Through COVID-19 and Beyond: The Roles of National & Local Wastewater Surveillance Systems

Wednesday, August 3rd
1:00 – 2:30 PM
Housekeeping

• All participants are in **listen-only mode**.

• You may submit your **questions** or **comments** at anytime through the online platform using the **Q&A feature**.
  
  • Type your question(s) into the “Q&A Box” located in the Zoom toolbar. Questions will be answered during the Q&A session, as time permits.

• This webinar will be recorded and available shortly after today. Presentation slides, call notes and resources from today's presentation will be shared as permitted by the speakers.
The Wastewater Surveillance Mentorship Program

2021-2022 Pilot Program
• Funded two mentees (Chautauqua County; Genesee and Orleans County) and one mentor site (City of Tempe, AZ).

2022-2023 Program (tentative)
• Additional information and application available in Fall 2022.
• Check our website at https://www.naccho.org/wash or contact Deise Galan (dgalan@naccho.org).
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<td>Welcome &amp; Housekeeping</td>
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<td>Presentation: Centers for Disease Control and Prevention</td>
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<td>Discussion and Q&amp;A</td>
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Centers for Disease Control and Prevention

Amy E. Kirby, PhD MPH
National Wastewater Surveillance System Program Lead
Waterborne Disease Prevention Branch
Division of Foodborne, Waterborne and Environmental Diseases
Centers for Disease Control and Prevention (CDC)
City of Tempe, AZ

Rosa Inchausti, MA
Deputy City Manager

Wydale K. Holmes, MPA, CPM, SPHR
Strategic Management Analyst
Genesee & Orleans Health Departments

**Keri Furness**
Lab Coordinator

**Brenden Bedard, MPH**
Director of Community Health Services
Chautauqua County Health and Human Services

Emily Beers, MS
Public Health Sanitarian

Breanne Agett, MS
Department Epidemiologist
Federal Perspective on Wastewater Surveillance and the National Wastewater Surveillance System

Amy E. Kirby, PhD MPH
National Wastewater Surveillance System Program Lead
Waterborne Disease Prevention Branch

NACCHO Webinar
August 3, 2022
Wastewater Surveillance | Public Health Toolbox

- Captures asymptomatic infections
- Independent of healthcare-seeking behavior and testing access
- Wastewater serves as an efficient pooled sample of community (or sub-community) infection levels
- Data available within days of viral shedding onset versus up to 2-week lag for other surveillance data
Successful Use of Wastewater Data for Response

State and local jurisdictions have used wastewater data to inform response decisions:

✓ Independent confirmation of true increases or decreases in cases
✓ Distribution, siting of test capacity
✓ Surveillance data in communities where clinical testing is limited or not available
✓ Near-term forecasting of cases or hospital utilization
✓ Monitoring the impact of home testing
✓ Detecting the emergence of Variants of Concern
NWSS Implementation

- 46 states, 5 major cities and 2 territories using CDC funds for wastewater surveillance
- Commercial testing contract services 315 sites nationwide, prioritizing vulnerable communities
  - Includes weekly sequencing
- >83,000 unique wastewater samples from >1200 sites in the NWSS data system representing >130M people
NWSS DCIPHER Data Dashboard: A one-stop shop for NWSS implementers

<table>
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<th>Metric</th>
<th>What does this show us?</th>
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<tr>
<td>Percent Change</td>
<td>Magnitude and direction of virus levels in a community</td>
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<tr>
<td>Percentiles</td>
<td>Relative levels of virus present in a community over time</td>
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<tr>
<td>Detection Proportion</td>
<td>How frequently is the virus detected in a community</td>
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<tr>
<td>Variant Specific Metrics</td>
<td>If a known variant is present, and at what proportion</td>
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Also includes-
- Resource library
- Contact list
- Automated QC reports
- Automated utility reports
- Support forum
SARS-CoV-2 Variant Tracking
SARS-CoV-2 Variant Tracking in Wastewater

- Wastewater sequencing is useful for known variant detection and tracking but the usefulness for variant discovery remains unclear.

- Interpretation is limited by:
  - fragmented genomes present in wastewater
  - methods detect variant-associated mutations, not full genomes
  - low method sensitivity relative to PCR
  - potential variation in shedding dynamics between variants, complicating analysis of relative proportions
US NWSS Sequencing Data Flow to Public SRA Repository

Organization chart

- Dept. of Health
- Federal Partner
- Commercial Partner

NCBI Sequence Read Archive (SRA)

US NWSS
DCIPHER AWS S3 Bucket

Data Generators

- Utility Partner
- Dept. of Health NWSS DoH Lab
- Academic Partners
- Federal Partner
- Commercial Partner TBD
NWSS Sequence Data Visualization Dashboard

**DCIPHER Dashboard Dominant Variant of Concern Map of US**

**Wastewater Dominant Variant per Sewershed for a wastewater sampling location**
NWSS Sequence Data Visualization Dashboard
Wastewater surveillance can inform diverse surveillance strategies

**Core**
- Regular surveillance for endemic or common diseases, such as flu or norovirus, that can be altered to fit the needs of the community.
- Provides regular, consistent updates at minimal cost

**Emergency**
- Rapid response for outbreaks, biosecurity concerns, or emerging diseases
- Provides acute, timely updates on a flexible platform

**Special Studies**
- Surveillance for diseases that disproportionately impact a region or demographic
- Provides specific, timely data for diseases of concern that may or may not be widespread
Transition to a single test type

The NWSS testing panel must be
- Quantitative
- Highly parallel or multiplexed
- Readily adapted
- Robust to inhibitors present in wastewater
- Low limits of detection

Digital PCR satisfies all of these requirements and is already in use by many NWSS laboratories
- Developing assays that are compatible with both BioRad and Qiagen dPCR systems
NWSS Panel v1.0

- Will include:
  - Fecal normalization control
  - Process control
  - Antibiotic resistance genes
  - Pathogen targets (influenza, STEC, norovirus, *Candida auris*)

- Reviewed annually by CDC NWSS Advisory Committee
- Additional assays developed for emergency use
- Anticipated roll out starting late 2022, early 2023
Monkeypox Outbreak in the US

As of August 1, 2022
- 5,811 confirmed cases in 48 states, DC, and Puerto Rico
  - CA – 827 cases
  - DC – 53 cases
  - FL – 442 cases
  - GA – 430 cases
  - IL – 520 cases
  - NY – 1390 cases
Challenges for Monkeypox Wastewater Surveillance

- Fecal shedding? – prevalence, magnitude, duration, and infectivity are unknown
- Dermal shedding may contribute to wastewater signal
- Assays (Orthopox or Monkeypox-specific) have not been validated in wastewater
  - Can virus be recovered and quantified reliably?
  - Are other, non-specific targets detected (false positives)?
- Case incidence may be too low and too widely distributed to be detectable
Positive detections in
- 19/22 saliva samples
- 21/23 rectal swabs
- 13/23 urine samples
- 14/22 fecal samples
Wastewater detections in California

Detection of monkeypox viral DNA in a routine wastewater monitoring program

Marlene K. Wolfe1*, Dorothea Duong2, Bridgette Hughes3, Vikram Chan-Herur4, Bradley J. White5, Alexandria B. Boehm3*

Monkeypox DNA Detection in Wastewater Solids

Wolfe et al. medRxiv July 26, 2022
Challenges for NWSS development and sustainability

- Extending coverage, 20% unsewered
- Improved metrics including estimating disease prevalence
- Optimal geographic and temporal sampling frame for multiple targets
- Improved methods, streamlined workflow
- Impact of vaccination and variants
- Improved data submission, dissemination, messaging
- Ethical transparency, especially around sample archiving
The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.
Through COVID-19 and Beyond: The Roles of National & Local Wastewater Surveillance Systems
Innovation Mission
To advance community health while serving as a national model, the City of Tempe utilizes sewage data derived from wastewater-based epidemiology to inform city decisions, strategic policy and operational strategies.

Rosa Inchausti
Deputy City Manager
Chief Innovation Officer

Wydale K. Holmes
Interim Director
Strategic Management & Diversity Office
Changing the trajectory of public health at a local level with science, equity and trust.
Indicators of Community Health: COVID-19
https://covid19.tempe.gov/pages/indicators

COVID Story Map: https://covid19.tempe.gov/

COVID Wastewater Dashboard
https://tempegov.maps.arcgis.com/apps/dashboards/45f1871d65824746a46aa25ea5955a5f

Tempe Opioids Wastewater Collection

Opioid Companion Story Map
https://tempegov.maps.arcgis.com/apps/MapJournal/index.html?appid=c40206ce59a442a8bc49bcfe6637b8f&folderid=8b2e74c10a0c456790fa75406269f729

Opioid Abuse Probable EMS Call Dashboard

Rosa Inchausti
Deputy City Manager
Chief Innovation Officer
rosa_inchausti@tempe.gov
480-350-8999

Wydale K. Holmes
Interim Director
Innovation and Strategic Management Office
wydale_holmes@tempe.gov
480-350-5312
WASTEWATER SURVEILLANCE
A RURAL PROSPECTIVE
GENESEE COUNTY, NEW YORK

BY: BRENDEN BEDARD, MPH AND KERI FURNESS
STAFF

Keri Furness – Lab Coordinator

Emily Nojeim – COVID-19 Response Specialist

Brenden Bedard, MPH – Director of Community Health Services/ Deputy Public Health Director
OUTLINE

• BACKGROUND ON GENESEE AND ORLEANS COUNTY HEALTH DEPARTMENTS
• GENESEE AND ORLEANS COUNTY LABORATORY PROCESS
• EPIDEMIOLOGY
• EXPANDED FUTURE USES
GENESEE AND ORLEANS COUNTIES

• Genesee and Orleans are rural counties that are located between the cities of Rochester and Buffalo in Western New York.

• It was estimated that 42,883 people, 16,119 households, and 10,872 families lived in the district of Orleans county 2020 census.

• There were 60,079 people living in Genesee County as of the 2020 census.
CROSS-JURISDICTIONAL PARTNERSHIP BACKGROUND

• RELATIONSHIP BEGAN IN OCTOBER 2012
• INITIALLY WAS A PILOT THAT WAS FUNDED BY THE ROBERT WOOD JOHNSON FOUNDATION
• ONLY TWO COUNTIES IN NEW YORK STATE THAT HAS THIS PARTNERSHIP
• STAFF ARE INTEGRATED BETWEEN BOTH COUNTIES
• FINANCIALLY HAS SAVED OVER MILLION DOLLARS FOR BOTH TAX COUNTY BASES
EPIDEMIOLOGY SURVEILLANCE

- Relying on sick people getting tested
- Asymptomatic carriers
- Laboratory Reporting
- Home tests
- Cost
USING WASTEWATER FOR SURVEILLANCE

- Captures virus of symptomatic and asymptomatic
- Early indicator
- Does not depend on people having access to care
- Does not depend on availability of COVID-19 testing
- Nearly 80% of US Households are served by municipal wastewater collection systems
WASTEWATER PROCESS OVERVIEW

STEP 1: Sample Collection
- Either at primary influent, sewer basin, or at facility

STEP 2: Transfer to testing lab for analysis

STEP 3: Addition of BCoV Matrix Recovery Control

STEP 4: Viral Concentration
- *Largest Bottleneck in Processing*

STEP 5: Viral RNA Extraction

STEP 6: Viral Quantification

STEP 7: Data Interpretation
SAMPLING PROTOCOL

• We follow the GT-Molecular Digital Wastewater Surveillance Guide for sampling collecting, transporting, processing and analyzing of wastewater samples for SARS-CoV-2
SAMPLE COLLECTION

• Testing 7 Wastewater Treatment Plants (WWTP) between Genesee and Orleans County.
  • Orleans County:
    • Albion, Holley, Lyndonville and Medina
  • Genesee County:
    • Batavia, Elba and Leroy
SAMPLE COLLECTION CONTINUED

• The samples are collected after the wastewater enters the treatment facility.

• 24 hour composite samples are collect by 6 out of the 8 WWTP's.
TRANSPORTING SAMPLES

SUPPLIES FOR TRANSPORT

• 50 ML CONICAL TUBES
• PLASTIC BAG
• CHAIN OF CUSTODY FORM
• ICE PACKS
MATRIX RECOVERY CONTROL

- BCoV – BOVINE CORONA VIRUS
CONCENTRATING THE SAMPLES

- CONCENTRATING IS EXTREMELY IMPORTANT
- ULTRAFILTRATION METHODS
- INNOVAPREP CONCENTRATION PIPETTE
INNOVAPREP CONCENTRATING PIPETTE

• INNOVAPREP WORKS BY END POINT FILTRATION

• THE WASTEWATER GETS PULLED INTO THE CONCENTRATING PIPETTE TIP (CPT) CONTAINING A HOLLOW FILTER

• ELUTED USING A WET FOAM SOLUTION
VIRAL RNA EXTRACTION

• EXTRACTION IS VITAL TO THE SAMPLE PROCESS.
• QIAGEN’S ALL PREP POWERVIRAL DNA/RNA KIT
DIGITAL PCR

• DIGITAL POLYMERASE CHAIN REACTION IS A BIOTECHNOLOGICAL REFINEMENT OF CONVENTIONAL POLYMERASE CHAIN REACTION METHODS THAT CAN BE USED TO DIRECTLY QUANTIFY AND CLONALLY AMPLIFY NUCLEIC ACIDS STRANDS INCLUDING DNA, CDNA, OR RNA.
Real-time qPCR

Bulk reaction analysis

Relative quantification: $C_q$

Digital PCR

Random distribution of molecules into partitions

Absolute quantification: Copies/µl
COVID-19 Wastewater Analysis

Public health departments are increasingly using wastewater as a public health tool to analyze for overall COVID-19 levels within a community. Research shows that individuals who have COVID-19 can shed viral particles in their stool.

When individuals positive with COVID-19 live in an area served by a sewer system (also known as a "sewer shed"), theyflush viral particles in their stool down the toilet which makes its way to the community wastewater treatment plant (WWTP). Then, their wastewater is combined with that of other households. Aggregated (combined) wastewater samples can then be collected at WWTPs, and the samples can be analyzed (expected) to find out how much virus is being shed by the people in the community.
Orleans County Weekly Case Incidence and Detected COVID-19 RNA Concentration by Sewershed Site

Weekly Incident Cases per 100,000 persons

RNA copies per Liter per 100,000 persons

Date*


Orleans County Incidence
CDC High Community Transmission
Albion
Holley
Lyndonville
Medina
SARS-CoV-2 detection level is displayed in three categories: Low, Moderate, and Substantial to High. Current estimated levels are based on the highest detection reported from the most recent three samples. These detection levels have been shown to correlate with estimated community transmission levels. Category change in the last 15 days is calculated by subtracting the current number of sites in each current level category from the number of sites in the same category.
EXPANDED FUTURE USES

• CAN DRIVE DIAGNOSTIC TESTING AND ENSURE RESOURCES ARE ALLOCATED EXACTLY WHERE THEY ARE NEEDED

• CAN MONITOR FOR MANY DIFFERENT PATHOGENS AND FUTURE THREATS.
  • INFLUENZA
  • MONKEYPOX
  • RSV
  • POLIO
REFERENCES

NEW YORK STATE WASTEWATER SURVEILLANCE NETWORK

• HTTPS://STORYMAPS.ARCGIS.COM/STORIES/B30CA571E00B42779875E3EAF7577B1B

NATIONAL WASTEWATER SURVEILLANCE SYSTEM (NWSS)

• HTTPS://WWW.CDC.GOV/HEALTHYWATER/SURVEILLANCE/WASTEWATER-SURVEILLANCE/WASTEWATER-SURVEILLANCE.HTML

GENESEE AND ORLEANS COUNTY HEALTH DEPARTMENTS

• HTTPS://GOHEALTHNY.ORG/EMERGING-ISSUES/

CHAUTAUQUA COUNTY, NEW YORK
COVID-19 WASTEWATER ANALYSIS PILOT PROGRAM

Breeanne Agett, MPH
Epidemiologist
Emily Beers, MS
Public Health Sanitarian

Chautauqua County
Health and Human Services
Division of Public Health
CHAUTAUQUA COUNTY

- Population – 127,657
- 23% - bachelors degree +
- Average of 127 people per square mile
- Two small cities – Jamestown and Dunkirk
- State and Community College

- Primarily rural
- Agriculture – corn & grapes
- Large seasonal population
- Job Corps
- Chautauqua Institution
  - 500 – 8,000
COVID-19

- First reported case March 24, 2020
- January 7, 2022 - 310 new cases reported
- Total positive cases in county – 26,157 (as of July 20, 2022)
- Large vaccination and testing clinics
  - Schools and Colleges
- Over 500,000 tests administered
WASTEWATER PILOT PROGRAM

- National Association of City and County Health Officials
- New York State Department of Health
- Planning started November, 2021
- Funding started January, 2022
- The first sample was pulled March 8
  - continued weekly sampling
- Possible new NYS program to pick up in August, 2022?
DUNKIRK & JAMESTOWN SEWERSHED

• DUNKIRK
  • Includes the city and eastern town
  • Population - 12,616
  • Residential, commercial & industrial
  • One hospital
  • Several nursing home & assisted living facilities
  • Exit off I-90

• JAMESTOWN BPU
  • Includes the city and village of Falconer
  • Population - 32,501
  • Residential & commercial
  • One hospital
  • Nursing homes & assisted living facilities
  • Jamestown Community College
  • Exit off I-86
- Facility tours
- Introduction webinar

Chautauqua County COVID-19 Wastewater Surveillance
• Currently sampling 1 time per week
• Samples are pulled at 8 am on Tuesday mornings
• Use of a 24 hour composite sampler with 50 mL pulls every 15 minutes
• 3 – 50mL conical tubes are filled and shipped over night on ice to the lab
LAB ANALYSIS

- University of Buffalo (UB) – Department of Civil, Structural & Environmental Engineering for lab analysis
  - BCoV for recovery control
  - RT-qPCR - dPCR
  - PMMoV fecal indicator
  - N2 gene target
- April 19, 2022 UB changed their methods to assure better accuracy and lower detection limits
INCORPORATING FLOW DATA

- Dunkirk WWTP is a combined sewer and storm water
- Jamestown BPU WWTP has a dumping station that accepts septic waste and landfill leachate
- Dilution of wastewater samples
- Visualization of typical flow processed at each plant over time
- Interference with lab analysis – leachate, PFAS, metals, herbicides/pesticides
  - Total RNA inhibition
CREATING THE DASHBOARD

- Utilizing GISOnline
- Making the data easily accessible and understandable
- Deciding what data would be most useful to include
  - To the public and health care providers
  - Vaccination data, positive test rates, hospitalizations
- Matching our data to mirror CDC and State presentation
  - Trends & levels or raw vs intensity data
Chautauqua County SARS-CoV-2 Wastewater Analysis Dashboard

Select a Sewerhed

Dunkirk
Jamestown

Last Updated: 7/28/2022

Recent wastewater trends: Trend data is calculated as the 15-day rolling average of wastewater virus copies per mL. In order to show an increasing or decreasing trend, the method used to identify the virus (H2 virus fragments) must change by at least 20%

Current RNA levels in wastewater by site: This metric shows whether SARS-CoV-2 levels at a site are currently higher or lower than past levels at the same site. It is calculated by first ordering the SARS-CoV-2 levels in wastewater for all samples collected since March 1, 2022 from the lowest to highest level. The ordered levels are then grouped into five categories (0-19%, 20-39%, 40-59%, 60-79%, and 80-100%) based on how low or high their levels are compared to previous levels. The levels in the 0-19% group represent the lowest levels seen at that sampling site and those in the 80-100% group represent the highest. These categories follow CDC guidance on indicators of community transmission available

RNA Levels Map

Jamestown

Recent Wastewater Trends Map

Wastewater facility flow data is shown to represent the amount of wastewater that is processed through the plant on each day. Higher flow rates through the treatment plant can dilute the wastewater sample and reduce the amount of SARS-CoV-2 RNA copies found per liter. In addition to wastewater, the Dunkirk Wastewater treatment facility also processes storm water and Jamestown BPU Wastewater treatment facility accepts septic and landfill leachate, storm water, etc. as well as septic and landfill waste can dilute the sample being tested for wastewater analysis.

Data in this dashboard is provided by Chautauqua County Health Department and University at Buffalo. This website and its contents herein, including all data, information, and analysis is unvaccinated.
UTILIZING WASTEWATER ANALYSIS

• Used as a tool to establish trends and an early warning system
• Unbiased form of monitoring and analysis
  • Allows us to capture COVID data without relying on testing
  • Those who don’t live in the sewershed
  • The asymptomatic
• Not used in the implementation of governmental decisions or mask mandates
• Easily accessed data that can be used by the public and health care facilities
• Weekly dashboard updates
• COVID-19 Chautauqua County fact sheet –
  • Hospitalizations
  • CDC community levels
  • Wastewater data
  • Vaccination rates
  • 7-day average % positive
• Putting data out on social media and our County website
HARDSHIPS

- Public skepticism and overall government distrust
- Limited support from local government & policy makers
- False information
- Fear of forced isolation and public rights violations
- Very vocal unhappy local citizens
- Funding for multiple samplings per week and other sewersheds
• Get your local government on board
  • Mayors & County Legislators
• Newsletter - fact sheet before the project starts
  • Distinctly list the abilities and inabilities of the program
• Wastewater treatment facility tours
• Have pre-set lines of communication
  • Public, State, health care providers, local officials
• Earlier establishment of the project
• Ignore the negative comments
THANK YOU TO OUR PARTNERSHIPS

National Association of City and County Health Officials – NACCHO
University of Buffalo
City of Tempe
New York State Department of Health
Syracuse University
CDC - NWSS
Genesee, Orleans and Monroe Counties
Arizona State University
Dunkirk and Jamestown BPU Wastewater Facilities
Q&A Discussion

You may submit your questions or comments at anytime through the online platform using the Q&A feature.
Stay Engaged!

Stay tuned for future call and webinar announcements!


Connect with us via the WASH Inbox at: WASH@naccho.org