Coronavirus Sewershed Surveillance Project

November 18, 2020

[Logos and graphics]
Background

- SARS-CoV-2 can be present in human waste even when the individual is pre-symptomatic or asymptomatic.

- Studies in the US and worldwide have detected the presence of SARS-CoV-2 genetic material in domestic sewage.

- Sewage testing is a cost-effective way to obtain population-level information about disease circulation that is not captured by clinical testing.

- Wastewater monitoring could also provide an early warning of new outbreaks.
Wastewater testing gains traction as a Covid-19 early warning system

By SHARON BEGLEY @sxbegle / MAY 28, 2020

How sewage could reveal true scale of coronavirus outbreak

Wastewater testing could also be used as an early-warning sign if the virus returns.

An early warning system for coronavirus infections could be found in your toilet

From the U.S. to Europe to Australia, scientists have detected the virus in wastewater ahead of spikes in local cases.

Poop could be the key to tracking COVID-19 outbreaks

Searching wastewater for the coronavirus is fast, cheap, and anonymous.

Kate Baggaley | Updated: April 27, 2020
Data from wastewater testing can help Missouri:

- examine the geographic distribution of SARS-CoV-2
- identify trends in the quantity of SARS-CoV-2 genetic material in sewersheds
- conduct targeted monitoring for indicators of SARS-CoV-2 reemergence to inform disease mitigation efforts
Common Infrastructure

• Water Sample Courier System

• Partnering Wastewater Treatment System Collaborators
Partnership

DNR is working with the wastewater treatment sector, municipalities and congregate facilities to coordinate sample collection and distribute supplies and equipment.

University of Missouri–Columbia is conducting sample analysis.

DHSS is funding the project and doing data analysis to inform public health strategy.
COVID wastewater testing in Missouri

- Now testing weekly samples from > 70 sites across the state
  - 4 Colleges
  - 21 DOC
  - 7 DMH
  - 3 MVC
  - 63 WWTF

- Project funded for initial period of one year

- One of the biggest wastewater surveillance projects in the nation
  - 1300 samples
  - 86% > 10k copies/L
Process Overview

1. Sample collection
   - WWTPs collect influent

2. Screen for COVID-19 indicators
   - Molecular analysis to detect viral markers
   - Is virus detected? How much?

3. Data informs public health decisions
   - Early detection and trends
Sample collection
Samples arrive and are filtered
Sample concentration

Samples are mixed with polyethylene glycol (PEG) and high salt.

-PEG acts as a chemical ‘sponge’, effectively concentrating the material
-salt (NaCl) masks the charge of molecules (like RNA) so that they can stick together

Smaller particles aggregate and then can be pelleted by centrifugation.
RNA extraction

RNA is extracted by the pelleted material using a type of ion exchange column (Qiagen RNA prep kit).

The robot does most of the work.
Principles of RT-qPCR

During PCR, the target sequence is effectively doubled each round.
Detection

If the target is present, the signal goes up each cycle. The more that is there, the faster the signal amplifies.
DHSS Efforts

- Data Analysis
  - Trends
  - Statistics
  - Metadata
- CDC Collaboration
- Collaboration with Local Public Health Agencies
Sedalia SE WWTP Sewage Concentration-Case Correlation

$r = -0.76$

$P = 0.123$
May 29, 2020 - Health Department announces new confirmed cases of COVID-19, new exposure notices

The Springfield-Greene County Health Department has seen 20 new confirmed cases of COVID-19 within the past 24 hours.

Six of our new cases include staff and residents of Wilson's Creek Nursing and Rehab at 3403 W. Mt. Vernon. Four residents and two staff tested positive. The facility had a symptomatic patient they tested, and when a positive result came back, they moved to test every patient and staff member in the facility.

Lesson: When numbers are low, a few cases can make a big change in wastewater numbers.
Me to Boise: “Was the spike in RNA levels surprising or as expected?”

Boise: “Expected. We have had several of our highest case days since the start of the pandemic. We went back into Phase 3 today (closed bars) so the next couple weeks will be interesting.”

Lesson. COVID likes it when you go to bars.
Cases/day (7 day average)  raw, corrected for flow

Phase 2  Phase 3  Phase 4  Back to Phase 3
(bars open)

Switched to daily wastewater testing
What can we do with all of this data?

Average reading =

$487,482 \text{ copies/L} \times 3.7 \text{ L/gallon} \times 28,400,000 \text{ gallons/day} \times 52 \text{ days} = 2.7 \times 10^{15} \text{ copies RNA}$

$2.7 \times 10^{15} \text{ copies RNA} / 7211 \text{ known COVID patients (during those 52 days)} =$

(up to) $4 \times 10^{11} \text{ copies/patient}$
Can we do this in Missouri too?

How many patients are actually in the sewershed?
What is the correlation between COVID RNA and COVID patients in different sewersheds?

Total COVID RNA vs total patients

Average COVID RNA/patient
Generally, correlation between wastewater RNA and diagnosed patients has been good.
Why are there outliers?

Differences in testing?

Differences in wastewater?

Some we understand. Carthage and Neosho
Carthage and Neosho

We caught the tail of an outbreak.
Carthage and Neosho

We caught the tail of an outbreak.
Did we forget to mention we treat Kansas too?

Us to KCBLU: Is this your whole sewershed?
KCBLU: Yes
Us to KCBLU: It doesn’t seem to match the numbers.
Other surprises, sampling at MU

Sampling at 4 dormitory clusters

Wastewater after freshmen class arrives
FAQs

- **When did project begin?** The pilot study began mid-May and expanded to > 70 sites at beginning of July

- **How long will testing continue?** Planned for 1 year, with possible extension

- **How were facilities selected?** DHSS considered a combination of factors based on data needs: hotspots; areas with no to low reported infection; critical industry areas; congregate institutions; and geographic coverage

- **Who receives test results and how?** Participating facilities and public health agencies have immediate access to test results through online portal. DHSS is also developing a dashboard to share data with public.

- **How will the data be used?** Data are monitored for early indicators of new outbreaks and upward or downward trends in the amount of viral genetic material. This helps alert public health officials about infection, or lack of infection, and could be helpful to direct resources, such as community testing events, to areas that might need it most.