Thematic Discussion Synthesis: Testing Sewage for Early Warnings About Covid-19

ABSTRACT

Testing sewage can be an effective tool for monitoring the spread of the Sars-nCoV-2 virus in populations. An 'Indian' protocol is needed that takes into the poor quality of sewage systems, challenges in transportation and testing of samples, and supports city and state governments to communicate with the public. This discussion elicited information on the components and challenges of such a protocol.

Contents

The topic leads

Topic 1: Arunabha Majumder, professor-emeritus with Jadavpur University's School of Water Resources Engineering, former director and professor, All India Institute of Hygiene & Public Health, Life-fellow, Indian Water Works Association & Institute of Public Health Engineers

Webinar speakers: M R Seetharam has been part of SVYM, a development organisation headquartered in Sargur, Mysore. An Orthopaedic surgeon by training, Seetharam has been a public health practitioner and development activist at heart all along. WASH and environment have been key areas of his interest and expertise. He is a key member of FANSA and is currently the National convener of the India chapter

Vishwanath has been working in the water and sanitation sector for the last 34 years. He is an Adjunct Faculty at Azim Premji University. His work has been on rainwater harvesting, sustainable sanitation systems, groundwater recharge and sustainable water systems

Sarada Prasad is an assistant professor at the Azim Premji University, Bangalore, India. He is also a researcher, sanitation specialist, WASH consultant, and photographer. His research is focused on sanitation access and work in low- and middle-income countries

Moderator: Sunetra Lala. She is the WASH Sector Leader for SNV Cambodia and manages projects on sanitation, rural FSM, WASH-nutrition. She has led numerous multi-sectoral initiatives. Her areas of expertise include WASH, faecal sludge management, social and behaviour change communication, gender, advocacy, capacity building and knowledge management.

Topic 2: Malini Reddy, a multi-disciplinary researcher and practitioner in urban governance and service delivery. She is deeply involved in sanitation (FSM&WWM) management, ICT for development, social marketing, gender, policy, innovations and social entrepreneurship were my areas of work

Introduction

Research from past epidemics of the severe acute respiratory syndrome (SARS) caused by coronaviruses has suggested viruses are excreted in stools by infected human beings. They have been detected in sewage. Mapping where they were found can help determine if there were infections in a geographic area. This method has been used to keep tabs on polio and use of drugs, especially cocaine[1].

Traces of the Corona virus have been detected in sewage. As per a guidance document (23rd April 2020) by WHO, there have been no evidence yet to suggest that the SARS–nCOV-2 virus transmitted through treated or untreated sewage is infectious. Tracking sewage for traces of the virus, however, can be one of the proxy indicators to identify where the infection is prevalent.

Surveillance of the Sars-nCov-2 virus that causes COVID-19 can be especially useful for surveillance in densely populated urban residential areas where individual testing and social distancing is difficult.

Some such residential areas have community toilets (CTs) connected to a sewer line from where samples can be obtained. This testing can be a sensitive tool to monitor circulation of the virus in a population.[2]

This discussion was set up to elicit inputs to work out an 'Indian' protocol to test sewage and develop an action plan based on the evidence to manage COVID-19 infections. Currently, urban local bodies (ULBs) have no alternate means to detect COVID-19 infections other than mass testing/herd testing.

The discussion was divided into three parts. The first focused on the inputs for the technical protocol, including sampling, transportation and testing. The second, a webinar, considered challenges of city and state governments in conducting and communicating testing, the safety of workers in sewage treatment plants and sanitation workers. The third focused on the process and tools for communication with the public using the evidence generated.

For the segment on protocol development, a few assumptions were stipulated:

I. The areas to be covered need to have a sewer system or a systematic method of collecting faecal sludge in non-sewered areas
II. There have been active/cured COVID-19 cases in the area; ideally there should active cases
III. Laboratory facilities for testing exist and were accessible

The sampling rate needed to be statistically significant. The exact size would be determined from the size of the population at a 95% confidence interval. From the areas, samples needed to be transported to a laboratory. Samples needed to be kept in an ice box in transit. The laboratory must be able to test for the Sars-nCov-2 virus fragments at high levels of dilution and contamination by other organic material and bacteria normally found in sewage.

City and state governments needed to be part of the process of developing and implementing the protocol. Currently, governments are hesitant to proceed to allow tests in the absence of guidelines from the Central or state governments.

If the virus was detected, community outreach was essential to inform and educate the public about the findings and precautions. This would include setting up a community level institutions, messaging, finance and governance. These were crucial to the continued success of the project both in terms of collection and testing, and outreach with the people on the results.

Discussion summary

The discussions highlighted the need for a testing protocol that fit with the 'Indian' characteristics of sewage systems, toilet habits and temperatures. Quoting articles in Nature[3], The Guardian[4] and other publications, members said wastewater-based epidemiology[5] (WBE) would be key to detecting Sars-nCov-2 cases in the general population. "With the economic and practical limits of medical screening for SARS-CoV-2/COVID-19 coming sharply into

[1] Zuccato, E., Chiabrando, C., Castiglioni, S. et al. Cocaine in surface waters: a new evidence-based tool to monitor community drug abuse. Environ Health 4, 14 (2005). https://rdcu.be/b4euJ
[2] 2020. Gertjan Medema, Leo Heijnen, Goffe Elsinga and Ronald Italiaander; KWR Water Research Institute, Nieuwegein, The Netherlands. The Presence of SARS-Coronavirus-2 in sewage
[3] How sewage could reveal true scale of coronavirus outbreak. Nature 580, 176-177; 2020. https://www.nature.com/articles/d41586-020-00973-x accessed on 14 June 2020
[4] Sewage and wastewater: the key to finding hidden clusters of coronavirus. The Guardian, 13 May, 2020. https://www.theguardian.com/world/2020/may/13/sewage-and-wastewater-the-key-to-finding-hidden-clusters-of-coronavirus accessed on 14 June 2020
[5] For purposes of this discussion and protocol, we are restricting wastewater to include only sewage and faecal sludge

focus worldwide, scientists were turning now to WBE as a potential tool for assessing and managing the pandemic."

Sewage systems in most Indian cities and towns are fragmented. They are a mix of underground (UDGs) and open drains; onsite sanitation systems (OSS), common in most low-income localities and small towns, were emptied by 'honey suckers'. The 2011 Census stated 47 per cent of urban households were connected to an OSS while 33 per cent were linked to a sewer.

To develop the protocol, members suggested the following approach.

1. Sampling strategy
2. Transportation methods
3. Testing methods
4. Addressing stakeholder concerns
5. Communicating with the public

1. ***A sampling strategy.*** For sampling, they suggested disaggregating a town into zones, mapping the sanitation systems and then develop the sampling strategy. This would have to cover single/representative OSS, connected grids and outfall points for continuous networked sewerage. The following collection sites were suggested from where there have been reported active/cured COVID-19 cases:
    a. Residential areas have community toilets (CTs) connected to a sewer line. Sewered areas need to be mapped to determine collection points which could be manholes, pumping stations of STP inlets
    b. Residential areas have community toilets (CTs) connected to a septic tank
    c. Sewage samples from COVID-19 hospitals, quarantine or isolation centres (where sewerage is existing)
    d. Sewage samples from Septic Tanks of COVID-19 hospitals, quarantine or isolation centres
    e. Inlets of municipal sewage treatment plants (STP) of hotspot areas as raw sewage
    f. Sludge samples before Biological treatment
    g. Sludge sample from or after the biological treatment
    h. Treated sewage samples

Members shared research papers that showed continuous sampling was used in The Netherlands (by KWR Water Research Institute, The Netherlands) and North America. KWR's paper stated the operators of the WWTP took a 24-hour flow-dependent composite sample of 250 mL that was stored at 4◦C during sampling. Biobot, a USA-based wastewater epidemiology company, also recommended a similar method.

Continuous sampling is possible in extremely limited conditions in India: only where sewer networks were connected to WWTPs or at sewage pumping stations, additional research

indicated. The half-life of the virus in sewage has been estimated at 4.8-7.2 hours, which corresponds to the average hydraulic retention time in most sewage networks[6].

Instead of continuous sampling, the papers research suggested a composite sample can be prepared from grab samples taken between 8 AM and 10 AM. This was used in Queensland, Australia[7]. The individual grab samples can be stored in an ice box and combined in the laboratory.

Sampling personnel need standard personal protective equipment (PPE) for sewage or faecal sludge sampling, such as long pants, steel capped boots, hard hats, safety glasses and gloves.

2. ***Transportation***. The second part of the process is transporting samples to a laboratory for testing. Participants suggested this must be done in a cool pack container (a normal ice box can be used) to minimize the sample degradation. The optimum temperature is 4◦C. Samples must reach the laboratory within one hour after collection. This is how researchers from the KWR Water Research Institute, The Netherlands, transported samples, as written in their paper. The samples were transported to the laboratory on melting ice and RNA was isolated on the day of sampling[8].

For the Indian protocol, these will require modifications for local traffic conditions and testing for the Sars-nCoV-2 virus fragments at high levels of dilution and contamination as is found in regular sewage.

The epidemiology of Sars-nCov-2 suggests its presence in sewage may not be infectious. Considering a high percentage of asymptomatic or undiagnosed cases, SBE in the absence of adequate clinical surveillance can provide the critical information required for the management of the public health crisis. Faecal matter may in fact be a more reliable test of infection than respiratory samples. Members said it is important to be vigilant in terms of management and handling of liquid, faecal, and bio-medical waste to prevent the spread of the Sars–nCov-2 virus.

3. ***Testing methods***. In the laboratory, viruses need to be extracted and concentrated using two previously published methods. Papers provided by members suggested these methods were Method A (direct RNA extraction from electro-negative membranes) and Method B (ultrafiltration). The RNA isolated from them was then tested for Sars-nCoV-2 activity using a real-time Reverse Transcription-Polymerase Chain Reaction (RTe-PCR) assay. The untreated samples tested positive, whereas the treated samples showed the presence of viral RNA,

---

[6] Computational analysis of SARS-CoV-2/COVID-19 surveillance by wastewater-based epidemiology locally and globally: Feasibility, economy, opportunities, and challenges. Olga E. Hart and Rolf U. Halden; Science of The Total Environment, Elsevier; 15 August 2020

[7] First confirmed detection of SARS-CoV-2 in untreated wastewater in Australia: A proof of concept for the wastewater surveillance of COVID-19 in the community. Warish Ahmed et al, Commonwealth Scientific and Industrial Research Organisation, Queensland, Australia. 2020; Science of The Total Environment, Elsevier B V. Available at https://doi.org/10.1016/j.scitotenv.2020.138764; accessed on 14 June 2020

[8] Presence of SARS-Coronavirus-2 in sewage. Gertjan Medema, Leo Heijnen, Goffe Elsinga and Ronald Italiaander; KWR Water Research Institute, Nieuwegein, The Netherlands, 2020

although it was unclear if the virus retained their infectious properties or faecal-oral transmission after the routine treatment[3, 4].

4. ***Addressing stakeholder concerns***. Tracking sewage or faecal sludge is complicated, especially in the context of India, where most many effluent streams are mixed – black water, grey water, bio-medical waste and industrial effluents – and wastewater systems are very fragmented. Wastewater-based surveillance is therefore focused on sewered areas as mentioned earlier. Slums and rural areas, thereby, remain untested largely because most people use onsite sanitation systems. These require a different collection method, said members. The sewage catchment area is huge, comprising of formal and informal set ups.

Competing priorities often tend to overshadow this kind of testing. And, in the absence of clarity on testing protocols, guidelines and regulations, Urban Local Bodies (ULBs) were hesitant to adopt sample testing.

The handling of human waste renders sanitation workers particularly susceptible. Formalizing the entire spectrum of sanitation work was not feasible. Likewise, the available PPE were not suitable for the range of activities associated with sanitation work. There were persisting issues related practicality and comfort, which hinder, rather than aid work.

5. ***Communicating with the public***. Once the tests results were in, members said city and state governments need to act if COVID-19 cases were found. However, there was no communication strategy in place. Multiple channels, filled with scientific and accurate information, can be used for public outreach. Local WhatsApp groups can be set up for the purpose. Kerala has instituted a daily press conference at a fixed hour. Local leaders can use Facebook Live and local TV channels.

To ensure scientific fidelity, these should quote the original science publication or organizational report and mention the constraints or limitations the original authors have raised. A reality check on how the virus was transmitted, chances of contracting an infection, the chances of falling seriously ill or dying need to be clearly stated in communication material. It needs to be stated clearly that on date, the World Health Organization says there is no evidence to suggest a person can get COVID-19 from sewage.

Some of the media suggested were WhatsApp, TikTok, Facebook, conventional print and electronic media and community radio. A schedule to send out content will be needed. For the Swachh Bharat Mission, IEC strategies were prepared for cities with messages, timings, media and person(s) responsible. The people trained as *swachhata doots* can be brought back and incentivised to work as COVID-19 communicators.

The state Government of Andhra Pradesh has introduced ward volunteers (1 for every 50 households) who were the point of contact with the households to note grievances, extend support for availing government services and for enhancing awareness and hence demand for government schemes. Given that the ward volunteers were members from the community, there is inherent trust that citizens place in them. If additional hands were needed, ASHAs, ANMs and anganwadi workers can be brought in, members suggested.

Topic 1: Technical Protocol

The first part of the discussion was led by Arunabha Majumder, Professor-Emeritus with Jadavpur University's School of Water Resources Engineering, Former Director and Professor, All India Institute of Hygiene and Public Health, and Life-Fellow, Indian Water Works Association and Institute of Public Health Engineers (India).

Majumder said in 2005 a study was conducted to assess the concentration and detection of SARS Corona virus in sewage from hospitals[9]. In this study, the persistence of severe acute respiratory syndrome-associated coronavirus (Sars-CoV) was observed in faeces, urine and water. Experiments showed the enormous differences in the time the virus persisted in sewage, faeces and urine. It was susceptible to disinfectants such as free chlorine.

This drew attention to the possible transmission of the virus by the sewage system because laboratory studies showed that patients excreted the Sars-Cov RNA in their stools. The precedent is from the polio eradication campaign. Wastewater/sewage monitoring has been used for decades to assess the success of vaccination campaign against the polio virus.

Recently, by sampling sewage across Greater Paris (reported on April 21, 2020) for more than one month, researchers detected a rise and fall in the Sars-nCov-2 virus concentration that corresponded to the shape of the COVID-19 outbreak in the region. The PCR test identified fragments of RNA from SARS-CoV-2 that causes COVID-19. The concentration of the virus in sewage was proportional to the number of infected people who contribute to the sewerage system.

A structured study if carried out through real-time monitoring basis (sewage/sullage sampling and testing) can predict presence of Corona virus-infections (symptomatic and asymptomatic people) in a locality of a city or village. The study can also predict the possibility of a second wave of outbreak of COVID-19. The extent and magnitude of COVID-19 outbreak can be assessed by extensive sewage/sullage sampling and testing.

He recommended the following samples be analyzed:

- Stool of COVID-19 patients
- Sewage samples from COVID-19 hospitals (where sewerage is existing)
- Sewage samples from Septic Tanks of COVID-19 hospitals (where U/G sewerage does not exist)
- In cities, the sewerage network may be divided in small zones and sewage samples may be collected from exit point of each zone
- Sewage samples from quarantine centres
- Sewage samples from isolation centres

[9] Study on the resistance of severe acute respiratory syndrome-associated coronavirus, 2005. Xin-Wei Wang, Jin-Song Li, Min Jin, Bei Zhen, Qing-Xin Kong, Nong Song, Wen-Jun Xiao, Jing Yin, Wei Wei, Gui-Jie Wang, Bing-yin Si, Bao-Zhong Guo, Chao Liu, Guo-Rong Ou, Min-Nian Wang, Tong-Yu Fang, Fu-Huan Chao, and Jun-Wen Lia. Elsevier Public Health Emergency Collection, 2005. Available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7112909/#bib31. Accessed on 12 June 2020

- Raw sewage sample(influent) entering to Sewage Treatment Plant
- Treated sewage samples
- In un-sewered areas samples from septic tanks (hospitals and quarantine centres) , sullage samples from surface drains were to be collected for testing
- In villages, sewage samples were to be collected from on-site sanitation systems (Two-pit Pour Flush Toilets, Septic tanks, etc).

Topic Summary

WBE has been used in health surveillance for long. For example, it has been used in polio surveillance and monitoring the use of cocaine in certain towns in Italy[10], according to documents shared by members. Members shared studies that examined the feasibility, economy, opportunities and challenges of enumerating active coronavirus infections locally and globally using WBE have indicated it is possible to detect one symptomatic/asymptomatic infected case per 100 to 2,000,000 non-infected people in sewage. Computer simulations from hotspots identified temperature, average in-sewer travel time and per-capita water use are key variables.

WBE surveillance cannot replace clinical testing but is far cheaper and faster. A study says for resource poor regions and nations, WBE may represent the only viable means of effective surveillance[11]. 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, said members, quoting a paper[12].

Moreover, aggregate, population-wide data can help inform modelling efforts. In the same paper, authors have reported they 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. They confirmed the identity of the PCR product by direct DNA sequencing. Viral titers observed were significantly higher than expected based on clinically confirmed cases in Massachusetts as of March 25.

While developing the protocol, Meenakshi Dewan said, there were no reports of the detection or persistence of viable, infectious SARS-CoV-2 virus itself in sewage. There have been no reported cases of COVID-19 due to contact with the faeces of an infected individual. According to WHO, the risk of faecal-oral transmission of COVID-19 is low.

She averred that sewage surveillance for the Sars-nCoV-2 virus' genetic material can be a valuable surveillance tool particularly in areas where individual testing for COVID-19 infections is a big constraint.

---

[10] Zuccato, E., Chiabrando, C., Castiglioni, S. et al. Cocaine in surface waters: a new evidence-based tool to monitor community drug abuse. Environ Health 4, 14 (2005). https://doi.org/10.1186/1476-069X-4-14

[11] Olga E. Hart et al

[12] Fuqing Wu, Amy Xiao, Jianbo Zhang, Xiaoqiong Gu, Wei Lin Lee, Kathryn Kauffman, William Hanage, Mariana Matus, Newsha Ghaeli, Noriko Endo, Claire Duvallet, Katya Moniz, Timothy Erickson, Peter Chai, Janelle Thompson, Eric Alm. SARS-CoV-2 titers in wastewater were higher than expected from clinically confirmed cases. medRxiv 2020.04.05.20051540; https://doi.org/10.1101/2020.04.05.20051540

Members pointed out the limitations of WBE. It cannot identify infected individuals and pinpoint their specific locations. Rather, it predicts infection trends in the sewershed. One paper provided by members stated WBE testing would indicate COVID-19 positive cases closer to the sampling points of the sewershed but could miss cases from its extremities because of longer travel times and higher dilution.

Another challenge in developing the India-specific protocol, linked to the fragmented and inefficient sewage systems, is the effect of temperatures on the virus, said members. Ambient sewage temperatures in India were much higher than in The Netherlands and North America, from where initial tests for the virus in sewage were carried out. Not compensating for temperature differences renders WBE data vulnerable to severe under-/over-estimation of infected cases. The half-life of the Sars-nCoV-2 virus was estimated to be 4.8 to 7.2 hours at 20◦C[13] that would be ambient temperature of water in most Indian towns in summer. It is also the average hydraulic retention time in sewage systems around the world.

Members said the predictions of infections based on sewage testing was complicated by the large floating population in a city. These people could use toilets in their offices or public toilets. If virus samples were found from sewage in these areas, tracing the COVID-19+ people would be like finding a needle in a haystack.

The cost-benefits of each part of the protocol need to be analysed, said Srikant Guruswamy. Sewage testing of households in hotspots would be more valuable than testing sewage from COVID hospitals. But this would hold true only if the sewage test was simpler, faster and cheaper than individual tests. The test data was time-sensitive; a negative result on one day could indicate no infections, but the situation could change within hours with new people getting infected.

Factors affecting the accuracy of sewage testing for surveillance include the sensitivity, effectiveness and reliability of detection methods and the number of samples to be tested for representation of the population, said Thakur Pandit. If these variables were factored in, the sewage testing method could be applied for disease outbreaks in general but may need to be improved to be a reliable predictor of COVID-19 cases.

A sampling frequency of three days, or five times during the quarantine period of 14 days, would present an accurate picture of COVID infections in a community, said M S V K V Prasad. Sampling could be done around 8:00 AM. They could be collected from septic tanks or sewers in glass bottles followed by disinfection of the outside. The samples should be sealed properly and transported kept in sturdy ice boxes, protected from bright sun. People collecting samples would need to wear protection suits to avoid any contamination.

Many countries, including Australia, were institutionalising testing sewage for the coronavirus. Elisabeth Muench said Victoria's chief health officer announced sewage testing was "important" and would be rolled out across the state. Australian scientific agency, CSIRO and the University of Queensland, had developed a way to do it, and tried it in small areas in

[13] Olga E. Hart et al0.

Queensland. These researchers had developed a method of sampling sewage from water treatment plants and spotting the "specific nucleic acid fragments" of the virus. This will help health authorities spot hidden clusters of coronavirus – if a high amount is detected in a region's wastewater, they can start large-scale testing and quarantine. While the situation in India is different, the sampling and analytical techniques would probably be similar.

Health authorities could provide data about new cases at the settlements/catchments of sewer systems. These could be analysed to determine sampling locations, said Thakur Pandita. It would be necessary to work with health agencies, accredited labs and sewage management agencies.

The sewerage coverage is scanty and most vulnerable areas or hotspots like slums were largely out of the network, said Kurian Baby, N C Narayanan and Nagendra Singh. The provenance of the WBE method came from industrialised countries; it may not be suitable for India as is. In many cities, sewage and faecal sludge from quarantine centres was disposed in the open or even in sewers. Open defecation continues in urban areas and people may defecate in areas far from their homes. These will complicate the testing.

There was evidence of community spread in some geographical areas like slums or others. The drinking water distribution networks in many places mixes with sewerage/waste water lines. The protocol must ensure safe drinking water, said members.

In the light of these factors, one must be extremely careful in extrapolating the findings of sewage tests as analytical evidence of the extent of spread. It can at best be used as a supplementary analytical tool for early warning and surveillance, members said.

For sampling, urban areas could be divided into zones, said Narayanan. In each, the sanitation system would need to be mapped. Separate sampling methods would be needed for single/representative OSS, connected grids and fall of points and continuous networked sewerage.

Governance institutions, comprising the over-stretched and sometimes under-capacitated bureaucracy in urban local bodies and pollution control boards may be unable or unwilling to take on an extra job. It would need a larger network of institutions – academia, think tanks, NGOs, consultancies – to come together and support the governance agencies, said Baby.

The protocol would have to have a mechanism to work with city or state governments. This would ensure ownership and eventually, use.

Section 2: Webinar on Allaying Stakeholder Concerns while testing

Considering a high percentage of asymptomatic or undiagnosed cases, WBE in the absence of adequate clinical surveillance, can provide the critical information required for the management of the public health crisis. Faecal matter may in fact be a more reliable test of infection than respiratory samples. Tracking sewage can not only serve useful to study the behavior of the virus but can also help in identifying the geographical area and the asymptomatic carriers and decode subsequent outbreaks, as has been done in the case of cholera in the past.

On 22 May, 2020, the India chapter of the Sustainable Sanitation Alliance, Water Aid India, IRC and the India Sanitation Coalition jointly organized a webinar on Addressing Stakeholder Concerns around Testing Sewage for Covid-19. The speakers were Malini Reddy (Administrative Staff College of India), M R Seetharam (SVYM), Sharada Prasad (Azim Premji University), S Vishwanath (BIOME). It was moderated by Sunetra Lala (SNV) and attended by 350 participants. The speakers at the webinar discussed the significance of testing sewage and the infrastructural, administrative and the social implications of the same.

The discussants shared that while most cities in India were yet to adopt sewage/faecal sludge tracking, it is important to be vigilant in terms of their management and handling. Safe management of sewage, faecal waste, and bio-medical waste is essential to prevent the spread of the SARS–nCOV-2 virus.

Further, workers at all levels should be wearing Personal Protection Equipment (PPE). A circular issued by the Central Public Health and Environmental Engineering Organisation (CHPHEEO) of the Government of India, to water and sewage utilities and pollution control boards, recommends that sewage treatment should be followed by chlorination. Further, it suggests PPE for sanitation workers, following certain health protocols – such as testing the workers for symptoms, hygiene and disinfection of contact surfaces of the STPs.

While important, these recommendations address only the formal sewage treatment set up. Meeting the recommendations will require changes in the design parameters for STPs that currently do not include chlorination as a means of disinfecting sewage.

Sewage or faecal sludge testing, though important, has inherent challenges. Tracking them is complicated, especially in the context of India, where most sewage is a cocktail of black water, grey water, bio-medical waste and industrial effluents. Sewage-based surveillance is focused on sewered areas. Slums and rural areas, thereby, remain untested largely because most people use onsite sanitation systems (OSS).

These will require a different collection method. The sewage catchment area is huge, comprising of formal and informal set ups. For example, in the city of Bangalore, there were 28 Sewage Treatment Plants (STPs) under the Bangalore Water Supply Sewerage Board, which caters to around 10 million people. There were more than 3,500 decentralized STPs mandated for apartments and gated communities, and community toilets run by the municipalities.

This is further compounded by the fact that there were more than 500,000 onsite systems, comprising of pit toilets, community septic tanks, and temporary toilets. These were serviced by more than 500 honeysuckers, which collected waste form the onsite systems and took it to either the STPs, or dumped it on farms or storm water drains.

It is also important to take into consideration the movement of sewage. In most cities, it flows through a vast hinterland. In the case of Bangalore, for example, treated sewage from the formal STPs flows up to 90 kms from the city, filling up lakes and recharging aquifers in the process. Farmers then tap into this through shallow open wells for agriculture.

In terms of the informal set up, only half of sewage gets collected and treated. The rest flows through stormwater drains and enters river systems. Farmers tap into the untreated sewage –

comprising of a cocktail of chemicals - for agricultural purposes. It is important to mention here that there were no standards for ground water recharge using treated sewage in India.

Competing priorities often tend to overshadow sewage testing. And, in the absence of clarity on testing protocols, guidelines and regulations, Urban Local Bodies (ULBs) were hesitant to adopt sample testing. They apprehend if test results were positive, it can lead to scare mongering.

Manual handling of human waste renders sanitation workers particularly susceptible. In India, the unique sanitation infrastructure implies that sanitation work comprises of a spectrum of activities – manual scavenging, cleaning stormwater drains, collection and segregation of solid waste, construction work, and more. Informality in sanitation work is widespread which in turn increases the risk factor associated with such work.

Formalizing the entire spectrum of sanitation work is not feasible. And, mechanization does not address the entire gamut of work involved. Likewise, the available PPE is not suitable for the range of activities associated with sanitation work. There were persisting issues related practicality and comfort, which hinder, rather than aide work.

The implications of sewage testing as a reliable tool to inform on the spread of the infection is significant. Regular monitoring of sewage is important in the context of COVID-19 as well as for any future public health emergency. The benefits of testing far outweigh the costs involved in the same. The willingness of ULBs, however, is an area requiring work. Additionally, it is important to have standard protocols and guidelines from the national government, and Central Pollution Control Boards in the states need to regulate STPs on the same, to mitigate any public health risk. Developing a risk matrix based on sewage and faecal sludge flows, at present, may prove useful as starting point.

Further, in addressing the pandemic, there is also a need to shift focus from development infrastructure to social infrastructure. Ensuring health and safety of sanitation workers is crucial. Sanitation workers work and live in close proximity to other citizens of the city. Thereby, having the right mechanisms in place is crucial from the public health outbreak point of view as well. Thus, COVID-19 presents an opportune moment to rethink sanitation, think about systemic changes towards building a sustainable public health infrastructure in India.

The link to the webinar is available here: https://www.youtube.com/watch?v=Y0l2NSQVaC4.

Topic 2: What can be a SOP for community outreach

Malini Reddy, Professor, Administrative Staff College of India (ASCI), was the topic lead. In her opening comments, she said the pandemic had once again exposed India's inadequate waste management abilities. While the guidelines and standard operating practices for handling solid waste (municipal, bio-medical, COVID contaminated domestic waste) were developed by the Central Pollution Control Board (CPCB) and the Health Ministry and operationalized at the state and municipal level, liquid waste and the associated problems during this period of pandemic were hardly being addressed.

A potential fallout of this increased reporting on the presence of COVID-19 in sewage and faecal sludge could be unnecessary public panic and the undesirable reactions towards

pandemic response activities by city or state governments. Better communication during the time of pandemic and emergency response was, therefore, a major challenge particularly in today's times of information overload and conflicting recommendations.

The principles of good risk communication required it to be quick, transparent, credible and consistent. Balancing this in the context of changing information and high chances of misunderstanding of research findings was difficult. Further, this could be particularly damaging in the context of "at-risk populations". Effective communication with these populations was integral to minimizing panic, illness and potential fatality. Local governments and others therefore needed to identify and plan the approach as well as the channels of communication in advance.

She asked SuSanA members the following questions.

- What communication challenges can the potential COVID-sewage/faecal sludge connection create/aggravate?
- What were the SOPs for establishing a robust communication infrastructure that delivers coordinated and consistent communication across multiple channels?
- What were some best practice communication engagement models for communication that we can learn from?
- What special measures were required for communication with "at risk" populations/ communities?

Topic Summary

Members echoed Reddy's concern that local governments were not communicating because of the possible consequences. Paresh Chajjed said local governments were not communicating at all because there were no norms spelt out by the state or Central governments. If messaging from the top was accurate and scientific, it would be useful.

The real challenge said Kurian Baby, was to communicate as simply and transparently as possible. Even though the weak statistical evidence is weak, the positive relationship provides opportunities for designing early warning signals and responses.

COVID has been described as 'deadly' and 'highly infectious', said Nitya Jacob. This painted a picture of an unseen 'enemy' that must be defeated at all costs. A reality check on how the virus is transmitted, chances of contracting an infection, the chances of falling seriously ill or dying need to be clearly stated in communication material. Further, it needed to be stated clearly that on date, there is no evidence to suggest a person can get COVID-19 from sewage. Meenakshi had made the point earlier.

Therefore, a standard operating procedure could have the following elements: data integrity and analytical rigour; impartial scientific observations with qualifying remarks; evidence based communication; identification of target audiences for structured communication; use results as awareness tools for behaviour change and nudging and; make the research methodology transparent.

Local governments and their arms would be the most effective channel of communication, said Baby. Local WhatsApp groups had a role to play but were also being used to spread fake news

and rumours. Kerala's strategy of holding a daily press conference at a fixed hour could be adopted easily.

Local governments could use community radio, community organizations, frontline staff, (anganwadi workers, ASHAs, ANMs, postmen, teachers, etc)

The Government of Andhra Pradesh has introduced ward volunteers, said Reddy. These were the main point of contact with the households. The volunteers report to Ward Secretariat which interacts directly with the municipality for improving the quality of public services. The same system is implemented in rural areas as well. The ward volunteers were members from the community, they enjoy the trust of citizens.

Members suggested using multiple channels to reach different audiences. Some of them were

WhatsApp: One of the most popular, used for spreading messages. It is powerful and multilingual. The district health officer can be provided readymade messages in the local language to transmit every day. They can be forwarded onto citizens through the health workers' network. However, it needs compatible phones and some literacy.

TikTok: Another hugely popular medium, this can run on lower-end phones and needs no literacy. Content can be produced and sent out in local languages.

Facebook: This has gained appeal during the lockdown and there is a lot of local language content. Can be used as a more static medium to put out messages by officials

Conventional media: Regular advertorials with detailed information can be placed in local papers and TV

Community radio: Can carry the audio content from TikTok to a local audience

A schedule to send out content will need to be established. The district swachhata preraks had developed an IEC strategy for districts with the messages, timings, media and person(s) responsible. This can be adapted for COVID-19.

Using outdoor channels could cause embarrassment to the "at risk" communities and lead to extended social stigma and ostracising, said Reddy. Social media channels could be construed to spread misinformation.

While social media channels were a quick way to reach a large audience, the messages were crucial, said Sunetra Lala. It should be possible for the leading doctors from hospitals in a town to endorse a message to the citizens that is credible and based on sound evidence. It should be around the reasons and benefits of testing sewage for COVID-19. The messages should clearly state there is no danger of getting COVID-19 from sewage or toilets if regular precautions like handwashing with soap were followed. Testing is being done with the sole purpose of identifying hot spots and taking preventive steps to contain the pandemic.

Community service officers could be an effective communication channel. They could be oriented, provided materials and protective gear, and deployed according to a calendar. They must be provided with enough information to communicate clearly and allay any fears people may have about surveillance and chances of infection.

For SBM, effective communications and monitoring channels were set up in most district and towns for toilet construction. These can be reactivated. The people trained as swachhata doots can be brought back and incentivised to work as COVID-19 communicators. Suitable modifications can be made in the guidelines for SBM 2 to enable this.

Therefore, while the need was more and accurate communication, this was not happening because of a lack of clarity on the messages and media. This underlined the challenge in communicating scientific evidence to people in a way that would not lead of mass panic. Members were clear it was required and an approach should be developed.

Way forward

The purpose of this discussion and the accompanying webinar was to understand how to develop a protocol for Indian conditions to test sewage and faecal sludge for the presence of the Sars-nCov-2 virus. The three parts are the technical protocol, a method to work with city or state governments, and a communications package for the public. The information provided in this discussion will guide the development of the protocol. This will be shared back with the community in draft form for specific inputs.

Respondents

The following SuSanA members contributed to the discussion

Name	Organization	Country
Arunabha Majumder	Jadavpur University	India
Swapnil Desai	Navi Mumbai Municipal corporation	India
Thakur Pandit	Freelancer (Civil Engineering)	Nepal
M S V K V Prasad	Swarnandhra College of Engineering & Technology	India
Arvind Raghuwanshi	Freelancer	India
Ajit Seshadri	Vels University	India
Srikant Guruswamy	Independent consultant	India
Elisabeth von Muench	Independent consultant	Australia
Seamus Kelly	Murphy Process Engineering	Ireland
Paresh Chajjed	Indian Institute of Technology, Bombay	India
Christian Zurbrugg	Swiss Federal Institute of Aquatic Science and Technology	Switzerland
N C Narayanan	Indian Institute of Technology, Bombay	India
Nagendra Singh	UNICEF	India
Carol McCreary	Public Hygiene Lets Us Stay Human	United States of America
Vanita Prasad	REVY Environmental Solutions Pvt. Ltd.	India
Claudia Viegas		Brasil
Nelson Enojo	Maasin City Health Office	Philippines
Malini Reddy	Administrative Staff College of India	India
Graham Alabaster	United Nations Settlements Programme	Switzerland
Sunetra Lala	SNV Cambodia	Cambodia
Kurian Baby	Consultant to Kerala Government	India
Meenakshi Dewan	India Sanitation Coalition	India
Rajesh Shah	Peer Water Exchange	India
Bernadette Dzifa Agbefu	Consultant	Ghana
Sruche Mittal	Administrative Staff College of India	India

Compiled by Nitya Jacob (Coordinator SuSanA India Chapter) and reviewed by Malini Reddy and Sanjeev Jha.

The Thematic Discussion Series Host

The thematic online discussion "*Thematic Discussion Synthesis: Testing Sewage For Early Warnings About Covid-19*" hosted by the Sustainable Sanitation Alliance (SuSanA) on the SuSanA Discussion Forum. The discussion is part of a series of online discussion taking place under the umbrella of the SuSanA India Chapter.

To view the whole discussion, please go to the SuSanA Forum: https://forum.susana.org/testing-sewage-for-early-warnings-about-covid-19-thematic-discussion-by-susana-india-chapter

Further Reading

1. Photo essay on sanitation workers in India, https://www.susana.org/en/knowledge-hub/resources-and-publications/library/details/3883
2. SARS-COV2 and the the water and wastewater management challenge in Bangalore, https://www.susana.org/en/knowledge-hub/resources-and-publications/library/details/3884
3. Sewage and wastewater: the key to finding hidden clusters of coronavirus, 2020. The Guardian. https://www.theguardian.com/world/2020/may/13/sewage-and-wastewater-the-key-to-finding-hidden-clusters-of-coronavirus
4. Tracking the course of the pandemic in wastewater. Eawag Aquatic Research. https://www.eawag.ch/en/news-agenda/news-portal/news-detail/tracking-the-course-of-the-pandemic-in-wastewater/
5. Computational analysis of SARS-CoV-2/COVID-19 surveillance by wastewater-based epidemiology locally and globally: Feasibility, economy, opportunities and challenges Olga E.Harta, Rolf U.Haldena. In Science of the Total Environment, 730 (2020) 138875. April 22, 2020. https://reader.elsevier.com/reader/sd/pii/S0048969720323925?token=C0480AE2B601A83A156DA1B7CFA0374DFE7B81BF20C5B7997DD65A24A4D23FA3034A0B1F95F073D3E505A3240278A6E5
6. SARS-CoV-2 titers in wastewater are higher than expected from clinically confirmed cases. Fuqing Wu, Amy Xiao, Jianbo Zhang, Xiaoqiong Gu, Wei Lin Lee, Kathryn Kauffman, William Hanage, Mariana Matus, Newsha Ghaeli, Noriko Endo, Claire Duvallet, Katya Moniz, Timothy Erickson, Peter Chai, Janelle Thompson, Eric Alm. https://doi.org/10.1101/2020.04.05.20051540
7. Monitoring wastewater for assessing community health: Sewage Chemical-Information Mining (SCIM). Christian G. Daughton, Journal of Science of the Total Environment. 2018. https://reader.elsevier.com/reader/sd/pii/S0048969717331601?token=8E976E4E4E86FF3C842807AAE5A8C8670DF18125EABFA33B70E7B4B82C275D2E20CA252A376AABBF7564DD77F45A2784
8. Aerosolization of Ebola Virus Surrogates in Wastewater Systems. Kaisen Lin, Linsey C. Marr. Environ. Sci. Technol. 51, 5, 2669-2675. Publication Date (Web): January 26, 2017. https://pubs.acs.org/doi/10.1021/acs.est.6b04846

9. Survivability, Partitioning, and Recovery of Enveloped Viruses in Untreated Municipal Wastewater. Yinyin Ye, Robert M. Ellenberg, Katherine E. Graham, and Krista R. Wigginton Environ. Sci. Technol. 50, 10, 5077-5085 April 25, 2016. 9pg. https://pubs.acs.org/doi/pdf/10.1021/acs.est.6b00876?ref=vi_coronavirus-survival-behavior
10. Evaluation of Phi6 Persistence and Suitability as an Enveloped Virus Surrogate, Nathalia Aquino de Carvalho, Elyse N. Stachler, Nicole Cimabue, Kyle Bibby. Environ. Sci. Technol. 51, 15, 8692-8700. June 28, 2017. https://pubs.acs.org/doi/pdf/10.1021/acs.est.7b01296?ref=vi_coronavirus-survival-behavior
11. Time course quantitative detection of SARS-CoV-2 in Parisian wastewaters correlates with COVID-19 confirmed cases. Sebastien Wurtzer, Vincent Marechal, Jean-Marie Mouchel, Laurent Moulin. https://doi.org/10.1101/2020.04.12.20062679
12. An Imperative Need for Research on the Role of Environmental Factors in Transmission of Novel Coronavirus (COVID-19) Guangbo Qu, Xiangdong Li Ligang, Hu Guibin Jiang. Environ. Sci. Technol. 54, 7, 3730-3732. March 23, 2020. https://pubs.acs.org/doi/10.1021/acs.est.0c01102?ref=pdf
13. Can a Paper-Based Device Trace COVID-19 Sources with Wastewater-Based Epidemiology? Kang MaoHua Zhang, Zhugen Yang. Environ. Sci. Technol. 54, 7, 3733-3735. March 23, 2020.3pg. https://pubs.acs.org/doi/pdf/10.1021/acs.est.0c01174?ref=vi_coronavirus-survival-behavior
14. A sewage surveillance effort to track COVID-19. March 26, 2020. Nicole Casal Moore. https://news.umich.edu/a-sewage-surveillance-effort-to-track-covid-19/
15. Poop could help stop the pandemic. Really. By Betsey Woodruff Swan, Daniel Lippman and Annie Snider. Politico. May 1, 2020. https://www.politico.com/news/2020/05/01/cdc-human-waste-coronavirus-222253?mc_cid=ce9fe77808&mc_eid=322767800e
16. How sewage reveals 'real numbers' on scale of outbreak. Tamara Ward, E&E News (Essential news for energy and environment professionals). Wednesday, May 6, 2020. https://www.eenews.net/stories/1063065235
17. EPA Expands Research on COVID-19 in the Environment April 20, 2020. https://www.epa.gov/newsreleases/epa-expands-research-covid-19-environment
18. How many people are infected with Covid-19. https://medium.com/@biobotanalytics/how-many-people-are-infected-with-covid-19-e7e8c6195d6b
19. The coronavirus has been found in Tacoma sewage. It could help scientists track the pandemic by Jeff Rice. Puget Sound Institute. https://www.pugetsoundinstitute.org/2020/04/coronavirus-found-in-tacoma-sewage-could-help-scientists-track-the-pandemic/
20. How sewage could reveal true scale of coronavirus outbreak. Wastewater testing could also be used as an early-warning sign if the virus returns. Smriti Mallapaty Nature. April 3, 2020. https://www.nature.com/articles/d41586-020-00973-x
21. The proof is in the poo: What your sewage can tell you about coronavirus hot spots. Chris McGuinnes for KGW8 (Portland) April 14, 2020.

https://www.kgw.com/article/news/local/tracking-coronavirus-covid19-in-sewage/283-68e6204d-8a44-462b-b0e6-20324ffcac22

22. Scientists are scrutinizing city sewage to study our health; It's not just useless crap. By Kate Baggaley. Popular Science July 5, 2017. https://www.popsci.com/city-health-sewage/
23. National Sewage Sludge Repository (NSSR) Run by the Laboratory of Dr. Ralf Halden at Arizona State University. https://biodesign.asu.edu/rolf-halden/research
24. More than 4 in 10 coronavirus cases are spread by those not obviously sick, a study suggests. By Tina Hesman Saey. Science News. April 15, 2020. https://www.sciencenews.org/article/coronavirus-covid-19-infection-contagious-days-before-symptoms-appear
25. An early warning system for coronavirus infections could be found in your toilet. By Brady Dennis. Washington Post. May 1, 2020. https://www.washingtonpost.com/climate-environment/2020/05/01/coronavirus-sewage-wastewater/
26. Zuccato, E., Chiabrando, C., Castiglioni, S. et al. Cocaine in surface waters: a new evidence-based tool to monitor community drug abuse. Environ Health 4, 14 (2005). https://doi.org/10.1186/1476-069X-4-14
27. Christian G. Daughton. Wastewater Surveillance for Population-Wide Covid-19: the Present and Future. Science of the Total Environment 2020, 736:139631; https://doi.org/10.1016/j.scitotenv.2020.139631
28. Christian G. Daughton, Monitoring wastewater for assessing community health: Sewage Chemical-Information Mining (SCIM), Science of The Total Environment, Volumes 619–620, 2018, Pages 748-764, ISSN 0048-9697, https://doi.org/10.1016/j.scitotenv.2017.11.102
29. Srikanth Guruswamy. Checking for COVID-19 in sewage schematic. https://www.susana.org/en/knowledge-hub/resources-and-publications/library/details/3885