge through the U.S. in April of 2020, the state of Utah decided to call on Aanderud for help. He is well known as a local expert in wastewater and they wanted to track infections in real time via a wastewater network. The Utah project was so successful that several other states followed with their own wastewater surveillance testing. The approach also captured the attention of his employer BYU, who asked him to create a similar network for on-campus housing as a way to monitor infection levels in the student population.

Today, Aanderud's lab processes about 50 samples per week for both the Utah and BYU projects using Quantabio's Q qPCR cycler and qScript® XLT 1-Step RT-qPCR ToughMix®. The ToughMix chemistry is very effective in overcoming common PCR inhibitors in environmental samples such as wastewater and highly sensitive at detecting low level copies of the virus. Aanderud's findings have enabled BYU's campus to remain open and have prevented more intensive outbreaks in his home state. "The only way we would have been able to do any of this is with the Quantabio Q qPCR cycler and ToughMix chemistry," he says.

The Q instrument arrived just in time. Aanderud purchased it a couple of weeks before he got the call from Utah officials about the COVID-19 project. It was meant to replace an existing qPCR instrument he had been using for years, and he was pleased to learn that it was already being used by the CDC. There is a lot to love about the Q, says Aanderud. It is highly efficient and can test up to 48 samples in a single run. Since implementing the new instrument, he has been able to generate reproducible results without any false positives.

The Q is also very easy to use, which is especially helpful in Aanderud's case, given that undergraduate students are collecting, processing and analyzing most of his samples.

There are no additional handling steps outside of loading the instrument: he does not have to add ROX reference dye or spin PCR samples in a centrifuge as the instrument takes care of this. Unlike the prior qPCR platform he was using, the Q does not require intensive training, so his undergraduate students have been able to quickly get up to speed without previous qPCR experience. Not only is it sturdy, but also much smaller than rival instruments. In fact, it is compact enough to transport in a car. "It's kind of cute," Aanderud says.

Aanderud had never studied viruses before he began tracking COVID-19 infections, but he was well experienced in studying wastewater. He has been using next generation sequencing and qPCR to analyze nucleic acid signatures in wastewater for over five years. His lab has helped municipalities around the country reduce the waste in their sewage using extremophilic bacteria. He has also enabled wastewater treatment plants to ensure that their effluents would not trigger the release of harmful toxins or algal blooms in local lake and river systems. Given this experience, he immediately understood how useful wastewater samples could be for detecting viral loads.

"There were so many people launching into COVID-19 research when it first began," says Aanderud, "but wastewater offers more predictability and a greater resolution on infection rates." The wastewater network project was initially funded by the Utah Department of Environmental Quality, which led the joint study with BYU, Utah State and the University of Utah. More recently, Aanderud's lab received a grant from the CDC to continue the work through the Utah Department of Health.

The data Aanderud's lab collects is real-time and actionable. By tracking trends in the viral loads, he can identify growing numbers of asymptomatic or untested individuals and notify the university or state that infections might begin to silently spread.

While wastewater epidemiology to detect viral loading is still a relatively new science, health departments are eager to put it to use. The CDC, for instance, wants to help communities create pandemic action plans that would be set in motion once certain wastewater viral load thresholds were met. It wants Aanderud to help set and detect these thresholds and to better understand how these thresholds might differ in urban versus rural communities.

For rural communities, wastewater testing could be used to determine when and where to deploy mobile testing equipment. Many rural populations do not have high capacity for testing, and have to be selective. Wastewater testing is also more reliable than in-person testing in places where resistance or economic hardship suppress testing rates. "The great thing about these sewer sheds is that you draw a boundary around people," says Aanderud. This allows him to have well defined areas and the corresponding rates of infection.

Aanderud suspects that he will continue monitoring wastewater through at least the end of 2021 given the current vaccine rollout and unknowns about new COVID-19 variants. If the CDC can put the wastewater networks' data to good use and get action plans in, there is plenty of room for optimism, both for containing COVID-19 and potentially for future pandemics.

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