Keeping Communities Safe With Environmental Testing

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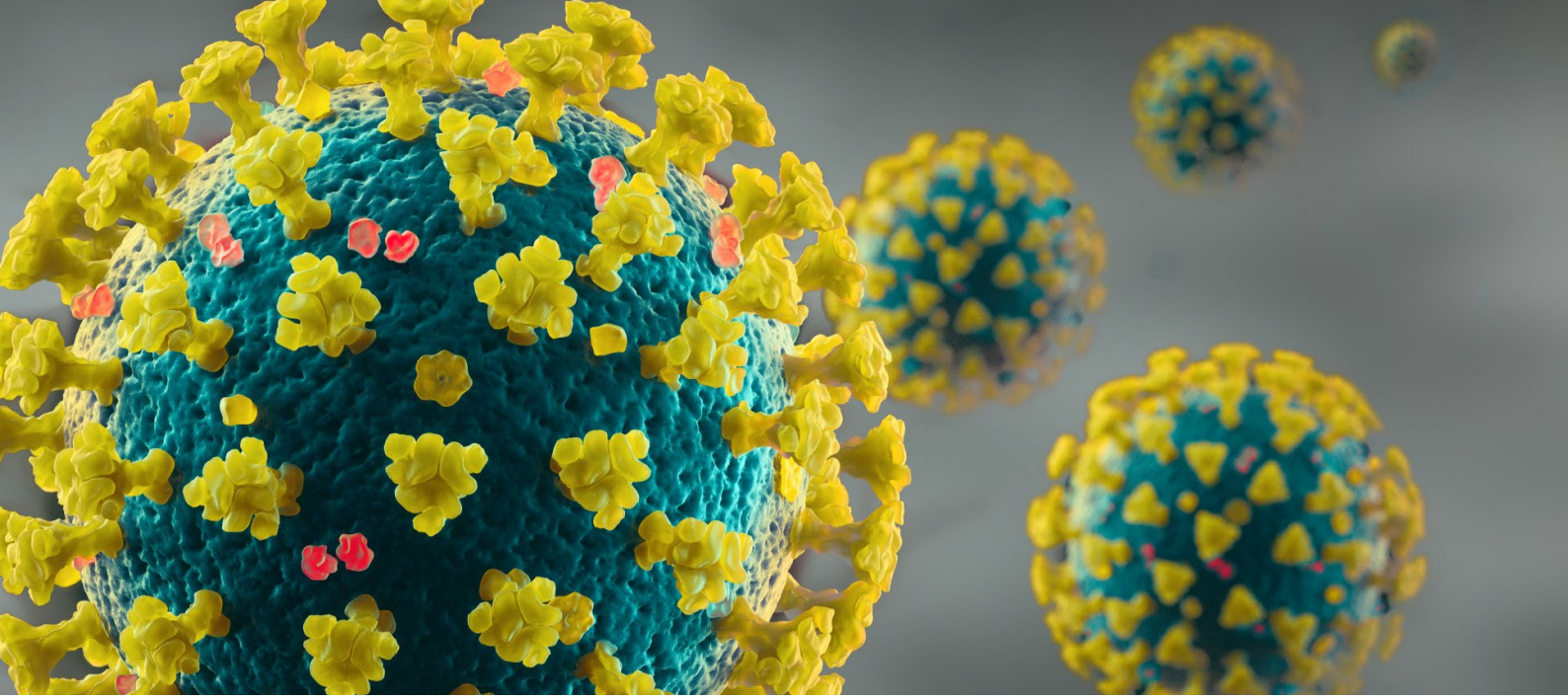
Environmental Testing Can Equip the Public Health System With Better Means to Monitor and Curb the Spread of Infectious Diseases.

From rapid antigen tests to gold standard RT-PCR assays, testing and contact tracing have become fixtures in our lives to help stave off the spread of COVID-19. After all, many of the symptoms like fever and sneezing overlap with other illnesses like the common flu. Not to mention, a large proportion of cases hardly show any symptoms at all.

With in-person activities like events and schooling now starting back up, health experts and authorities are hoping to keep disease transmission low even as restrictions ease. Flagging surges in COVID-19 cases is vital to initiating a quick and effective public health response, such as by imposing localized lockdowns or increasing testing efforts in the area.

But without proper surveillance systems in place, the virus can stealthily spread through communities. To this end, the answer may lie in moving beyond individualized screening to broader environmental testing—supplementing clinical diagnoses with community-wide health monitoring.



Scanning the Air

Testing is no doubt key to diagnosing COVID-19, but such risk mitigation efforts remain only as effective as the extent of coverage. But this may be inaccessible especially for low-income households, who may opt to forego testing for fear that a positive diagnosis would keep them from work or add to their expenditures.

Even in communities with good testing capabilities, preventing infection isn't as simple as getting a negative result. One challenge is that SARS-CoV-2, the viral agent causing COVID-19, spreads through the air and viral particles can linger for a long time in areas without proper ventilation.

Given this airborne mode of transmission, Indonesia-based microbiome and microbial diagnostics company Nusantics partnered with lab solutions provider Sartorius to test whether monitoring air quality is a viable strategy for detecting SARS-CoV-2 and informing health policies.

The team developed the AirScan protocol for quantifying SARS-CoV-2 using Sartorius' MD8 Air Sampler to capture the air and Nusantics' mBioCoV-19 RT-PCR kit to detect the viral genetic material. They first simulated viral emission in a chamber and found that accurate detection is possible as far as 12 meters from the source and as low as three SARS-CoV-2 genome equivalent copies per liter of air.

"The MD8 Air Sampler's combination of gelatine filters as well as adjustable flow rate and collection time to ensure that we collect the precise amount of air for SARS-CoV-2 quantification," said Mr. Revata Utama, Co-founder and Chief Technology Officer of Nusantics.

Sartorius' MD8 Air Sampler was set up in a local cinema to capture the air and enable detection of viral particles. (Photo: Sartorius)

These properties led to a high retention efficiency and efficient recovery of the viral particles, essentially preventing SARS-CoV-2 particles from flowing out of the MD8 container and facilitating detection via RT-PCR. Previously, Sartorius' scientists and collaborators designed the gelatine filters to collect airborne microbes including the seasonal influenza (H3N2) virus, with the MD8 instrument later on being used in air monitoring protocols during the MERS-CoV outbreak.

The effectiveness of the protocol was further validated by testing it in various environments, including a local mosque, cinema and school campus. Given the differences in air flow and the location's size, the team adapted by dividing the space and deploying a sampler in each subarea, leading to effective capture and accurate quantification of SARS-CoV-2 particles. Read more about the project by downloading the application note here: *Validation of an Airborne SARS-CoV-2 Surveillance System in a Controlled Space, Cinema, and Mosque in Indonesia.*

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Director of the Microbiology and Molecular Epidemiology Division at NEA

By monitoring the air quality, the team also developed a COVID-19 Infection Risk Index, similar to an alert level system to guide decisions on lockdowns and other pandemic measures. Utama explained that these environmental surveillance efforts, coupled with individual testing and other health protocols, can pave the way for reopening the economy while minimizing the risk of COVID-19 exposure—allowing people to enjoy more activities without compromising their safety.

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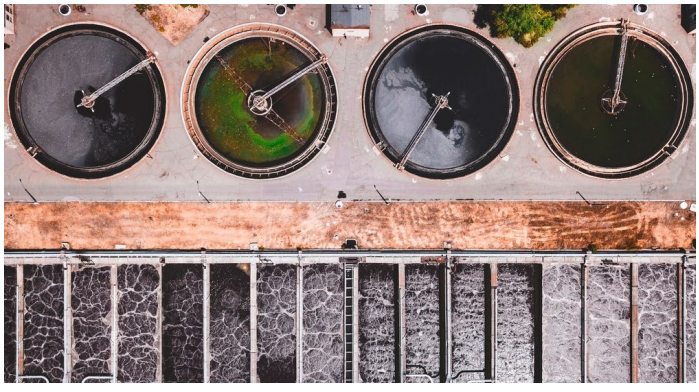

Pathogens detected in wastewater can be useful for monitoring disease spread in a community. (Photo: Ivan Bandura/Unsplash)

Testing the Waters

The value of environmental monitoring isn't limited to airborne illnesses like COVID-19. A myriad of diseases such as dengue and parasitic infections are linked to poor sanitation. Accordingly, various methods are already being used to detect the presence of pathogens in wastewater and drinking water, primarily to ensure access to clean and safe water.

Scientists have also recognized the value of wastewater testing in monitoring the spread of infectious diseases. Drinking contaminated water, for example, can lead to waterborne illnesses like giardiasis, marked by diarrhea and vomiting.

In the early days of the COVID-19 pandemic, Singapore's National Environment Agency (NEA) quickly launched wastewater surveillance studies and developed protocols to help reduce the risk of transmission in the community.

"We knew from the 2003 SARS outbreak that coronaviruses can be found in stools of individuals, so we initiated wastewater surveillance to assess the COVID-19 situation and guide decisions on targeted clinical testing," explained Dr. Judith Wong, Director of the Microbiology and Molecular Epidemiology Division at NEA.

In a high-risk neighborhood, for example, wastewater monitoring detected viral presence in the sewage system. Although none of the residents in quarantine had reported symptoms, one positive case was found upon clinical testing.

Wong highlighted that such early case detection shows the value of wastewater testing in aiding infection control strategies. Moreover, the method provides relevant data regardless of people's health-seeking behavior and current clinical testing guidelines.

"It provides an additional indicator of the prevailing infection rate. For example, an increase in viral load in the wastewater may suggest an increase in infections, whereas a decrease in viral load may suggest that the intervention measures are working," Wong said.

Starting from eight sites in May 2020, the NEA has expanded its wastewater surveillance coverage to 440 sites—proving to be a critical component of Singapore's fight against the pandemic. The strategy has also shifted from early case detection in high-risk areas, to providing situational awareness to achieve COVID resilience across the city-state. The current protocol is also able to detect emerging variants, when the virus load is sufficient.

"With research and development, the wastewater surveillance systems set up for COVID-19 could potentially be expanded to other infectious diseases," Wong concluded. "These surveillance programs are important for safeguarding public health in the long term."

Advancing Health Monitoring

Whether air or water, environmental monitoring can importantly enable disease detection on a much larger scale. These surveillance systems also provide insight into trends such as sudden case surges, acting as a separate yet accurate metric regardless of the public's participation rate in clinical testing. Equipped with near real-time awareness of rapidly changing situations, health authorities can make better decisions and quickly pivot to implement appropriate public health protocols.

Given that public health and the environment are constantly entangled, the World Health Organization has actively pushed for a One Health Approach to effectively intervene against disease spread. Bridging various sectors from medicine to policymaking, this framework recognizes the interdependence of human health and planetary health—making environmental monitoring all the more crucial an endeavor for achieving better public health outcomes.

With stronger health surveillance systems, communities can better fight the ongoing pandemic and elevate public health practice against infectious diseases as a whole.

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