Tracking SARS-CoV-2 in wastewater

DETAILS

SECTOR | Water

STAGE | Operations and Maintenance

TECHNOLOGIES | Virus detection, Pandemic management

SUMMARY

Covidtech covers a new wave of technologies aimed at detecting, testing for and tracking SARS-CoV-2, the virus causing the Covid-19 pandemic. Tracking of the virus in wastewater (domestic sewage) can monitor its presence at a community-wide level. Traditionally the presence of viruses in wastewater is tested in a laboratory. Samples are taken from the sewerage system and tested using standard techniques. The advent of COVID-19 has led to several new technologies being developed to aid or speed up this process. One such aspect is the use of digital tech to manage the spatial data being produced. Emerging technologies are also be developed to perform rapid wastewater tests in the field with portable test kits or faster laboratory tests.

These technologies are being developed to aid public authorities in controlling the pandemic through a better understanding of the virus presence and movement. There is increasing evidence for the presence of SARS-CoV-2 virus in untreated domestic wastewater. Wastewater based epidemiology (WBE), or sewer surveillance, is an approach using analysis of wastewater to identify the presence of biologicals or chemicals relevant for public health monitoring. WBE is not new, as wastewater has previously been used to detect the presence of pharmaceutical or industrial waste, illicit drug use (opioid abuse), viruses and potential emergence of antibiotic resistant organisms. This tool is now being used to track COVID-19 outbreaks in many regions of the world.

Detection and tracking of SARS-CoV-2 needs to be timely to be effective. Testing entire populations is difficult from many perspectives. Not everyone presents symptoms to alert the need for testing. Some people choose not to be tested or a testing facility may not be available. Although WBE cannot identify which individuals have been infected, it is much more cost-effective in obtaining population-wide data, complementing increased clinical testing to identify hotspots and enabling early warning signals of a COVID-19 outbreak in localised regions or populations. The use of WBE is also effective as the virus can be identified in wastewater before symptoms occur in the population.

The desired outcome is to provide health officials with up to date information on the spread of SARS-CoV-2. The digital tools can estimate the number of infections upstream of the sample and also then direct wastewater sampling to the most strategic locations. This can then lead to efforts to contain the virus such as increased testing, community hotspot alerts, and localised restrictions.

There are many ways in which Covidtech is developing. One of these is in the detection of SARS-CoV-2 where rapid field test kits are being developed to allow field staff to obtain results in under an hour while on site. Lab

tests are moving to enhance many aspects of the laboratory method to speed up the process. As more data becomes available and as our understanding of the virus improves, digital technologies will be further developed and provide more useful information.

VALUE CREATED

Improving efficiency and reducing costs:

- Wastewater based epidemiology allows health officials with the help of water utilities to track and monitor Covid-19 at a community level. There are efficiencies here because it does not rely on every person getting tested to have an understanding of community levels of infection. Individual testing is important to help limit the spread.
- The use of digital WBE tools makes the tracking of COVID-10 more efficient as data can be compiled, visualised and evaluated centrally. Digital tools also promote collaboration across regions.

Enhancing economic, social and environmental value:

- WBE for detecting and tracking the presence of SARS-CoV-2 in wastewater has social value as a tool that can be used by health authorities to understand the impacts that various measures have on virus numbers. The expansion and contraction of social restrictions can be tested against the viral numbers in wastewater.
- Efforts to reduce the effects of the virus on economies around the word will have a flow on effect to reduce costs across a range of areas e.g. medical care, government stimulus, etc.
- Similarly, better control of the virus will reduce the impact on people's livelihoods and their physical and mental health.

POLICY TOOLS AND LEVERS

Legislation and regulation:

Funding and financing: Wastewater based epidemiology programs require funding to be undertaken due to the volume of testing performed and the geography involved which may be city, state or nationwide. The source of funding will depend on the organisation undertaking the works. Wastewater samples are typically taken by water authorities. Testing is undertaken by independent or government laboratories. Collation of data and the use of digital tools as an emerging field, is undertaken by health/research institutions with assistance from private organisations. The overarching programs being run are typically government led so funding can allocated to the overall program and then reallocated to individual elements are they are undertaken. Where programs are collaborative, a split of funding contributions can be established.

Effective institutions: The planning, testing, collection and assessment of data requires a coordinated approach to make effective use of a WBE program. This is typically performed by a state or national health department, research institutes or private organisations offering services. Many programs are collaborative in nature due to the many stakeholders involved in the process.

Transition of workforce capabilities: Given the short timeframe required for implementation during the Covid-19 pandemic, workforce capabilities need to used as they currently stand. Workforce priorities may be required to change, to be allocated to new roles or take on new tasks required. For example, this might include taking additional sewage samples for testing that was not performed prior to the pandemic. The techniques used by laboratory staff are well established, but as new technologies emerge, some transition may be required. Operational staff who are taking on non-clinical or non-laboratory technologies will require training in the operation of such technologies to ensure their correct use.

IMPLEMENTATION

Ease of Implementation

WBE programs are not difficult to implement as has been evidenced by several programs running starting up recently across the world. Many of these programs have been established quickly for COVID-19 monitoring. Many countries have run previous WBE programs to track parameters such as other viruses or illicit drugs.

Cost

The digital technologies vary as some are offered as pro bono whereas others are commercial offerings. The cost of WBE programs overall depend on how much testing is done. Large programs of sampling require large investment in labour to gather samples, and laboratory time and materials for testing.

Country Readiness

Digital tools for WBE can be applied in any country as they are hosted online. The data that is fed into the digital tools may be more limited to those countries with the resources and budget to gather and test wastewater. The analysis of wastewater samples is dependent on a laboratory's ability to prepare samples and test for SARS-CoV-2.

Technological Maturity

Wastewater based epidemiology is a mature concept having been using to track other substances. The virus testing in laboratories uses proven mature methods. The latest digital tools are in pilot or early commercial phases. Elements along the value chain are being developed through research and development in response to the pandemic. It is expected that new technologies will have a faster route to maturity due to the need to find and develop solutions.

RISKS AND MITIGATIONS

The use of digital tools to track SARS-CoV-2 carries almost no risk. Wastewater base epidemiology is well established and the adaptation of it to this application bears no extra risk. The sampling of wastewater does have typical risks for wastewater network operators and for handling sewage.

EXAMPLES

Example	Implementation	Cost	Timeframe
GoAigua Sewer Surveillance System	A proprietary big data platform to synthesize automatic sampling results with data from utility networks and measure the spread of COVID-19 across city districts in real-time.	Cost depends on the size of a utility's program. There is an initial consulting fee plus monthly instalment for the app. Specific pricing is on a case by case basis.	Knowledge transfer to laboratory technicians typically takes 4-6 weeks; Setting up the sampling plan and protocols takes about 2-3 weeks; Integrating the tool with the utility systems and lab results is other 4 weeks approx.
Water Research Australia - ColoSSoS	The sewage surveillance project will track and monitor the presence of the virus that causes COVID-19 and its persistence in the Australian sewerage network, thus providing information on where it is present in the population.	The project was collaboratively funded by 12 participating organisations.	The project commenced with a short lead time in response to the pandemic, and is ongoing to track SARS-CoV-2 over time.
BioBot	Provides communities with a dynamic virus map of the spread to new areas and a reduction in established hotspots. Workers on the ground collect samples and mail them to Biobot for lab analysis. Biobot estimates each area's COVID-19 density by searching for traces of the virus's RNA.	Sampling kits and shipping costs are approximately US$120/€106 per sample. Approximately US$1,000/€888 per sample to run the lab test.	The project commenced with a short lead time in response to the pandemic, and is ongoing to track SARS-CoV-2 over time.

CONTACT INFORMATION

Pablo Calabuig	GoAigua	pablo.calabuig@go-aigua.com	CEO
Kelly Hill	Water Research Australia	kelly.hill@waterra.com.au	Research Manager
Newsha Ghaeli	BioBot Analytics	newsha@biobot.io	President