



COVID-19 and Sanitation, Wastewater & Water Literature Review

Administrative Staff College of India | Centre for Innovations in Public Systems

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ABSTRACT

Safely managed water, sanitation, and hygiene (WASH) services are essential for protecting human health and preventing infectious disease outbreaks such as COVID-19. The pandemic has brought the importance of investing in core public health infrastructure, including water and sanitation systems into the centre of discussions. Having said this, currently there is limited understanding about transmission of COVID-19 through water, human waste and wastewater and what waste management practices can serve as barriers to human-to-human transmission of the virus in homes, communities, health care facilities, schools, and other public spaces.

The Administrative Staff College of India is aiming to find answers to several questions that regarding the linkage, prediction and prevention of COVID-19 with water, sanitation and wastewater. These questions range from transmission routes, monitoring, safety protocols and PPE:

- Can virus persist in septage, deep row trenches and sludge drying beds? And if so, then how long? Is there evidence that suggests/asserts the faecal-oral transmission of SARS-COV2?
- What are the medium and long term systems' (governance, administration, training /CB (war games), changes in designs, retrofits) measures that need to be in place for managing similar outbreaks in future?
- What are the possible transmission routes (Hygiene, Solid /hazard waste, wastewater – sewage, wastewater- combined, sewage network, drainage/nallah system, STP/FSTP) from various population /facilities (eg. apartments, hospitals, community, and public toilets etc)?
- Based on the above understanding what would be Public Health response elements/strategies for risk assessment, risk management and risk communication?
- What are the changes that needs to be incorporated in existing water and wastewater treatment plants/ solid waste management/ manual handling of septage and sewage to make it pandemic resilient?
- What are the technological interventions required to overcome COVID challenges on sustaining WASH service delivery?
- What are the Dos and Don't about such activities like what chemicals should be avoided, dilutions etc.?
- Given that people infected with the virus are also found to be asymptomatic for few days, are there any changes required in current processes of treatment of faecal waste?
- What kind of safety protocols are to be followed while providing faecal waste desludging services particularly to facilities such as isolation zones/ units?
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- What type of personal protective equipment (PPE) is to be used by sanitary workers depending on their job type?

This document enlists and summarises the current understanding, research and evidence on (a) detection of COVID-19 in drinking water, sewage system, and human waste (b) measures for early detection and predicting spread, (c) the conditions that influence how long the virus remains active, (d) affordable rapid testing options (e) need for safety protocols and so on.

Studies conducted so far have not found traces of COVID-19 in drinking water. Traces of coronavirus are found in faeces however the risk of transmission of the virus from faeces is not yet known and could potentially be low, basis the experience and data from earlier outbreaks like SARS and MER. Traces are detected in waste water and conventional municipal wastewater treatment methods (like filtration, Chlorine or UV light) may be enough to inactivate coronavirus in sewage. Hence, most of the treatment plants routines can kill or remove the coronavirus from both drinking water and wastewater. PPE and hygiene precautions by sanitation workers are essential and enough to protect from COVID-19.

Wastewater surveillance may represent a complementary approach to measure the presence and even prevalence of infectious diseases when the capacity for clinical testing is limited. Wastewater testing could also be used as an early-warning sign if the virus returns. The research suggests that number of COVID cases can increase with a sewage leak that carries the infection. Hence monitoring for leakages needs to be strengthened. Further, health care facilities that are not connected to sewage systems need to take special precautions to prevent ground water contamination.

Basis the findings from the studies so far, it is observed that waterboards in various cities of India, like Hyderabad, Bangalore and Kolkata have stated taking precautions of disinfecting the sewage from COVID-19 virus.

The studies and publications referred to are listed overleaf.

LIST OF PUBLICATIONS

Journals/Research papers

1. **Water, sanitation, hygiene and waste management for COVID -19 Virus** (World Health Organisation, Technical Brief). Pg. 7-8
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8. **How sewage could reveal true scale of coronavirus outbreak** (Nature, news article). Pg. 19-20
9. **SARS-CoV-2 titer in wastewater are higher than expected from clinically confirmed cases** (MEDRXIV, Research paper – preprint). Pg. 21-22
10. **Virus can spread through Sewage systems says CPCB in latest guidelines** (The New Indian Express, news article). Pg.23
11. **Low-cost, paper-based device being developed for rapid coronavirus detection** (Mongabay, article). Pg. 24
12. **SARS-CoV-2 viruses detected for the first time in domestic water** (DERSTANDARD, news article). Pg. 25
13. **Waster and COVID-19 FAQs: Information on COVID-19 in drinking water, recreational water and wastewater** (CDC, article). Pg..26-27
14. **Does COVID-19 virus survive in sewage? Bangalore citizens group asks in report** (The News minute, newspaper article). Pg.28
15. **Tracking the course of pandemic in wastewater** (eawag, article). Pg.29-30

16. **Sewage maybe a potential COVID source** (The Hindu, newspaper article). Pg.31
17. **Sewage samples could help scientist find coronavirus outbreak before they begin** (NOWCAST, newspaper article). Pg.32
18. **Coronavirus: Sewage study should predict second COVID-19 peak** (Fr24 news, newspaper article). Pg.33
19. **Wastewater testing could help track COVID-19** (University of Maryland, article). Pg.34
20. **Traces of coronavirus found in sewage in Gujarat** (Hindustan, article). Pg.35
21. **COVID 19 sample for months before 1st outbreak in Wuhan, found in Barcelona water** (Daily Sabah, newspaper article). Pg. 36



Journal/Research papers

Technical Brief - 19th March 2020
World Health Organization

Water, sanitation, hygiene, and waste management for Covid -19 virus

Source: <https://www.who.int/publications-detail/water-sanitation-hygiene-and-waste-management-for-covid-19>

The technical brief by WHO supplements the earlier documents on infection prevention and control (IPC). It refers to and summarizes WHO guidance on water, sanitation and health care waste relevant to viruses, including coronavirus. The provision of safe water, sanitation, and hygienic conditions is essential for protecting human health during all infectious disease outbreaks, including COVID – 19. Ensuring good and consistently applied WASH and waste management practices in communities, homes, schools, marketplaces, and health care facilities helps prevent human-to-human transmission of COVID-19 virus.

According to the document, there is no evidence about the survival of the COVID-19 virus in drinking-water or sewage. The COVID-19 is an enveloped virus which is less stable in the environment and is easily affected by oxidants, like chlorine. It quotes a study that reports COVID-19 surviving for 2 days in dechlorinated tap water and in hospital wastewater at a temperature of around 200 C. On the other hand, laboratory studies of surrogate coronavirus indicated that the virus could remain infectious for several days to even weeks in water contaminated with faeces.

Some of the findings presented point out that conventional water treatment methods that use filtration and disinfection could inactivate COVID-19 virus and that COVID-19 seems to be sensitive to chlorine and other oxidant disinfection as well as to UV light. The document advises that risks pertaining to the adequacy of the collection system or to treatment and disposal methods should be assessed following a safety planning approach, with critical control points prioritized for mitigation. For example if health care facilities are connected to sewers then a risk assessment should be conducted to confirm that wastewater is contained within the system (that is, the system does not have leakages) before its arrival at a functioning safe treatment or disposal site, or both. Similarly, best practices for protecting the health of workers at sanitation treatment facilities should be followed.

The document emphasizes the importance of preventing contamination of the environment by excreta, especially for groundwater. Specifically, it mentions the

need for health facilities not connected to sewage system to ensure maintaining 1.5 meters between the bottom of the pit and the groundwater table.

In situations of high groundwater table or lack of space to dig pits, excreta should be retained in impermeable storage containers and left for as long as feasible to allow for a reduction in virus levels before moving it off-site for additional treatment or safe disposal, or both. PPE (long-sleeved gown, gloves, boots, masks, and goggles or a face shield) should always be worn when handling or transporting excreta offsite, and great care should be taken to avoid splashing during pumping out tanks or unloading desludging trucks.

Key takeaways

- A study found COVID-19 to be present in dechlorinated water and in hospital wastewater at 20°C for 2 days.
- A laboratory study stated that the virus could be potentially infectious in water contaminated with faeces for days or even weeks.
- Conventional treatment methods (like filtration, Chlorine or UV light) can potentially disinfect the virus from sewage.
- PPE and hygiene precautions by sanitation workers are essential to avoid contact with COVID-19.
- Health care facilities that are not connected to sewage systems should take special precautions to prevent ground water contamination.

Opinion Paper - 26th March 2020
Thomas Reuters Foundation News

Coronavirus- Wakeup call to ensure water & sanitation for all

Source: <https://news.trust.org/item/20200326104523-wfz4n>

Today, many people lack access to the most basic weapons to shield themselves from COVID-19: water and soap. UN-Water reports that 2.2 billion people around the world do not have safely-managed drinking water, while 4.2 billion go without safe sanitation services and three billion lack basic handwashing facilities. Furthermore, an estimated 896 million people use health care facilities with no water service and 1.5 billion use facilities with no sanitation service. These conditions present a constant source of stress and disease, particularly for vulnerable and marginalized communities where people sometimes need to skip bathing to save water for cooking.

As the virus moves to low-income countries and water scarce regions, there is a deep concern about the future of sustainable development and the impact it could have among vulnerable populations with no access to basic water services. With this in the background, we are unfortunately still trying to solve new problems with old solutions and our past experience turns to be our worst enemy about shifting our mind-set. We continue to work in silos; our policies are set without aligning objectives with the required resources; we count on public funds that are insufficient and poorly targeted; and the new sources of finance for water and sanitation constrained by regulatory, institutional and other barriers. Our ambitious strategies for water and sanitation services are hampered too often when they are not accompanied by proper consideration for how or by whom they will be implemented, and how they will be financed.

Safe water, sanitation and hygiene, collectively known as WASH, are crucial for human health and well-being. When the world moved from the Millennium Development Goals (MDG) to Sustainable Development Goals (SDG) in 2015, the governments set the WASH performance bar higher, shifting the target from basic to safely managed services. At a time when the world has acknowledged a grave need to significantly accelerate progress in achieving SDGs and climate-related targets, the COVID-19 outbreak should be a wake-up call for all of us that the economic and social costs of failure will likely be catastrophic.

A new paradigm is therefore needed that turns this approach on its head and changes the way we manage and finance water and sanitation. It is not only about money. Solving wicked water and sanitation problems requires creativity

and innovation to turn risks into opportunities; providing fit for purpose solutions; reducing the high level of non-revenue water in drinking water and agriculture,

providing strong governmental leadership and accountability; as well as recognizing the role of communities, acknowledging multiple knowledge cultures, and accepting the inevitability of uncertainty.

An acceleration framework for SDG number 6, 'water and sanitation for all', bringing together strengths of various stakeholders and strongly anchored to the acceleration of the SDGs in general, informed by the lessons learned during the COVID-19 crisis, will be an essential tool for that.

Key takeaways

- There is a need for enhanced finance and leadership in the WASH sector.
- New problems cannot be solved with old solutions. There is a need to change mindset and take a holistic approach to problem solving.
- Need to accelerate achievement of water and sanitation related SDG goals
- Important for all the countries to go over their WASH finance and ensure that there is a safe distribution as well as safe water treatment methods (which includes treating SARS-CoV-2).

Research Summary - 03rd April 2020

Science daily

Removing the novel coronavirus from the water cycle

Source: <https://www.sciencedaily.com/releases/2020/04/200403132347.htm>

Two researchers, Haizhou Liu, an associate professor of chemical and environmental engineering at the University of California, Riverside; and Professor Vincenzo Naddeo, director of the Sanitary Environmental Engineering Division at the University of Salerno, have called for more testing to determine if water treatment methods are effective in killing SARS-CoV-19 and coronaviruses in general. During a 2003 SARS outbreak in Hong Kong, a sewage leak caused a cluster of cases through aerosolization. Though no known cases of COVID-19 have been caused by sewage leaks, the novel coronavirus is closely related to the one that causes SARS, and infection via this route could be possible.

The novel coronavirus could also colonize biofilms that line drinking water systems, making showerheads a possible source of aerosolized transmission. This transmission pathway is thought to be a major source of exposure to the bacteria that causes Legionnaire's disease, for example. Fortunately, most water treatment routines are thought to kill or remove coronaviruses effectively in both drinking and wastewater. Oxidation with hypochlorous acid or peracetic acid, and inactivation by ultraviolet irradiation, as well as chlorine, are thought to kill coronaviruses. In wastewater treatment plants that use membrane bioreactors, the synergistic effects of beneficial microorganisms and the physical separation of suspended solids filter out viruses concentrated in the sewage sludge.

They also suggest upgrading existing water and wastewater treatment infrastructure in outbreak hot spots, which possibly receive coronavirus from places such as hospitals, community clinics, and nursing homes. For example, energy-efficient, light-emitting, diode-based, ultraviolet point-of-use systems could disinfect water before it enters the public treatment system.

Potable water-reuse systems, which purify wastewater back into tap water, also need thorough investigation for coronavirus removal, and possibly new regulatory standards for disinfection, the researchers wrote. The extent to which viruses can colonize biofilms is also not yet known. Biofilms are thin, slimy bacterial growths that line the pipes of many aging drinking water systems. Better monitoring of coronaviruses in biofilms might be necessary to prevent outbreaks. The surge in household use of bactericides, virucides and disinfectants will probably cause an increase of antibiotic-resistant bacteria in the environment. Treated wastewater

discharged into natural waterways demands careful monitoring through the entire water cycle.

"It is now clear to all that globalization also introduces new health risks. Where water and sanitation systems are not adequate, the risk of finding novel viruses is very high," Naddeo said. "In a responsible and ideal scenario, the governments of developed countries must support and finance water and sanitation systems in developing countries, in order to also protect the citizens of their own countries."

Key takeaways

- The research suggests that number of COVID cases can increase with a sewage leak that carries the infection
- Novel coronavirus can also colonize biofilms that line the drinking water, but the same is yet to be confirmed.
- Most of the treatment plants routines can kill or remove the coronavirus from both drinking water and wastewater. An upgrade of their treatment plants may be required in the hotspot areas (like hospitals).

Research Paper – 21st April 2020

The BMJ

Viral load dynamic and disease severity in patients infected with SARS-CoV-2 in Zhejiang province, China, January-March 2020: Retrospective cohort study

Source: <https://www.bmj.com/content/369/bmj.m1443>

This research article presents the findings of a study of more than 3000 respiratory, blood, serum, stool, and urine samples collected daily over a period of 4 months from 96 patients with COVID-19 in hospitals in Zhejiang province in China. The study systematically estimated the viral loads and analysed the temporal change and the correlation between viral loads in different sample types and disease severity.

While previous studies have found that the peak load of SARS-CoV-2 in upper respiratory tract specimens was during the early stages of the disease; this study found that the duration of virus shedding in lower respiratory tract samples was longer, and peak viral shedding occurred after about two weeks from symptom onset. These findings are important for effective control and prevention of the epidemic as it suggests strict management of the whole disease process in patients with SARS-CoV-2. The study also found that the viral load in patients with severe disease was significantly higher than in patients with mild disease, suggesting that high viral load might be a risk factor for severe disease.

The duration of SARS-CoV-2 is significantly longer in stool samples than in respiratory and serum samples, highlighting the need to strengthen the management of stool samples in the prevention and control of the epidemic, especially for patients in the later stages of the disease.

Key takeaways

- The duration of SARS-CoV-2 is longer in stool samples than in respiratory and serum samples.
- It is important to strengthen the management of stool samples in order to prevent and control of the epidemic.

Journal Pre-proof – 26th April 2020
Science of total environment

SARS-CoV-2 in wastewater: State of knowledge and research needs

Source: <https://doi.org/10.1016/j.scitotenv.2020.139076>

The ongoing pandemic of coronavirus disease (COVID-19) caused by severe acute respiratory syndrome (SARS-CoV-2) has been a public health emergency of International concern, which was officially declared by the World Health Organization (WHO). Although the major transmission routes of SARS-CoV-2 are inhalation from person-to-person and aerosol/droplet transmission, currently available evidence indicates that the viral RNA is present in wastewater, suggesting the need to better understand wastewater as potential sources of epidemiological data and human health risks.

The researchers review the current knowledge related to the potential of wastewater surveillance to understand the epidemiology of COVID-19, methodologies for the detection and quantification of SARS-CoV-2 in wastewater, and information relevant for human health risk assessment of SARS-CoV-2. There has been growing evidence of gastrointestinal symptoms caused by SARS-CoV-2 infections and the presence of viral RNA not only in feces of COVID-19 patients but in wastewater.

The understanding on the potential role of wastewater in SARS-CoV-2 transmission is largely limited by knowledge gaps in its occurrence, persistence, and removal in wastewater. One of the major challenges in SARS-CoV-2 detection/quantification in wastewater samples is the lack of an optimized and standardized protocol. Current data is insufficient for conducting a quantitative microbial risk assessment (QMRA) for SARS-CoV-2 exposure pathways. However, modelling-based approaches have a potential role to play in reducing the impact of the ongoing COVID-19 outbreak, and QMRA parameters obtained from previous studies on relevant respiratory viruses help to inform risk assessments of SARS-CoV-2.

Key takeaways

- COVID-19 virus is traced in feces and also in wastewater (Sewage)
- One of the major challenges faced in detection/quantification of the virus in wastewater samples is the lack of an optimized and standardized protocol.
- There is a need to establish methodologies for wastewater surveillance

Research paper – 26th April 2020
Science direct – Water Research

Coronavirus in water environments: Occurrence, persistence and concentration methods – a scoping view

Source: <https://doi.org/10.1016/j.watres.2020.115899>

The recent outbreak of coronavirus disease 2019 (COVID-19) has become a public health emergency worldwide. SARS-CoV-2, the virus responsible for COVID-19, is spread by human-to-human transmission via droplets or direct contact. However, since SARS-CoV-2 virus has been found in the fecal samples and anal swabs of some patients, the possibility of fecal-oral (including waterborne) transmission need to be investigated and clarified.

This scoping review was conducted to summarize research data on COVID-19 in water environments. A literature review captures 12 relevant studies investigating three main areas:

- COVID persistence/ survival in waters
- COVID occurrence in water environments
- Methods for recovery of COVID from waters

The review states that SARS Coronavirus has been detected in wastewater but not as infectious particles. The data suggests that COVID seems to have a low stability in the environment and is very sensitive to oxidants, like chlorine and COVID appears to be inactivated significantly faster in water than non-enveloped human enteric viruses with known waterborne transmission. Temperature is reported as an important factor influencing virus survival.

There is no current evidence that coronaviruses are present in surface or ground wates or are transmitted through contaminated drinking-water. The authors call for further research to adapt to enveloped viruses the methods commonly used for sampling and concentration of enteric, non-enveloped viruses from water environments. The evidence-based knowledge reported in this paper is useful to support risk analysis processes within the drinking and wastewater chain (i.e., water and sanitation safety planning) to protect human health from exposure to coronavirus through water.

Key takeaways

- There is no evidence of coronaviruses transmission through contaminated water
- Coronavirus seems to have a low stability in the environment and is sensitive to oxidants like chlorine.
- Temperature is an important factor influencing viral survival.
- Coronavirus appears to be inactivated significantly faster in water than non-enveloped human enteric viruses with known waterborne transmission.



News articles

Article - 27th March 2020

National institute of public health and environment (RIVM)

Novel coronavirus found in wastewater

Source: <https://www.rivm.nl/en/news/novel-coronavirus-found-in-wastewater>

The novel coronavirus that causes COVID-19 has been detected in wastewater in the Netherlands, according to research by RIVM (National Institute for Public Health and the Environment) research. A small percentage of patients with COVID-19 have the novel coronavirus in their gastrointestinal tract, and thus excrete it in their faeces. When their stool is flushed down the toilet, it ends up in the sewer, and then in the wastewater. Research indicates that monitoring wastewater is a good strategy for detecting whether specific viral infections are present in a population. RIVM has previously used this approach to detect the presence of norovirus, antibiotic-resistant bacteria, the poliovirus and the measles virus in wastewater. Employees working in wastewater treatment plants are protected against viral infections, such as the coronavirus that causes COVID-19, should follow the hygiene protocols.

Using molecular methods, the virus that causes COVID-19 was detected in wastewater at Amsterdam Schiphol Airport, Tilburg and at the wastewater treatment plant in Kaatsheuvel. This plant is located in the Loon op Zand town, Netherlands where the first reported COVID-19 patient lives. From the 17 February 2020 on, weekly wastewater samples were taken at Schiphol Airport, for the first two weeks, the COVID-19 virus was not detected. However, the COVID-19 virus was detected in the airport wastewater samples which were taken on 2, 9 and 16 March. The first sample containing the virus was taken four days after the first person in the Netherlands tested positive for COVID-19 on 27 February. Similarly, other wastewater treatment plants in Kaatsheuvel showed the presence of COVID-19 in the sewage.

Previous research has shown that the protective measures that are already the standard for people working at wastewater treatment plants provide sufficient protection against pathogens. These measures are also effective against the virus that causes COVID-19. People who work with wastewater should avoid direct contact with wastewater, and should avoid ingesting, swallowing and/or breathing in wastewater spray or mist. During all activities that lead to possible contact with wastewater, they must wear personal protective equipment. Moreover, like everyone, wastewater treatment plant personnel must maintain good hand hygiene: wash hands according to protocol, do not touch eyes, nose

or mouth with unwashed hands, wash hands before eating and after each toilet visit, and use the inside of the elbow to cover sneezes or coughs.

Key takeaways

- In the Netherlands, after the first case of COVID-19 was clinically tested, immediate traces of the virus were found in different wastewater plants.
- PPE and hygiene precautions that have already been taken are enough for wastewater and sewage cleaners to protect from COVID-19

Article - 03rd April 2020

Nature

How sewage could reveal true scale of coronavirus outbreak

Source: <https://media.nature.com/original/magazine-assets/d41586-020-00973-x/d41586-020-00973-x.pdf>

Research groups across the world are analysing wastewater for traces of coronavirus to predict the total infections in a community, given that 100% testing is not feasible. So far, the traces of the virus in wastewater have been detected in studies conducted in the Netherlands, United States, and Sweden. Researchers are also analyzing wastewater for assessing the presence of virus and spread through urine or faeces.

According to Gertina Medema, a microbiologist at KWR Water Research Institute in Nieuwegein, Netherlands, monitoring wastewater at scale can provide good estimates for the spread of coronavirus as wastewater surveillance can account for even those who have not yet shown symptoms. Quantification of the scale of infection in a population from wastewater samples, requires information on the extent of viral RNA excreted in faeces and generalizing the number of infected people in a population from concentration of RNA in water samples.

Supporting this approach, Ana Maria de Roda Husman an infectious-disease researcher at the Netherlands National Institute for Public Health and the Environment states that virus control measures may control the pandemic but lifting of the measures could lead to reappearance of the virus. She therefore suggests routine wastewater surveillance as a non-invasive early-warning tool to alert communities to new COVID-19 infections. The institute has been involved in monitoring sewages for outbreak of norovirus, antibiotic-resistant bacteria poliovirus and measles. A study by de Roda Husman's group shows the traces of SARS-CoV-2 in wastewater at Schiphol Airport, Netherlands about four days after clinical testing of their first COVID-19 case.

Wastewater monitoring has been used for decades to assess the success of vaccination campaigns against poliovirus, says Gerba, an environmental microbiologist at the University of Arizona in Tucson. The approach could also be used to measure the effectiveness of interventions. Gerba reports finding traces of SARS-CoV-2 in raw sewage in Tucson.

Tamar Kohn, environmental virologist at the Swiss Federal Institute of Technology, Lausanne refers to the studies that have shown that SARS-COV-2 appears in faeces within 3 days of infection. This is faster than any clinical testing. Tracking

wastewater for the virus can therefore give a head start to public-health officials and support informed decision making, such as implementation of lockdown in a geographical area and so on. Early identification of the virus in a community might limit the health and economic damage caused by COVID-19, especially when reappearance is expected.

Key takeaways

- SARS-CoV-2 can be detected in faeces within 3 days of someone being infected.
- Routine monitoring of the sewage can be used as a non-invasive early warning tool for the virus.
- Wastewater testing could be used as an early-warning sign if the virus returns

Article- 07th April 2020

Medrxiv – The preprint server for health science

SARS-COV-2 titers in wastewater are higher than expected from clinically confirmed cases

Source: <https://doi.org/10.1101/2020.04.05.20051540>

The study tested wastewater collected at a major urban treatment facility in Massachusetts and found the presence of SARS-CoV-2 at high titers in the period from March 18 - 25 using RT-qPCR. The data available demonstrates the feasibility of measuring SARS-CoV-2 in wastewater. The implications of this research are that wastewater-based epidemiology (WBE) can be leveraged to detect population level prevalence of SARS-CoV-2 in cities across the world. In a setting where in-person testing may not be available, longitudinal analysis of wastewater can provide population-level estimates of the burden of SARS-CoV-2. These data may help inform decisions surrounding the advancement or scale back of social distancing and quarantine efforts based on wastewater catchment-level estimations of prevalence. Additionally, wastewater collection at the municipal or community level may allow for more granular detection of SARS-CoV-2 in cities with lower COVID-19 disease burden, thereby functioning as an early warning system to help pre-emptively enact public health measures prior to the widespread onset of disease.

The study states that the estimates of viral load in stool from positive patients are still a matter of uncertainty, but at least one recent publication suggests levels as high as 600,000 viral genomes per mL of faecal material. This number would suggest roughly 5% of all faecal samples in the treatment facility catchment were positive for SARS-CoV-2 in the March 18 – 25 period, a number much higher than the 0.026% confirmed for the state of Massachusetts on March 25. Another paper reported a maximum observed value close to 30,000,000 viral particles per mL in a single faecal sample. If the authors use this number instead, we would estimate a prevalence of 0.1%, closer to, but still much higher than the number of confirmed clinical cases. Additional data on viral shedding in stool over the course of disease is required to fully interpret these findings.

Key takeaways

- Traces of SARS-CoV-2 has been detected in wastewater treatment plants of Massachusetts

- Wastewater surveillance may represent a complementary approach to measure the presence and even prevalence of infectious diseases when the capacity for clinical testing is limited.
- Aggregate population-wide data can help inform modelling efforts.
- The data may help in decisions making of the advancement or scale back of social distancing and quarantine efforts based on wastewater catchment-level estimations of prevalence.
- Wastewater collection at the municipal or community level may allow the detection of SARS-CoV-2 in cities, thereby functioning as an early warning system to enact public health measures prior to the widespread of disease.

News Article – 21st April 2020

The new Indian express

Virus can spread through sewage systems, says CPCB in latest guidelines

Source: <https://www.newindianexpress.com/nation/2020/apr/21/coronavirus-can-spread-through-sewage-systems-says-cpcb-in-its-latest-guideline-2133093.html>

The guidelines issued by the country's top pollution watchdog say transmission to operators may be possible during treatment of sewage treatment plants (STPs) and has called for use of personal protective equipment (PPE). Issued by the Central Pollution Control Board (CPCB), the Guidelines for handling, treatment and disposal of waste generated during treatment/diagnosis/ quarantine of COVID-19 patients also says that while “minuscule traces” of coronavirus in non-potable water like water supply used for cleaning streets has been found by French authorities in Paris, currently there is no evidence of coronavirus spread through sewerage systems.

As per the information available at CDC (Centres for Disease Control and Prevention), the risk of transmission of virus that causes COVID-19 through sewerage systems is thought to be low but transmission to operators may be possible during treatment processes at effluent/ Sewerage Treatment Plants (STPs). Operators of STPs attached with discharge from healthcare facilities and isolation wards should adopt standard operational practices, practice basic hygiene precautions, and should wear (PPE) — goggles, face mask, liquid repellent coveralls, waterproof gloves and rubber boots, the CPCB said adding, that during the period of COVID-19 pandemic, utilization of treated wastewater in utilities within healthcare facilities may be avoided.

The guidelines also talk about the management of general waste from quarantine homes and masks/gloves from other households. It says used masks and gloves generated from home quarantine or other households should be kept in paper bags for a minimum of 72 hours prior to disposal as general waste. Users are advised to cut the masks prior to disposal to prevent reuse.

Key takeaways

- Traces of the COVID-19 virus in non-potable water, like water supply used for cleaning streets have been reported in Paris.
- Chances of COVID-19 spread from wastewater and at STPs is low, but the workers at STPs should take precautions by following safe processes and use of PPE.

News Article – 21st April 2020
MONGABAY

Low-cost, paper-based device being developed for rapid coronavirus detection

Source: <https://india.mongabay.com/2020/04/low-cost-paper-based-device-being-developed-for-rapid-coronavirus-detection/>

This news article talks about the team of scientists from the University of Cranfield, United Kingdom, who are working on a low-cost, paper-based device that can detect SARS-CoV-2 in the wastewater generated by communities. The cost per device is less than Rs 96 and a positive result is easily visible as appearance of a green circle in about 30 minutes after adding the test sample.

The paper-based device is folded and unfolded to filter the nucleic acids of the virus from wastewater, which then reacts with preloaded reagents that reveal the presence of SARS-CoV-2. A green circle indicates a positive result. According to Zhugen Yang, a lecturer in sensor technology at Cranfield Water Science Institute, with further modifications, the device will be easy to use by non-experts. "This test will be able to detect whether there are potential COVID-19 carriers in local areas which no known cases," said Yang. The test will make it possible to determine the extent of virus presence by capturing and analyzing images, he added. The team has tested the device with the genetic material of the virus in wastewater for proof-of-concept and it shows "high potential to detect SARS-CoV-2." Consequently, researchers are developing a rapid, on-site test using a wastewater epidemiology approach where wastewater at treatment plants can be tested as an early monitoring tool to help local governments and agencies to decide effective courses of action.

The device does not require power for running hence making it suitable for regions where power supply is unreliable. Apart from this, "paper analytical devices are also easy to stack, store and transport because they are thin and lightweight, and can also be incinerated after use, reducing the risk of further contamination." The paper-based technology is promising and may prove to be particularly useful in the future.

Key takeaways

- Rapid, on-site test is important to predict infections and act as an early monitoring tool to help local governments and agencies to decide effective courses of action.
- Development of low-cost technologies for testing would promote risk management

News article- 22nd April 2020

DERSTANDARD

SARS-CoV-2 viruses detected for the first time in domestic water

Source: <https://www.water-technology.net/news/australian-researchers-develop-system-to-detect-covid-19-gene-in-sewage/>

The article talks about development of an early warning surveillance system designed to test the presence of SARS-CoV-2 virus, in untreated wastewater (sewage) of Australia by the University of Queensland and Australia's national science agency CSIRO. The researchers claim that their surveillance system has successfully demonstrated the presence of the coronavirus gene in raw sewage.

According to Australia's Federal Minister for Health, Mr Greg Hunt the Covid-19 wastewater surveillance scheme is extremely encouraging and has the potential to further strengthen Australia's response to the global pandemic. He believes that the work could add to the broader suite of identification and measuring the containment of Covid-19 in different areas of Australia that the government can use. Adding to this the chief executive of CSIRO, Dr Larry Marshall hopes that eventually it would be possible to detect the geographic regions where COVID-19 is present and approximate the number of people infected without having to test every individual in a location. This will give the public a better sense of the extent of containment of this pandemic.

The researchers concluded a proof of concept study using wastewater samples from two wastewater treatment plants in South East Queensland. UQ Queensland Alliance for Environmental Health Sciences Director professor Kevin Thomas said that systematic sampling and analysis of wastewater was used for the research for SARS-CoV-2 using a standardised approach based on refined analytical methods. The wastewater samples were analysed for specific nucleic acid fragments of the virus using RT-PCR analysis, which is used to identify a gene fragment from SARS-CoV2.

Key takeaways

- Australia has developed a system to test SARS-CoV-2 in wastewater (Sewage). This system is based on refined analytical approach method.
- A proof of concept exists for other researchers to learn from.
- The system can be useful in identifying and measuring the spread of the virus in an area without having to test every individual and thus help in better management of the pandemic.

Article - 23rd April 2020

Centre for disease control and prevention (CDC)

Water and COVID-19 FAQs: Information on COVID-19 in drinking water, recreational water and wastewater

Source: <https://www.cdc.gov/coronavirus/2019-ncov/php/water.html>

This article by the Centre for Disease Control and Prevention presents guidance based on the centre's recent research findings to the questions on whether the virus that causes COVID-19 is found in drinking water, in recreational water and in faeces. It also presents the findings on whether the virus can spread through sewerage systems and if wastewater workers should take extra precautions to protect themselves from the virus that causes COVID-19.

The article suggests that the virus that causes COVID-19 has not been detected in drinking water. Further, conventional water treatment methods, like filtration and disinfection already present in most municipal drinking water systems can either remove or inactivate the virus. No evidence was found about the spread of the virus to people through the water in pools, hot tubs, spas, or water play areas. It is opined that proper operation and maintenance (including disinfection with chlorine and bromine) of these facilities should inactivate the virus in the water.

Traces of COVID-19 virus are shown in faeces of patients clinically tested positive for COVID-19. However, the amount of virus released from the body in stool, duration for the virus shed and whether the virus in stool is infectious are still not known. While the risk of transmission of the virus from the faeces of an infected patient is unknown, it is expected that the risk would be low. This inference is based on data from previous outbreaks of related coronavirus, such as severe acute respiratory (SARS) and Middle East respiratory syndrome (MERS). The article further adds that as on date there is no evidence of faeces-oral transmission of COVID-19.

The article strongly recommends the use of standard practices, hygiene precautions, and wearing of personal protective equipment (PPE) by wastewater and sewage cleaners as prescribed for current work tasks. CDC does not recommend any additional COVID-19 specific protection for the members involved in wastewater management operations, including those at wastewater treatment facilities.

Key takeaways

- Traces of coronavirus are found in faeces however the risk of transmission of the
- Virus from faeces is not yet known and could potentially be low, basis the experience and data from earlier outbreaks like SARS and MER.
- The standard municipal wastewater system chlorination may be enough to inactivate coronavirus in sewage.
- PPE and hygiene precautions to be mandatory for wastewater and sewage cleaners.

Newspaper article – 28th April 2020

The news minute

Does COVID-19 virus survive in sewage? Bangalore citizens group asks in reports

Source: <https://www.thenewsminute.com/article/does-covid-19-virus-survive-sewage-bengaluru-citizens-group-asks-report-123477>

Bangalore Environment Trust (BET), an advisory body headed by environmentalist Yellappa Reddy, in its report titled 'Blindsided' refers to several international studies that have found traces of coronavirus in faeces and urine. The report states that while India and the world has been focussed on dealing with the spread of the virus through air, the virus has entered the water and wastewater streams. The report raises an alarm and calls for more studies in the Indian context to assess the potential spread of virus through sewage. "SARS-CoV-2 (or coronavirus) is a polluting pathogen greatly threatening our lakes and rivers. The virus swimming in the waterways is a disconcerting and terrifying fact," said the report authored by Nirmala Gowda, Dr Nidhi Paliwal, Rajani Santhosh and Sandhya Balasubramanian.

The BET report said infected sewage flowing in from drains, septic tanks and soak pits in the two sealed off areas, including Bapujinagara and Padarayanapura, could potentially contaminate groundwater. The two localities have a large number of shanties, small homes and are close to a storm water drain, which finds its way to other water bodies. BET urged the government to issue disinfection guidelines and identify sewage treatment plants that could treat wastewater from infected areas. It also brings to front the need for treating sludge from STPs and faecal sludge which is currently disposed off in water bodies.

Referring to Bengaluru's sewage infrastructure are insufficient, ineffective and poorly managed, the report states that grossly mismanaged urban sewage 'is at the crux of the problem' and blamed the Bangalore Water Supply and Sewerage Board (BWSSB) for not waking up to the challenge. It calls upon the water board and pollution control board to take concrete steps to avert the potential spread of virus through water and wastewater streams. It also stresses upon the importance of wastewater surveillance particularly near hospitals and containment zones to support pandemic management related decisions.

Key takeaways

- Inadequate and poorly managed sewage systems could accelerate the spread of the coronavirus contagion.
- Pollution control boards and water boards need to ensure that all STPs include disinfection process.

Article- 30th April 2020
eawag – The aquatic research

Tracking the course of pandemic in wastewater

Source: <https://www.eawag.ch/en/news-agenda/news-portal/news-detail/tracking-the-course-of-the-pandemic-in-wastewater/>

In studies conducted across multiple cities in Switzerland, the researchers at EPFL and Eawag have detected coronavirus in wastewater and are now working to optimize the method. They aim to develop a system for early warning signals of the coronavirus that is faster than clinical testing.

More than 300 wastewater samples collected since February 2020 from Lausanne, Zurich and Lugano are being analysed. Basis early results from part analysis, researchers have detected the novel coronavirus in all the samples analyzed and in the most recent test, the virus was relatively easy to detect as the concentration of the virus was high in wastewater.

The successful detection of low viral concentrations at an early stage of the outbreak means that it should be possible, to trace the rise of COVID-19 curve. While it will take several weeks to analyze all the sample (about 300) which are currently frozen and stored the researchers believe that it will scarcely be possible to calculate the exact number of infections on this basis- especially considering the fact that the quantity shed per case is different.

Testing wastewater for the virus is becoming a trend. Over the last few days taking the samples from Lausanne as an example, the scientists were able to roughly trace the increase in SARS-Cov-2 concentration in wastewater between March and April : One of the scientist, Kohn estimate that this represents a 10-100-fold rise.

The main aim of their project is to develop an early warning system. The scientists say that with 20 large treatment plants distributed all of Switzerland, they could monitor wastewater from around 2.5 million people. Also, if the samples are analyzed rapidly, a resurgence of infection during the lockdown exit period could probably be detected earlier than the diagnostic tests.

Key takeaways

- The success of detection of novel coronavirus in wastewater at the early stage of outbreak means it is possible to trace the rise of COVID-19 curve.
- It is scarcely possible to detect the exact number of infected on bases of testing wastewater for COVID-19

- Wastewater surveillance can help in detecting the prevalence and resurgence of infection earlier than diagnostic tests.

Newspaper article – 02nd May 2020

The Hindu

Sewage maybe a potential COVID source

Source: <https://www.thehindu.com/news/cities/Hyderabad/sewage-may-be-potential-covid-source/article31491472.ece>

The potential of sewage as a causative factor to the spread of COVID-19 is not yet fully understood. A few studies point to the presence of the virus in stool samples of COVID-19 patients. According to the chairman of Institution of Engineering, maintenance and sample collection of treatment water at Sewerage Treatment Plants (STPs) should be monitored along with functioning of Interception & Diversion (I & D) units as coronavirus is known to stay in faecal flow for 48 hours.

Sewage can therefore become a potential threat and necessary precautionary needs to be implemented by cities. It is important for cities to evaluate their wastewater management systems to see if they are robust enough to deal with a situation of sewage contributing to the outbreak. If not, then the chances of the disease flaring up are extremely high.

The Telangana State Pollution Control Board (TSPCB) has advised healthcare facilities and agencies involved in operating the sewage treatment plants to disinfect the treated wastewater to deactivate coronavirus. The Hyderabad Metropolitan Water Supply and Sewerage Board (HMWSSB) said that the treated water must be disinfected before released into the water. The water is treated by mixing it with either Chlorine or Sodium hypochlorite before being released.

Maintenance of sewerage infrastructure is critical, and leakages must be plugged. A case in point is that the Gandhi hospital, a major COVID-19 healthcare facility in Hyderabad does not have its own STP and all the outflows from the hospital are treated at the nearest STP (Amberpet). Leakages on the way would cause concern and should be monitored and repaired. Another point of concern is that the current capacity of STPs in Hyderabad treat only upto 50% of the city's sewage and the rest of the untreated is released in the Musi River endangering the lives of hundreds of slum dwellers living near the river bank.

Key takeaways

- Sewerage can be a potential causative factor for spread of coronavirus
- Water boards should implement precautionary measures – check nallas and aged pipes for any leaks and fix them, ensure all treated water from STPs are disinfected before release for reuse or otherwise.

Newspaper article – 04th May 2020
NOWCAST

Sewage samples could help scientists find coronavirus outbreak before they begin

Source: <https://www.wisn.com/article/coronavirus-sewage-could-help-scientists-find-outbreaks-before-they-begin/32370190#>

Scientists at the School of Freshwater Sciences, University of Wisconsin, Milwaukee have started testing sewage samples for signs of coronavirus. The researchers at Milwaukee inform that the testing of sewage samples can warn the healthcare providers days/weeks before the number of COVID-19 cases increase. They also mention that, when testing a sewage sample, the number of cases in that area cannot be defined; but can state, if the cases are increasing or decreasing. As the virus shows up in sewage samples before patients begin to show symptoms. If there is an increase in the number of cases, the team wants to launch an outreach so they can try tracing a more specific location.

Currently, the researchers are working with Milwaukee Metropolitan Sewerage District to collect sewage samples and test them. Data collected by the University will be available in a couple of weeks,

Key takeaways

- Sewage shows early signs of coronavirus.
- When testing a sample, we cannot give the number of people infected by the virus, but state whether the virus has increased or decreased in an area.

Newspaper article – 06th May 2020
FR24 News

Coronavirus: Sewage study could predict second COVID-19 peak

Source: <https://www.fr24news.com/a/2020/05/coronavirus-sewage-study-could-predict-second-covid-19-peak.html>

The article discusses the initiative by UK Department for the Environment, Food and Rural Affairs (Defra) and School of Natural Sciences, Bangor University, Wales for testing wastewater samples across Wales for presence of coronavirus and number of people infected.

With 75% of Wales' population connected to 21 individual treatment plants operated by Welsh Water, the team from Bangor university felt sewage sample testing was an effective method for tracking data on the majority of the population in a relatively inexpensive and simple manner.

Results from weekly monitoring show the presence of virus to be low in North West Wales and high in the North East Wales and South East Wales. These results were found to be in line with actual cases reported.

The scientists believe the methodology would help in predicting a second peak of Covid-19 up to two weeks before people become symptomatic.

Defra is “actively engaging with the research community and government science advisers to determine whether surveillance of sewage could be used as a means of monitoring the prevalence of the virus”. Similar study is being planned by University of Newcastle.

Key Takeaways:

- Sewage can show early warning signs of COVID-19 virus
- A regular surveillance of the sewage is required to track the level of COVID-19 virus contamination.

Article – 15th May 2020

Division of Research, University of Maryland

Wastewater testing could help track COVID-19

Source: https://research.umd.edu/news/news_story.php?id=13081

This article reports the study design being followed by Birthe Kjelleruo, assistant professor at Maryland University, USA and her colleagues. The researchers are testing a promising new approach of by gathering samples from wastewater shed and treatment facilities and tracking the presence of COVID-19 with help of molecular tools. Using this method, the researchers aim to determine the increase, decrease or no change between subsequent samples. Observing the changes in the virus content can help identifying the locations that may have caused the rise.

“The approach has the potential to detect if there’s been a rise in the virus content of wastewater from a particular location, such as an apartment building, school, nursing home, or prison. If so, we’ll know that in a matter of days people there will start testing positive. That way we get some lead time to implement social distancing measures,” Kjellerup said.

In addition, the researchers aim to map the wastewater data onto other layers of information—including socioeconomic, demographic and transportation data—to obtain a more comprehensive view of the pandemic’s impact, including on vulnerable or disadvantaged populations.

The project is on a pilot phase and the researchers are still trying to assess if their methodology yields useful findings and whether it could be extended to local sewage sheds to obtain more detailed and neighbourhood specific results.

Key Takeaways:

- Regular sewage surveillance can help healthcare providers with early information
- Wastewater data combined with socioeconomic, demographic and transportation data can help in obtaining a more comprehensive view of the pandemic’s impact, including on vulnerable or disadvantaged populations

Article – 25th June 2020

Hindustan Times

Traces of coronavirus found in sewage in Gujarat

Source: <https://www.hindustantimes.com/india-news/traces-of-virus-found-in-sewage-in-gujarat/story-dK4peiboaaYzGT7bt6EmTK.html>

Gujarat is the first state in the country to report finding traces of Sars-CoV-2 RNA in sewage tests in Gujarat. The article refers to the findings of National Centre for Disease Control (NCDC) which began sewage testing in April 2020. It also quotes the study by Indian Institute of Technology (IIT) in Gandhinagar in collaboration with the Gujarat Biotechnology Research Centre and the Gujarat Pollution Control Board that studied samples of wastewater collected on May 8 and May 27 from one of waste water treatment plants in Ahmedabad, also found traces of Sars-CoV-2.

The article emphasises upon the need for assessing the potential danger of the disease spreading through this channel as the next step and establishing a disease surveillance system. It also speaks about the need for other states to undertake similar studies and report findings.

Key Takeaways:

- Traces of the virus have been found in sewage samples in Gujarat, India.
- More cities need to undertake tests and move towards establishing a disease surveillance system.

Article – 26th June 2020

Daily Sabah

COVID-19 sample from months before 1st outbreak in Wuhan, found in Barcelona water

Source: <https://www.dailysabah.com/world/europe/covid-19-sample-from-months-before-1st-outbreak-in-wuhan-found-in-barcelona-wastewater>

This article discusses a yet to be published study by University of Barcelona which identified the novel coronavirus in a frozen wastewater sample from Barcelona, from March 2019.

The researchers collected sewage samples from two large wastewater treatment plants in Barcelona to detect the evolution of the virus in the city. They analysed weekly samples from April 13 until May 25 and studied frozen archival samples. Upon detecting SARS-CoV-2 in samples from early January, a good 15-41 days before the first official confirmed case in the city, the researchers tested samples from December 2019 till further back to January 2018.

All the samples except for the one on March 12, 2019 were found to be negative for SARS-CoV-2 genome presence. The study opines that "It is possible for a similar situation to have taken place in other parts of the world, and since most of the COVID-19 cases show a similar symptomatology to the flu, those cases could have been disguised as the flu."

The study is undergoing peer review and therefore the findings are yet to be confirmed. This early publication however is of significance from the stand that if confirmed, the study would establish the need for re-examining the accepted timeline of the virus and the notion that it originated in China in December 2019.

Key Takeaways:

- There is a possibility that the virus was present way in Spain as early as in 12th March 2019.
- Studying sewage for coronavirus is a positive and emerging field.