Wastewater Surveillance and COVID-19

• Why measure COVID-19 viruses in wastewater

• How the COVID-19 wastewater monitoring program developed

• Where wastewater based COVID-19 monitoring is headed
Background

- During the COVID-19 pandemic, we needed information about the spread of the virus.
- Initially, clinical testing was our primary source of information about COVID-19.
- This testing allowed us to track the spread of the virus.
Clinical Testing Limitations

• The data is biased
  • In the beginning of the pandemic, testing was only for those feeling ill

• The data stream is fading
  • Reported tests have declined since home tests became widely available
Measuring viruses in wastewater has advantages

• It is an unbiased sample
  • Everybody poops

• Gift that keeps on giving
  • Don’t have to worry about running out of sewage

• It is more cost-effective
  • You don’t need tens of thousands of individual tests
Impediments to adopting wastewater monitoring

• Research scientists had to get their technical house in order

• Wastewater utilities had to be convinced to collect samples

• Health departments had to be convinced to use a new data source

• Needed clear and timely mechanism for communication
Getting scientists’ technical house in order

• What to sample
  • Solids or influent

• How to process the samples
  • Finding balance between cost and sensitivity

• How often to sample
  • Daily or weekly
What did scientists do?

• Performed method comparison studies

• Created Standard Operating Procedures
  • Spelling out how to process samples

• Determined the limits of detection for the methods

• Shared the methods and technology across the scientific community
Method Comparison at a Large Urban Treatment Plant

Log_{10} SARS-CoV-2 copies per L

Date

Zymo
UC Berkeley
SCCWRP
BioBot
Getting wastewater utilities on board

• Wastewater utilities stepped up in a big way

• More than 40 California wastewater utilities sampled early in the pandemic

• Many continue to sample without compensation
Getting health departments on board

• Health departments understood the limitations of clinical data

• Wastewater was an unknown data source
  • Wanted to be sure they could trust and use the data

• They didn’t even know the players
What did the wastewater surveillance community do?

• Set up communication between agencies and researchers
  • State Water Board and California Department of Public Health collaborated for National Wastewater Surveillance System pilot program

• California Water Quality Monitoring Council created the Wastewater Based Epidemiology Committee
  • Built trust and increased communication

• Scientists generated comparisons between COVID viruses in wastewater and clinical case counts
  • Won the public health agencies’ trust
COVID in wastewater vs clinical case rates

Average COVID-19 Incidence Rate (/100K/day)

- LASAN_Hyp: $R^2=0.94$
- OCSD_PI: $R^2=0.94$
- SDPU_PILam: $R^2=0.87$

Average COVID-19 Viruses in WW per L

Rabe et al., 2022
Coordinating data flows and communication

• Needed to communicate the wastewater results across different disciplines and to the public
  • Most scientists are not experts at communication

• Scientists worked with visualization experts to create dashboards to convey data
  • Public health experts, google, design experts
Dashboard example

Number of weeks shown in graph: 6

Width of charts: 600

Genes found in all SARS-CoV-2 variants:
- N gene - all variants / PMMoV
- S gene - all variants / PMMoV

Variants:
- BA.1 Omicron / PMMoV
- BA.2 + BA.4 + BA.5 Omicron / PMMoV
- BA.4 + BA.5 Omicron / PMMoV

Palo Alto
Tracking change in quantity of 2 SARS-CoV-2 genes since Jun 8

Quantity of RNA, normalized

Date of Sample

wbe.stanford.edu
Where wastewater based COVID-19 monitoring is headed

- Transferring the technology from research labs to public health labs
- Tracking COVID-19 variants in wastewater
- Applying these new technologies for the long term
Technology transfer from research labs to public health labs

• California now has a public health wastewater based epidemiology laboratory
  • Successfully transitioned from research laboratories to a state laboratory
  • Intercalibration studies conducted to ensure a smooth transition

• The lab is processing samples from 16 facilities three days per week
  • Looking to expand to more facilities
Tracking COVID variants in wastewater

• Wastewater also provides an opportunity to analyze COVID variants

• Now able to detect variants in wastewater before they show up in clinical samples
New technologies, new opportunities

- The same technologies used to measure COVID in wastewater can work on other constituents

- Other viruses or bacteria
  - Respiratory viruses
  - Potential epidemic pathogens
  - Antimicrobial resistance

- Chemicals
  - Pharmaceuticals
  - Drugs
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Questions?

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