National Wastewater Surveillance System (NWSS)

Wastewater Surveillance in Low-Resource Waste Systems

Use this guidance to implement wastewater-based disease surveillance. Wastewater-based disease surveillance is a rapidly developing science, and CDC will continue to update guidance and information as it becomes available.

Overview of wastewater surveillance in low-resource waste systems

Wastewater surveillance for SARS-CoV-2, the virus that causes COVID-19, is the strategic sampling and testing of wastewater for the presence of SARS-CoV-2 RNA to provide information about the presence of COVID-19 in a community. Low-resource waste systems are ineffective centralized systems (e.g., systems with substantially decaying infrastructure) or wastewater-impacted environmental waters. Wastewater surveillance may be beneficial to the COVID-19 public health response in settings served by low-resource waste systems as these systems are often present in areas with disease surveillance challenges.

SARS-CoV-2 data from wastewater testing are not intended to replace existing COVID-19 surveillance systems, but rather complement existing surveillance systems for the following reasons:

- As SARS-CoV-2 can be shed in the feces of individuals with symptomatic or asymptomatic infection, wastewater surveillance for SARS-CoV-2 may provide community infection information not collected through reported cases.
- Although SARS-CoV-2 detection in wastewater has been demonstrated as a leading indicator of COVID-19 presence in communities, it is less documented in low-resource waste systems.
- Low-resource waste systems often occur in settings with reduced individual-based disease surveillance data, where timely SARS-CoV-2 clinical testing is underutilized or unavailable. In such settings, wastewater surveillance could provide disease information for communities with otherwise limited or no data.

Definitions

- **Wastewater**, also referred to as **sewage**, includes water from household or building use (such as toilets, showers, and sinks) that can contain human fecal waste, as well as water from non-household sources (including rainwater runoff and industrial use).
- **Wastewater surveillance** is the strategic sampling and testing of wastewater and analysis and interpretation of the collected data (such as presence or concentration of pathogens, physical-chemical measures) to better understand disease within a community. **Wastewater-impacted environmental waters** include open drains, canals, or surface waters that directly receive untreated human fecal waste.
- **Centralized** (or sewered) **wastewater systems** transport wastewater through a piped network to a central waste treatment facility and often serve urban communities.

- **Decentralized wastewater systems**—like pit latrines or septic tanks—collect, treat, and/or dispose of wastewater close to the point of generation and often serve smaller communities or individual households.
- **Low-resource waste systems** are ineffective centralized systems (e.g., systems with substantially decaying infrastructure) or wastewater-impacted environmental waters. These systems have unknown fecal inputs and losses and are open to environmental processes that unpredictably impact the persistence of SARS-CoV-2 RNA throughout the system, including sunlight, predation from other microorganisms, and variable pH and temperature.

Uses of wastewater surveillance in low-resource waste systems

Wastewater surveillance for SARS-CoV-2 is a useful supplement to case surveillance because it provides data on COVID-19 presence within a community that is independent of healthcare-seeking behavior or access and potentially in advance of clinically reported cases. For these reasons, wastewater surveillance for SARS-CoV-2 in low-resource waste systems could provide a critical supplementary data source, particularly in communities without clinical surveillance resources. For information on wastewater surveillance in centralized systems, see CDC National Wastewater Surveillance System.

Distinct from SARS-CoV-2 surveillance in effective centralized systems, wastewater infectious disease surveillance in low-resource waste systems presents unique challenges because:

- Fecal inputs and losses in ineffective centralized systems are unknown, as they often have significant infrastructure damage that can allow wastewater to flow into the surrounding environment and can allow for the introduction of unknown amounts of water and other contaminants into the waste system.
- When untreated wastewater from communities flows into open drains, canals, or surface waters, wastewater mixes with groundwater and surface water in the environment (river water, runoff, or precipitation). These wastewater-impacted environmental waters are open to environmental processes that unpredictably impact the decay of SARS-CoV-2 RNA within the system.
- The residence time of feces within low-resource waste systems often cannot be determined due to immeasurable fecal inputs and losses, as well as environmental decay processes.
- Large portions of the population may be served by decentralized waste systems (such as pit latrines or septic systems), which are less effective for wastewater surveillance because they receive waste from small or undefined populations and are usually not well mixed to allow for representative sampling.

Considering these challenges, wastewater surveillance for SARS-CoV-2 in low-resource waste systems **can be used to**:

1. **Confirm the presence** of COVID-19 within a community when community-level transmission has already been established by case surveillance.
    - Presence of SARS-CoV-2 RNA can inform clinical testing and community mitigation strategies, such as increased testing of individuals in the affected community and increased public health communication.
    - When community-level transmission has not been established by case surveillance, presence of SARS-CoV-2 might serve as a leading indicator for COVID-19 in the community, but this application has not yet been demonstrated in low-resource waste systems and reliance on this as a stand-alone approach is not advised.
2. **Potentially screen specific populations for COVID-19** by targeting waste flowing from specific facilities, such as hospitals.
    - Currently, there are few data evaluating the use of this approach for informing public health action or institutional operations and more research is warranted.
    - See CDC's considerations for targeted wastewater surveillance
3. **Generate SARS-CoV-2 genome sequence data** that can be used to better understand different SARS-CoV-2 strains circulating in a community.

Limitations of wastewater surveillance in low-resource waste systems

There is a lack of data on the concentration of SARS-CoV-2 shed in feces—both throughout the duration of illness in a single person and by different people. In addition, SARS-CoV-2 concentration and persistence in low-resource waste systems can vary considerably over space and time.

Therefore, wastewater surveillance for SARS-CoV-2 in low-resource waste systems **cannot be used to:**

1. **Indicate the absence** of COVID-19 within a community. The amount of SARS-CoV-2 RNA in a sample collected from a low-resource waste system may be below the lowest amount that the test used can detect. This low level could be because few people in the community are shedding SARS-CoV-2 in their feces, the amount of virus shed by infected people is low, or the SARS-CoV-2 shed in feces is diluted or degraded due to ineffective centralized wastewater systems or factors in the wastewater-impacted environment.
2. **Determine trends in new infections within a community.** To determine trends in SARS-CoV-2 concentrations, the fecal inputs and persistence of the virus must be relatively consistent over time, which is unlikely in low-resource waste systems.
3. **Estimate the number of infected individuals (COVID-19 disease prevalence) in a community**. To develop and utilize models that estimate infection numbers, fecal inputs and persistence of the virus must be relatively consistent over time, which is unlikely in low-resource waste systems.

Implementation of wastewater surveillance in low-resource waste systems

The public health utility of wastewater surveillance for SARS-CoV-2 has not yet been thoroughly demonstrated in low-resource waste systems. Prior to implementing wastewater surveillance in these systems, sustainable sampling and analytical methodologies must be developed and pilot studies are needed to establish sampling and testing logistics (such as the ability to collect samples and the turnaround time for test results) to provide useful data. These studies will require environmental engineering and microbiology expertise, laboratory capacity, and collaboration with epidemiologists and other public health experts to generate data for public health use. Consider the following with regard to sampling, testing, and public health use of SARS-CoV-2 wastewater surveillance data from low-resource waste systems:

Sampling

- Follow standard safety practices for those handling untreated wastewater, including engineering and administrative controls, hygiene precautions, specific safe work practices, and personal protective equipment (PPE) required when handling untreated wastewater. Perform site- and activity-specific biosafety risk assessments should be performed to determine if additional biosafety precautions are warranted.
- Wastewater surveillance for infectious poliovirus [PDF – 28 pages] has been used for decades as a supplement to acute flaccid paralysis. Long-term polio surveillance sampling sites, including both centralized and low-resource waste systems, may be ideal for SARS-CoV-2 wastewater surveillance because they represent known populations.
- For more information regarding sampling frequency and site selection for evaluating SARS-CoV-2 presence in a community, see NWSS Sampling Strategies.

Testing

- Specialized equipment and supplies for SARS-CoV-2 detection in wastewater may be difficult to procure. Consistent power supply may also be a challenge in some areas, especially in rural areas where these types of resources are more limited.

- Since environmental molecular microbiology laboratories are not common, clinical microbiologists may need to be trained to process and test environmental samples for the detection of SARS-CoV-2 RNA.
- Measuring a human-specific fecal marker in samples can help quantify the contribution of total human feces in the sample, which may aid in understanding the relative contribution of fecal matter to SARS-CoV-2 RNA detected. These markers may need to be established for individual communities since measures may vary by diet or location.
- Robust laboratory controls and a quality management system are necessary to generate reliable SARS-CoV-2 data from complex sample types like wastewater and wastewater-impacted environmental waters.

Public Health Interpretation

- **SARS-CoV-2 wastewater surveillance is not a standalone surveillance approach**. It is critical to partner with epidemiologists, environmental engineers, and other public health partners to best understand these data in the context of public health response and other health indicators.
- **The absence of SARS-CoV-2 RNA does not indicate lack of COVID-19 in the community.** There is a lack of data on the concentration of SARS-CoV-2 shed in feces throughout the course of infection, and the fecal inputs and viral persistence in low-resource waste systems are difficult to characterize. SARS-CoV-2 RNA may not be present in low-resource waste system samples until after community-level transmission has already been established through case surveillance.
- **Data generated from an ineffective centralized system may not be representative of the populations surrounding the network.** For example, large proportions of residents in areas served by these systems may not have access to the piped network (such as those living in informal settlements or who have a decentralized sewer system such as a septic system).

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