Wastewater-Based Disease Surveillance for Local Public Health Action

TEXAS Health and Human Services
Texas Department of State Health Services

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Introduction

Background

Wastewater-based disease surveillance is an innovative approach in public health, utilizing the analysis of municipal wastewater to detect the presence of pathogens within a community before trends in clinical cases are observed. This method provides a non-invasive, anonymous approach to monitor pathogen trends and can offer early warning signs of disease outbreaks, including COVID-19, influenza, and other communicable diseases. By examining municipal wastewater, public health officials can identify potential threats by pathogens before they become widespread, enabling a rapid response to mitigate their impact.

Wastewater-based disease surveillance involves the collection and analysis of sewage samples from municipal wastewater treatment plants and sewer systems. These samples are tested for genetic material of pathogens that provide insights into the level of disease transmission within a population. The data obtained from wastewater-based disease surveillance complements traditional public health surveillance methods, offering a broader and more inclusive snapshot of community health.

The Texas Department of State Health Services (DSHS) Wastewater Epidemiology and Surveillance Program is a statewide disease monitoring system. The Program partners with local water utilities and health departments to monitor pathogens in municipal wastewater and help communities prepare for and act against disease outbreaks.

Purpose

The primary objective of this document is to translate the data gathered from wastewater-based disease surveillance for public health insight and action. Local public health departments have a critical role in protecting and promoting the health of their communities, and this document aims to provide them with a structured approach to utilize wastewater data effectively. By integrating wastewater data into public health practice, local health departments may enhance their surveillance capabilities, improve outbreak response times, and ultimately safeguard the health and wellbeing of our communities.

The document was developed by the DSHS Wastewater Epidemiology and Surveillance Program in consultation with the DSHS Emerging and Acute Infectious Disease Unit. This document is not prescriptive, and public health action at various levels of pathogen detection should be tailored to each local health department and community.

Resources

CDC National Wastewater Surveillance System (NWSS)
https://www.cdc.gov/nwss/

Houston National Wastewater Surveillance System Center of Excellence
https://www.hou-wastewater-epi.org/

Contact

DSHS Wastewater Epidemiology & Surveillance Program
https://www.dshs.texas.gov/wastewater-epidemiology-surveillance-program

DSHS Emerging and Acute Infectious Disease Unit
https://www.dshs.texas.gov/idps-home/emerging-acute-infectious-disease-eaid-unit

Influenza virus

Influenza is a contagious respiratory illness caused by influenza viruses that infect the nose, throat, and sometimes the lungs.[1] It can cause mild to severe illness (e.g., fever, cough, body aches, fatigue), and at times can lead to death.[1] Shedding of influenza virus RNA has been reported in respiratory secretions and in feces of infected individuals.[2] Influenza virus RNA may enter sewage systems through toilets, sinks, and shower drains, which has been confirmed by the detection of influenza virus RNA in wastewater samples.[3]

There are four types of influenza viruses: A, B, C, and D.[4] Influenza A and B viruses cause seasonal epidemics of disease (known as flu season) every fall and winter in the United States.[4] Influenza A viruses are the only influenza viruses known to cause flu pandemics (i.e., global epidemics of flu disease).[4]

Influenza virus wastewater data is normalized using sewershed population and is reported as gene copies per liter per 1,000 individuals (gc/L/1,000). Seasonal influenza virus baselines are evaluated weekly and are calculated as the tenth percentile of non-zero seasonal influenza virus wastewater values. Non-zero seasonal influenza virus wastewater values are ordered from lowest to highest and the ordered values are grouped into five categories: Very Low (1-20%), Low (21-40%), Moderate (41-60%), High (61-80%), and Very High (81-100%).

Actions to Consider

Very Low	Low	Moderate	High	Very High
Prepare a prevention and response plan that includes vaccines and testing.	Continue monitoring public health surveillance systems.	Remind higher risk facilities (e.g., childcare centers, schools, long term care facilities, prisons) of infection control measures.	Community outreach (e.g., K-12 text or email alerts, media outreach, social media outreach, etc.). Host vaccine and testing centers.	Consider a Health Alert to notify healthcare providers.
If suspected cases exist, encourage healthcare providers to coordinate with local health departments on clinical sample submission. Implement a prevention and response plan as applicable based on level of detection. As one moves to higher levels of detection, actions at lower levels may be considered or continue to be implemented as appropriate.				

Contact the DSHS influenza team (flutexas@dshs.texas.gov) and your appropriate Public Health Region for assistance with local public health response efforts.

Influenza A(H5) virus

Highly pathogenic avian influenza (HPAI) viruses usually spread between birds.[5] One subtype of HPAI viruses, HPAI A(H5), is spreading worldwide in wild birds and causing sporadic outbreaks in U.S. poultry and dairy cows.[5] In addition to spreading to an increasing number of mammals, HPAI viruses have caused some rare human infections.[5] Human illness caused by HPAI A(H5) viruses has ranged from mild symptoms (e.g., mild fever, eye redness and irritation, cough, sore throat, runny or stuffy nose, muscle or body aches, headaches, fatigue) to severe illness (e.g., high fever, shortness of breath, altered consciousness, seizures).[5] Most human cases of HPAI A(H5) in the U.S. have been mild and most had known exposure to sick or infected animals.[5] Infected birds and other animals can spread HPAI A(H5) virus RNA through their mucous, saliva, or feces.[5] HPAI A(H5) virus RNA may enter sewage systems through discarded contaminated animal products (e.g., milk, poultry, etc.) as well as secretions or excretions from asymptomatic or symptomatic individuals.

HPAI A(H5N1) virus wastewater values are grouped into three categories:

- **No recent detection**: HPAI A(H5N1) virus was not detected in any samples in the past four weeks.
- **Detection**: HPAI A(H5N1) virus was detected in one or two samples in the past four weeks.
- **Persistent detection**: HPAI A(H5N1) virus was detected in more than two samples in the past four weeks.

Actions to Consider

No Recent Detection	Detection	Persistent Detection
Prepare a prevention and response plan that includes testing and public health follow-up. Continue monitoring public health surveillance systems.	Consider potential animal sources of HPAI A(H5). Contact the DSHS zoonosis team (the.vet@dshs.texas.gov) and your appropriate Public Health Region for assistance.	Consider a Health Alert notifying healthcare providers – include a recommendation to consider HPAI A(H5) in providers' differential diagnoses. Consider occupational health education and/or surveillance (e.g., dairy farm workers; poultry farm workers) if applicable. Contact the DSHS Occupational Health Surveillance Program (epitox@dshs.texas.gov), DSHS zoonosis team (the.vet@dshs.texas.gov), and your appropriate Public Health Region for assistance.
If suspected human cases exist, encourage healthcare providers to coordinate with local health departments on clinical sample submission and public health follow-up. Implement a prevention and response plan as applicable based on level of detection. As one moves to higher levels of detection, actions at lower levels may be considered or continue to be implemented as appropriate.		

Contact the DSHS influenza team (flutexas@dshs.texas.gov) and your appropriate Public Health Region for assistance with local public health response efforts.

Measles virus

Measles is a highly contagious respiratory illness caused by measles virus that infects the nose and throat.[6] It can cause mild to severe illness (e.g., fever, cough, runny nose, red eyes, sore throat, rash), severe complications (e.g., pneumonia, encephalitis, weakened immune system), and at times can lead to death.[6] Measles is one of the most contagious of all infectious diseases. Individuals infected with measles are contagious about four days before rash onset to four days after the rash appears. Up to 90% of individuals nearby a person with measles will also become infected with measles if not immune.[6] Shedding of measles virus RNA has been reported in urine from infected individuals.[7] Measles virus RNA may enter sewage systems through toilets, sinks, and shower drains, which has been confirmed by the detection of measles virus RNA in wastewater samples.[7]

Wild-type measles virus wastewater values are grouped into three categories:

- **No recent detection**: Measles virus was not detected in any samples in the past four weeks.
- **Detection**: Measles virus was detected in one or two samples in the past four weeks.
- **Persistent detection**: Measles virus was detected in more than two samples in the past four weeks.

Actions to Consider

No Recent Detection	Detection	Persistent Detection
Prepare a prevention and response plan that includes vaccines, testing, and public health follow-up. Continue monitoring public health surveillance systems.	Contact the DSHS Vaccine Preventable Disease team (VPDTexas@dshs.texas.gov) and your appropriate Public Health Region for assistance. Community outreach (e.g., K-12 text or email alerts, media outreach, social media outreach, etc.). Offer measles education and vaccines during public health activities. Include measles prevention and postexposure prophylaxis in discussions with healthcare providers. Consider a Health Alert notifying healthcare providers – include a recommendation to consider measles in providers' differential diagnoses.	Host vaccine and testing centers. Expand approval processes to increase testing and case identification. Remind higher risk facilities (e.g., childcare centers, schools, long term care facilities, prisons) of infection control measures. Provide infection control education to healthcare facilities and providers. Consider targeted awareness and vaccination campaigns.
If suspected cases exist, encourage healthcare providers to coordinate with local health departments on clinical sample submission and public health follow-up. Implement a prevention and response plan as applicable based on level of detection. As one moves to higher levels of detection, actions at lower levels may be considered or continue to be implemented as appropriate.		

Contact the DSHS Vaccine-Preventable Disease Team (vpdtexas@dshs.texas.gov) and your appropriate Public Health Region for assistance with local public health response efforts.

Monkeypox virus

Mpox (formerly known as monkeypox) is a disease caused by infection with monkeypox virus.[8] People with mpox often get a rash that may be located on hands, feet, chest, face, mouth, or genital area.[8] Shedding of monkeypox virus DNA has been reported in skin lesions, saliva, feces, and urine from infected individuals.[9] Monkeypox virus DNA may enter sewage systems through toilets, sinks, and shower drains, which has been confirmed by the detection of monkeypox virus DNA in wastewater samples.[9]

There are two types of mpox: clade I and clade II. Clade I is responsible for the current rise of cases in Central and Eastern Africa.[8] Historically, clade I caused higher numbers of severe illnesses than clade II, with up to 10% of people dying.[8] Recent outbreaks have seen much lower death rates of about 1 to 3.3%.[8] Clade II is the type that caused the global outbreak that began in 2022.[8] Infections by clade II monkeypox virus are less severe – more than 99.9% of people survive.[8] Clade II is endemic to West Africa.[8]

Monkeypox virus wastewater values are grouped into three categories:

- **No recent detection**: Monkeypox virus was not detected in any samples in the past four weeks.
- **Detection**: Monkeypox virus was detected in one or two samples in the past four weeks.
- **Persistent detection**: Monkeypox virus was detected in more than two samples in the past four weeks.

Actions to Consider

No Recent Detection	Detection	Persistent Detection
Prepare a prevention and response plan that includes vaccines, testing, and public health follow-up. Continue monitoring public health surveillance systems.	Offer mpox education and vaccines during public health events and activities. Include mpox prevention in discussions about HIV PEP (post-exposure prophylaxis), HIV PrEP (pre-exposure prophylaxis), or doxy PEP.	Consider a Health Alert to notify healthcare providers – include a recommendation to consider mpox in providers' differential diagnoses. Consider targeted awareness and vaccination campaigns.
If suspected cases exist, encourage healthcare providers to coordinate with local health departments on clinical sample submission and public health follow-up. Implement a prevention and response plan as applicable based on level of detection. As one moves to higher levels of detection, actions at lower levels may be considered or continue to be implemented as appropriate.		

Contact the DSHS High Consequence Infectious Diseases Team (eaidumonitoring@dshs.texas.gov) and your appropriate Public Health Region for assistance with local public health response efforts.

Norovirus

Norovirus is a very contagious virus that causes acute gastroenteritis, an inflammation of the stomach or intestines, that leads to vomiting and diarrhea.[10] Norovirus is the leading cause of foodborne illness in the United States.[10] Shedding of norovirus RNA has been reported in vomit and in feces of infected individuals.[10] Norovirus RNA may enter sewage systems through toilets, sinks, and shower drains, which has been confirmed by the detection of norovirus RNA in wastewater samples.[11] Noroviruses are classified into five genogroups, with most human infections resulting from genogroups GI and GII.[10]

Norovirus wastewater data is normalized using sewershed population and is reported as gene copy per liter per 1,000 population (gc/L/1,000). Norovirus baselines are evaluated weekly and are calculated as the 10th percentile of non-zero norovirus wastewater values. Non-zero norovirus wastewater values are ordered from lowest to highest and the ordered values are grouped into five categories: Very Low (1-20%), Low (21-40%), Moderate (41-60%), High (61-80%), and Very High (81-100%).

Actions to Consider

Very Low	Low	Moderate	High	Very High
Prepare an outbreak prevention and response plan that includes testing and public health follow-up.	Continue monitoring public health surveillance systems.	Remind food services of safe food handling practices. Remind higher risk facilities (e.g., childcare centers, schools, long term care facilities, prisons) of infection control measures.	Community outreach (e.g., K-12 text or email alerts, media outreach, social media outreach, etc.).	Consider a Health Alert to notify healthcare providers.
Report suspected norovirus outbreaks in the CDC National Outbreak Reporting System (NORS) and the CDC National Environmental Assessment Reporting System (NEARS). If a suspected outbreak exists, encourage healthcare providers to coordinate with local health departments on clinical sample submission and public health follow-up. Implement a prevention and response plan as applicable based on level of detection. As one moves to higher levels of detection, actions at lower levels may be considered or continue to be implemented as appropriate.				

Contact the DSHS Foodborne Illness Team (foodbornetexas@dshs.texas.gov) and your appropriate Public Health Region for assistance with local public health response efforts.

Respiratory syncytial virus

Respiratory syncytial virus, or RSV, is a common respiratory virus that infects the nose, throat, and lungs.[12] RSV symptoms make it difficult to distinguish it from the common cold or other respiratory viruses (like the flu or COVID-19).[12] Shedding of RSV RNA has been reported in respiratory secretions and in feces of infected individuals.[13] RSV RNA may enter sewage systems through toilets, sinks, and shower drains, which has been confirmed by the detection of RSV RNA in wastewater samples.[13]

RSV wastewater data is normalized using sewershed population and is reported as gene copy per liter per 1,000 population (gc/L/1,000). RSV baselines are evaluated weekly and are calculated as the 10th percentile of non-zero RSV wastewater values. Non-zero RSV wastewater values are ordered from lowest to highest and the ordered values are grouped into five categories: Very Low (1-20%), Low (21-40%), Moderate (41-60%), High (61-80%), and Very High (81-100%).

Actions to Consider

Very Low	Low	Moderate	High	Very High
Prepare a prevention and response plan that includes vaccines, testing, and public health follow-up.	Continue monitoring public health surveillance systems.	Remind higher risk facilities (e.g., childcare centers, schools, long term care facilities, prisons) of infection control measures.	Community outreach (e.g., K-12 text or email alerts, media outreach, social media outreach, etc.). Host vaccine, immunization, and testing centers.	Consider a Health Alert to notify healthcare providers.
If a suspected outbreak exists, encourage healthcare providers to coordinate with local health departments on clinical sample submission and public health follow-up. Implement a prevention and response plan as applicable based on level of detection. As one moves to higher levels of detection, actions at lower levels may be considered or continue to be implemented as appropriate.				

Contact the DSHS Vaccine-Preventable Disease Team (vpdtexas@dshs.texas.gov) and your appropriate Public Health Region for assistance with local public health response efforts.

SARS-CoV-2

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is the virus that causes COVID-19 (coronavirus disease 2019).[14] COVID-19 most often causes respiratory symptoms that resemble a cold, the flu, or pneumonia.[14] Other parts of the body may also be affected by the disease.[14] Most people with COVID-19 have mild symptoms, but some people become severely ill.[14] Shedding of SARS-CoV-2 RNA has been reported in respiratory secretions and in feces of infected individuals.[15] SARS-CoV-2 RNA may enter sewage systems through toilets, sinks, and shower drains, which has been confirmed by the detection of SARS-CoV-2 RNA in wastewater samples.[16]

SARS-CoV-2 wastewater data is normalized using sewershed population and is reported as gene copy per liter per 1,000 population (gc/L/1,000). SARS-CoV-2 baselines are evaluated weekly and are calculated as the 10th percentile of non-zero SARS-CoV-2 wastewater values. Non-zero SARS-CoV-2 wastewater values are ordered from lowest to highest and the ordered values are grouped into five categories: Very Low (1-20%), Low (21-40%), Moderate (41-60%), High (61-80%), and Very High (81-100%).

Actions to Consider

Very Low	Low	Moderate	High	Very High
Prepare a prevention and response plan that includes vaccines and testing.	Continue monitoring public health surveillance systems.	Remind higher risk facilities (e.g., childcare centers, schools, long term care facilities, prisons) of infection control measures.	Community outreach (e.g., K-12 text or email alerts, media outreach, social media outreach, etc.). Host vaccine and testing centers.	Consider a Health Alert to notify healthcare providers.
If a suspected outbreak exists, encourage healthcare providers to coordinate with local health departments on clinical sample submission. Implement a prevention and response plan as applicable based on level of detection. As one moves to higher levels of detection, actions at lower levels may be considered or continue to be implemented as appropriate.				

Contact the DSHS SARS-CoV-2 Team (coronavirus@dshs.texas.gov) and your appropriate Public Health Region for assistance with local public health response efforts.

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Wastewater Epidemiology & Surveillance Program
dshs.texas.gov/wastewater-epidemiology-surveillance-program