

COVID-19 – The What and Why of Sewage Surveillance

Introduction

Sewage testing has long been successfully used in the population-wide surveillance of infectious diseases such as poliovirus, hepatitis A, typhoid, and norovirus, particularly in early detection of outbreaks and complementing routine surveillance in cost-effective ways. Viruses and other pathogens are commonly found in wastewater, and hence the testing of wastewater for viruses is a routine exercise undertaken by water utilities.

The current global coronavirus pandemic (COVID-19) is a respiratory disease caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) virus. The SARS-CoV-2 virus belongs to a group of viruses that have a fragile lipid envelope, meaning that they are not associated with waterborne disease transmission. Studies have confirmed that people have COVID-19 will shed the virus into the wastewater system through handwashing, used tissues, and through their stool. We also know that people may continue to shed the virus for several weeks beyond their infectious period.

By monitoring wastewater for the virus, we are able to support health agencies in their response to the current pandemic by providing reliable and robust data on the presence of SARS-CoV-2 in wastewater catchments and by sharing knowledge among the global community.

SARS-CoV-2 Detection in Wastewater

Coronaviruses are a large and diverse family of viruses. The name 'corona' comes from their round appearance and the spikes on their surface that can be likened to a solar corona (Figure 1(a)).

Coronaviruses have a fragile lipid membrane, containing a single-strand of RNA that holds the virus genome. When this lipid envelope is destroyed, the virus protein is unable to attach to a host cell in humans.

When looking for the virus in wastewater, scientists look for the fragments of genetic information that indicate the presence of SARS-CoV-2 in its incapacitated (Figure 1(b)) or degraded (Figure 1(c)) form.

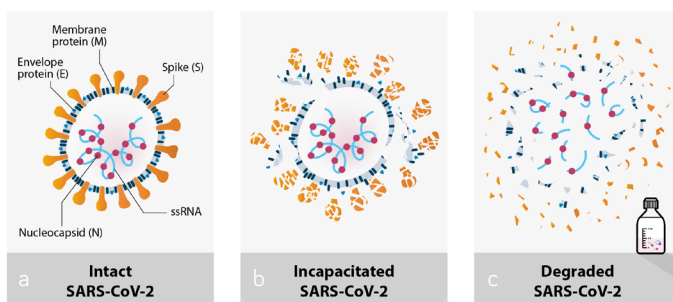


Figure 1(a) SARS-CoV-2 structure; (b) Incapacitated SARS-CoV-2, (c) Degraded virus used in the analysis of sewage

The ColoSSoS Project

Wastewater monitoring and wastewater-based epidemiology (WBE) have long been used to help inform broader infectious disease epidemiological surveillance and mitigation efforts. Over time, these efforts have led to the development of standardised methods for testing wastewater and numerous reviews have compared such methods. These methods have formed the basis for the COVID-19 sewage surveillance efforts.

The Collaboration on Sewage Surveillance of SARS-CoV-2 (ColoSSoS) Project is a national collaboration between state health departments, water utilities, universities, and other industry partners, co-ordinated by Water Research Australia. The purpose of this research is to inform development and trialling of a state-wide programs encompassing the sampling of sewage, laboratory testing, and analysis for SARS-CoV-2, as well as the interpretation of results and their integration with COVID-19 disease case data.

Since its inception, the project has successfully and rapidly developed sampling, processing and laboratory testing methods for sewage surveillance. The research is continuing to ensure initial detection methods used are robust, sensitive, specific and comparable, while also identifying any improvements that can deliver greater efficiency and ease of implementation.

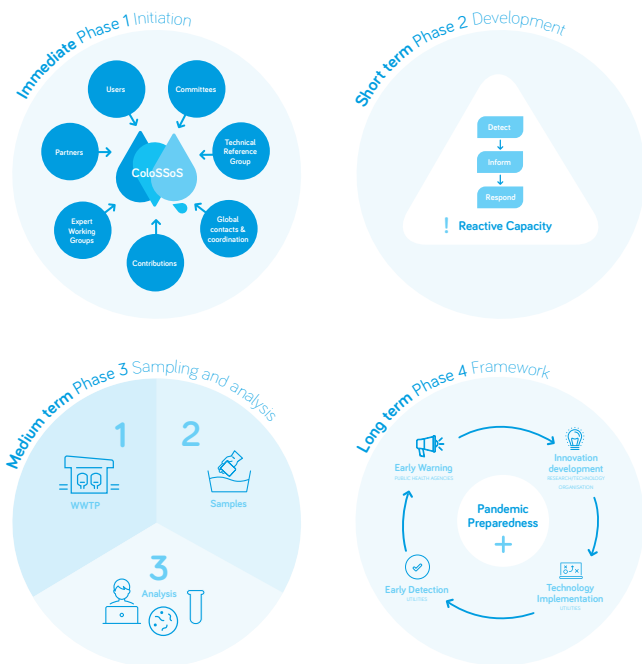
Sewage Surveillance Key Points

- Wastewater monitoring can give a snapshot of the possible presence of SARS-CoV-2 - the virus that causes coronavirus (COVID-19) - in a local area.
- The SARS-CoV-2 virus is present as viral RNA fragments in wastewater. These fragments do not pose a threat to human health.
- Samples are taken from numerous metropolitan and regional locations across Australia, and correlations drawn to known active or recent cases in specific areas.
- Understanding when and where an outbreak is likely to occur can assist governments in channelling their efforts.
- This research aims to inform and assist the current pandemic response and increase future pandemic preparedness.

The Research

The anticipated outcome of the sewage surveillance project is to develop a robust framework for rapidly instituting sewage surveillance for future outbreaks in order to assist the public health response.

The current ColoSSoS project is being delivered in four phases:



Phase 1: Initiation

This phase saw the scoping of the project and rapid formation of a project team that consists of project partners, technical reference groups, expert working groups, and other users as well as local and global contributors. Task groups were formed to utilise the specialist skills in distinct activities.

Phase 2: Development

The development phase involved ensuring that analytical methods were sufficiently robust to move to their routine application. Early samples collected were used and preliminary assessments provided to local, state, and national health departments. Existing known standard methods were adapted to the current context.

Phase 3: Sampling and analysis

Routine and ad-hoc sampling is undertaken from a list of sites in order to understand the association between sewage data and notified cases of COVID-19. This also verifies the sensitivity and specificity of sewage testing as a diagnostic test. Adequate quality assurance and control processes are developed to ensure consistency across sampling and analysis locations.

Phase 4: Framework

Development of a framework for early detection and co-ordination with public health agencies to complement public health responses based on lessons learned from the current research. This will increase the national level of pandemic preparedness.

Opportunities for Public Health

Positive Detection of Coronavirus – what does it mean?

An important step in the sewage surveillance process is integrating the wastewater data with clinical testing results to confirm whether or not the detection is consistent with known cases in a particular area. Because a positive detection is indicative of someone who has or has recently had COVID-19, if there are no known cases in the area, it may indicate that there are people within the community who have not been diagnosed, or it may be due to a visitor to the area. For this reason repeated testing is necessary – a repeated positive result would indicate that the source of the detected virus is from a member of the community and not a visitor to the area.

Targeting specific sites

Targeted sewage surveillance has the potential to be used to follow-up and support contact tracing, identifying and assessing potential hotspots. It is possible to track at a finer scale, such as specific:

- sewer catchments;
- sewer sub-catchments;
- buildings or large facilities;
- transport vessels.

Public Health Response

Understanding when and where an outbreak is likely to occur can assist governments in channelling their efforts, for example, in promoting prevention messages such as hand hygiene and physical distancing, or in campaigns to encourage members of the community to get tested for COVID-19.



Further information / references

Hill, K., Zamyadi, A., Deere, D., Vanrolleghem, P.A., and D. Crosbie, N.D., SARS-CoV-2 known and unknowns, implications for the water sector and wastewater-based epidemiology to support national responses worldwide: early review of global experiences with the COVID-19 pandemic.

Victoria State Government Department of Health and Human Services – Wastewater testing may provide early warning of coronavirus (COVID-19), 2020. <https://www.dhhs.vic.gov.au/wastewater-testing-covid-19>

FREQUENTLY ASKED QUESTIONS

Why is sewage surveillance being undertaken?

Wastewater monitoring can give health authorities an indication of whether or not SARS-CoV-2 is present in a local area, particularly in instances where clinical data may not yet be available to highlight the presence of infection. This may give health authorities an indication of when cases may spike ahead of such spikes being detected, improving response preparedness.

Where is sampling being undertaken?

Sampling is currently being undertaken across a diverse range of metropolitan and regional sites. The research protocol allows for adaptive targeted sampling to be undertaken at sites that are at a potential higher risk of an outbreak, where it is deemed to be beneficial.

How are wastewater samples taken and tested?

Wastewater is routinely sampled for testing by utility operators using a variety of standard methods. These may include taking a one-off “grab” sample, a “composite” sample over several hours, or using an instrument called an “autosampler”. The sampling protocols for the ColoSSoS project adhere to strict health and safety procedures and are only undertaken with the correct authorisations from the owner of the network being sampled.

Once obtained, samples are sent to a laboratory where genetic sequencing methods are used to detect the presence of coronavirus in the wastewater.

Are any other countries doing sewage surveillance?

Numerous countries are already undertaking similar research, such as the USA, Europe (Germany, Spain, UK, France, Switzerland, Netherlands), and NZ. We are very well linked in to this international community and will continue to keep abreast of latest international developments.

Will wastewater testing replace other testing for coronavirus (COVID-19)?

No. Wastewater testing is being developed as a tool to complement the existing public health response and testing of people.

If there are viral fragments in wastewater, does this mean that wastewater, recycled water or treated wastewater poses a public health risk?

There is no evidence that coronavirus is transmissible via wastewater systems. There is also no evidence that coronavirus (COVID-19) can be spread via recycled water nor via treated wastewater released to waterways. The samples taken for this surveillance work is taken at the inlet of wastewater treatment plants – the existing standard treatment processes that wastewater goes through are effective for the coronavirus.



Is my drinking water safe from coronavirus?

There is no impact on your local water supply from wastewater testing. Drinking water supplied by water utilities is safe to drink and for normal household uses.

The current evidence indicates that the virus is most likely transmitted from person-to-person by:

- close contact with an infectious person;
- contact with droplets from an infected person's cough or sneeze;
- touching objects or surfaces (like doorknobs or tables) that have cough or sneeze droplets from an infected person, and then touching your mouth or face.

For further guidance on appropriate precautions and information relating to hygiene, water and sanitation for coronavirus (COVID-19), see www2.health.vic.gov.au/about/publications/factsheets/hygiene-water-sanitation-covid19

Where can I find more information about the project?

To find out more information about the project, please visit WaterRA's COVID-19 Community of Interest page: www.waterra.com.au/research/communities-of-interest/covid-19/

For media enquiries, please email press@dhhs.vic.gov.au