Monitoring the Spread of COVID-19 Through Environmental Scanning
SPEAKERS

Newsha Ghaeli
President & Cofounder,
Biobot Analytics

Dr. Rekha Singh
Wastewater Surveillance Manager
Virginia Department of Health

Michael Harris
Stormwater and Environmental Programs Manager,
Department of Works
New Castle County, Delaware
NOW SPEAKING:

Newsha Ghaeli
President & Cofounder,
Biobot Analytics
NOW SPEAKING:

Dr. Rekha Singh
Wastewater Surveillance Manager,
Virginia Department of Health
Wastewater Surveillance in Virginia

Presentation to: National Association of Counties (NACo)
Rekha Singh, PhD, MPH | VDH-OEHS
April 20, 2021
VDH WWS Team Members

Rekha Singh, PhD, MPH
Wastewater Surveillance Manager

Marcia Degen, PhD, PE
Project Coordinator

Haniyyah Majeed, MS
Wastewater Surveillance Data Manager

Michelle Yancey, MPH
Wastewater Surveillance Data Analyst
Wastewater Surveillance in Virginia
NWSS is a collaboration between Centers for Disease Control and Prevention (CDC), the US Department of Health and Human Services, and agencies throughout the federal government. The data generated by NWSS will help public health officials to better understand the extent of COVID-19 infections in communities.
Goals of Virginia Surveillance Program

Goal 1. Data Collection
- Optimize data transfer
- Develop core standards
- Create training materials on core standards

Goal 2. Data Analysis and Visualization
- Overlay case data onto sewersheds
- Provide training on data use
- Create visualizations with interpretation
- Improve data analysis/reporting

Goal 3. Community of Practice
- Facilitate participation
- Improve data collection and methods
- Resolve issues around reporting
- Create a channel for feedback
Partner Contributions

**Utilities**
- Sampling methods
- Operational factors
- Data sharing

**Laboratories**
- Testing methods
- Data comparability
- QA/QC

**Other Partners**
- Surveillance efforts
- Field expertise
- Public health action
Active Workgroups in VA

**SOUTHWESTERN VA**

- VDH Virginia Department of Health
- RUC Radford University Carilion
- VT Virginia Tech
- Western Virginia Water Authority
- University of Virginia

**EASTERN VA**

- VDH Virginia Department of Health
- HRSD
- Chesapeake Virginia
- Old Dominion University
HRSD SARS-CoV-2 Surveillance Data

Daily New Clinical Cases and Viral Load in HRSD Treatment Facilities

New Clinical Cases by Date

Viral Load in Wastewater (copies)

- Stay at Home Order
- Phase 1 Reopening
- Phase 2 Reopening
- Phase 3 Reopening
- Hampton Roads Restrictions
- Phase 3 Reopening
- Increased Restrictions

Thanksgiving
Christmas
Program Challenges

- **Allocation of funding**
  - Initial funding for staff only
  - All sampling done voluntarily (no funding for sampling)

- **Our challenge**
  - Communicate the need clearly
  - Simplify data sharing process
  - Keep open lines of communication
  - Demonstrating the usefulness of data to public health professionals
● Enhance surveillance in Virginia
  ○ Sentinel monitoring, localized projects, etc.

● Develop or enhance partnerships
  ○ Support data collection/reporting to NWSS

● Participate
  ○ NWSS Public Health Community of Practice

● Collaborate
  ○ Other health departments/jurisdictions
Questions?
Thank you!

rekha.singh@vdh.virginia.gov
marcia.degen@vdh.virginia.gov
haniyyah.majeed@vdh.virginia.gov
michelle.yancey@vdh.virginia.gov
Michael Harris
Stormwater and Environmental Programs Manager,
Department of Works
New Castle County, Delaware
Looking Down the Drain: How The Sewer Became An Emerging Public Health Resource
About New Castle County

• Northernmost of 3 Delaware Counties
• Population 560,000
• NCC Government provides police and paramedics service plus manages parks, libraries, buildings, land use, stormwater management and operation of the sanitary sewer.
• Operate 3 wastewater treatment plants and 1,600 miles of sanitary sewer.
Facing a public health crisis

• Spring of 2020—
  • Changing information and knowledge of SARS-CoV-2
  • Lack of federal guidance and leadership
  • Lack of adequate testing
Wastewater Epidemiology

- Looks for biomarkers or chemicals in wastewater to assess health of population
- Equivalent to obtaining fecal and urine sample from everyone in the sewered population.
- 2013 Wastewater Epidemiology detected re-emergence of Polio in Israel
- More recently, used for detecting Opioids
  - Biobot Analytics study in Cary, NC
  - Helped direct resources – 40% reduction in overdoses
- Vast Potential- SARS-CoV-2 and beyond
Evolution of Our Program

• NCC entered one sample in the Biobot pro bono study
• Wilmington WWTP Influent tested on a weekly basis starting April 15th (450,000+ residents)
• Added 11 additional sites a few weeks later for better identification of the magnitude and extent of the outbreak. 12 sites in paid study
• Moved testing to UD Center for Environmental Wastewater Epidemiology Research (CEWER)
• Assembled team of experts from UD, Christiana Care, Delaware Data Innovation Lab, and Duffield Associates to review data and steer efforts
What This Wastewater Data Provides

- An estimate of the scope of the outbreak independent from patient testing or hospital reporting, and inclusive of data from asymptomatic individuals,

- Decision support for officials determining the timing and severity of public health interventions to mitigate the overall spread of the disease,

- A means of tracking the effectiveness of interventions and measure the wind-down period of the outbreak, and

- An early warning. Data acts as a “leading indicator” of more clinical cases.
CEWER analysis of SARS-CoV-2 across the county includes analysis of samples twice a week at 4 wastewater treatment plants of varying sizes

- Wilmington: ~500,000 People
- Delaware City: ~2,500 People
- Port Penn: ~400 People
- M.O.T.: ~17,000 People
Wilmington Wastewater Treatment Plant
Sample collection date: May 6, 2020

SARS-CoV-2 virus in sewage
DETECTED
Virus concentration per liter of sewage: 25,733 copies

Reported COVID-19 cases in New Castle County, DE

<table>
<thead>
<tr>
<th>New cases</th>
<th>Cumulative cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>108</td>
<td>2,067</td>
</tr>
</tbody>
</table>

On May 6, 2020, as reported by USAVX.org

Biobot COVID-19 case estimate

9,700 cases
(1.3% prevalence rate)
Using a reported rate of 72,000

Confidential COVID-19 prevalence in your facility’s environment with other participating facilities, normalized across all samples.

Biobot prevalence rate estimates in context

This sample is red, your past samples are yellow. Other facilities are grey.

Biobot case estimates in context

Biobot case estimates are trending with reported cases across all samples to date.
This sample is red, your past samples are yellow. Other facilities are grey.
Leading Indicator

CASE STUDY

Comparing Concentrations and New Cases in New Castle County, DE

Spikes in virus concentration preempt case testing data by 3-7 days, allowing governments more time to take action.

Source: USAFacts and Biobot Analytics, Inc.
Visualizing Virus Levels Detected Over Time

The reductions of virus in wastewater are accompanied by reductions in clinical cases.
About This Data

“We will track anywhere and everywhere to collect data to make this invisible enemy more visible.”

— County Executive Matt Meyer

Have feedback? Email us at COVID19Info@newcastlede.org

This data is derived through the science of wastewater-based epidemiology that can be used to detect the level of virus that causes COVID-19 in our wastewater. It can be used alongside clinical testing data to understand the burden of disease in our local population.

This data is provided through the leadership of New Castle County Executive Matt Meyer in partnership with the Center for Environmental and Wastewater-based Epidemiological Research (CEWER) and Ecolab Analytics, Inc. The County began wastewater testing in response to the COVID-19 pandemic in April of 2020.

The Northern New Castle County Aggregate Sewer System sampling site includes all the wastewater in New Castle County except for Delaware City/Salt City, New Castle, and Port Penn. The sampling covers approximately 480K of the 500K residents in New Castle County.

The amount of virus detected in wastewater is shown on a graph with a logarithmic (or log) scale. This is a way of showing a wide range of numerical data in a relatively compact scale. The numbers are shown in increments of a factor of 10.

The log scale chart allows for a better understanding of the coronavirus pandemic over time. Here specifically, the amount of virus detected in multiple areas in New Castle County varies and the log scale helps depict this data most accurately.

Samples are collected during the middle of the work week.
About this Data

“We will look anywhere and everywhere to collect data to make this invisible enemy more visible.”
— County Executive Matt Meyer

Have feedback? Email us at COVID19@newcastlede.org

This data is derived through the science of wastewater-based epidemiology that can be used to detect the level of virus that causes COVID-19 in our wastewater. It can be used alongside clinical testing data to understand the burden of disease in our local population.

This data is provided through the leadership of New Castle County Executive Matt Meyer in partnership with the Center for Environmental and Wastewater-based Epidemiological Research (CEWER) and Biobot Analytics, Inc. The County began wastewater testing in response to the COVID-19 pandemic in April of 2020.

The Northern New Castle County Aggregate Sewer System sampling site includes all the wastewater in New Castle County except for Delaware City/St. Georges, South of the Canal (excl. Middletown) and Port Penn. The sampling covers approximately 480K of the 560K residents in New Castle County.

The amount of virus detected in wastewater is shown on a graph with a logarithmic (or log) scale. This is a way of showing a wide range of numerical data in a relatively compact scale. The numbers are shown in increments of a factor of 10.

The log scale chart allows for a better understanding of the coronavirus pandemic over time. Here specifically, the amount of virus detected over multiple areas in New Castle County varies and the log scale helps depict this data most rationally.

Samples are collected during the middle of the work week.
Siting Covid Testing Locations
Path Forward

Regular meetings with wastewater epidemiology team:
- Christiana Care
- Delaware Data Innovation Lab
- Duffield Associates
- University of Delaware Center for Wastewater Epidemiology (CEWER)

Move to smaller sewer catchments

Potentially looking for SARS-CoV-2 variants in wastewater.
Using the data to evaluate public health actions
Small Catchment Areas

- Scientists do not fully understand shedding rates of SARS-CoV-2 related to positive clinical cases or asymptomatic individuals.
- In October and November 2020 our team studied virus detected across six residence halls including where students were isolated (positive clinical cases) or quarantined (exposure). We continue to assess this data.
- Expanding pilot into public and private schools.

University of Delaware and Duffield Associates collect samples at a residence hall at UD, Fall 2020.
Looking for variants

• Small changes in the virus genome, called mutations, occur naturally as viral genomes are copied

• Some SARS-CoV-2 variants are now being identified around the world

• Our team is investigating sequence analysis of the virus community within the sewershed
  • Not simple due to the relatively low amount of virus in each sample and the high numbers of different virus types, which may include multiple variants of interest
Some Lessons Learned

• Not established textbook science – on leading edge. Methodology and reporting has changed several times throughout our study.

• Case estimate science changed and is more complex.

• Constantly evolving improvements
  • Normalizing viral data by comparison with other viral markers in stool to account for rainwater in sewer.
Thinking beyond SARS-CoV-2

- Wastewater epidemiology infrastructure now in place.
- Ready for the future
  - SARS-CoV-2 re-emergence
  - Opioids
  - Influenza
  - The next pandemic
In Closing
QUESTIONS?

- Place your question/comment in the “chat box”
- Use the “raise hand” function to be recognized
- Unmute when appropriate
SPEAKER CONTACTS

Jennings Heussner  
Business Development Manager,  
Biobot Analytics  
jennings@biobot.io

Dr. Rekha Singh  
Wastewater Surveillance Manager  
Virginia Department of Health  
rekha.singh@vdh.virginia.gov

Michael Harris  
Stormwater and Environmental Programs Manager,  
Department of Works  
New Castle County, Delaware  
NewCastleDE.gov/PublicWorks
Biobot Analytics

We are building early warning health analytics from data available in our sewers.

Newsha Ghaeli
President and Cofounder
newsha@biobot.io
Our wastewater epidemiology platform enables early warning health analytics to combat pandemics.

**Predictive**

Wastewater data is a leading indicator for new infectious disease cases.

**Inclusive**

Everyone has a voice in the sewer. Our data includes everyone, not just people who access clinical care.

**Versatile**

Wastewater is a rich source of health data, including Covid19, influenza, opioids, diet, stress, and others.
The largest database of its kind.

46 states + provinces

8000+ samples tested

13% of U.S. population
We are leading the emerging market of wastewater epidemiology
FastCo biotech award: #3 behind Pfizer and Moderna

1. PFIZER-BIONTECH
   For being first to market with an effective COVID-19 vaccine

1. MODERNA
   For making a COVID-19 vaccine that can travel

3. BIOBOT ANALYTICS
   For using sewage to detect the next surge

4. OXFORD UNIVERSITY-ASTRAZENECA
   For finding a different path to a COVID-19 vaccine
We started by addressing the opioid epidemic
<table>
<thead>
<tr>
<th>Site ID</th>
<th>Population</th>
<th>Median age</th>
<th>Median HH income</th>
<th>Demographic breakdown [%]</th>
<th>Hispanic</th>
<th>Total MME</th>
</tr>
</thead>
<tbody>
<tr>
<td>03</td>
<td>6,557</td>
<td>36</td>
<td></td>
<td></td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>7,896</td>
<td>36</td>
<td></td>
<td></td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>05</td>
<td>8,368</td>
<td>36</td>
<td></td>
<td></td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>06</td>
<td>10,853</td>
<td>42</td>
<td></td>
<td></td>
<td>15%</td>
<td></td>
</tr>
<tr>
<td>07</td>
<td>6,622</td>
<td>47</td>
<td></td>
<td></td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>08</td>
<td>5,306</td>
<td>44</td>
<td></td>
<td></td>
<td>3%</td>
<td></td>
</tr>
<tr>
<td>09</td>
<td>9,332</td>
<td>34</td>
<td></td>
<td></td>
<td>4%</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>5,503</td>
<td>46</td>
<td></td>
<td></td>
<td>4%</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>7,408</td>
<td>35</td>
<td></td>
<td></td>
<td>25%</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>4,490</td>
<td>34</td>
<td></td>
<td></td>
<td>13%</td>
<td></td>
</tr>
</tbody>
</table>

Legend:
- Prescription opioids
- Fentanyl
- Heroin
- Treatments

Note: Units in MME/day (1000 prostitution)
SARS-CoV-2 is shed in the stool of infected patients
How it works

1. Online Order Form
   Customers sign up and order kits online

2. Biobot shipping kit
   Next day delivery of sample at 4C.

3. Lab analysis
   Molecular biology and chemistry analyses, applying Biobot's protocol in high-throughput.

4. Computational biology and data science
   We develop models based on wastewater and clinical data.

5. Report and Dashboard
   Data analysis and visualization is then packaged as a report for public health officials.
“It’s amazing how many residents wait for these numbers and have come to trust these more than [clinical] testing”

— Wastewater treatment plant director in the State of Massachusetts
Nationwide trends (legend)
7-day average of new cases
3-sample average wastewater concentration
COVID-19 Data Dashboard

ALERT! The School Committee adopted updated metrics on November 12, 2020. Read Superintendent's message in regards to the adoption of these metrics.

This CPIS COVID-19 Data Dashboard is intended to provide the community with meaningful and updated information to determine the risk of COVID-19 transmission in CPIS schools.

1. Public Health Metrics used to determine CPIS opening status
   2. Confirmed COVID-19 cases in CPIS
   3. Staff COVID-19 Testing Participation Rates

To provide feedback on this dashboard, send a message to covid19@cpis.org. CPIS will also allow for web-based commenting with a matrix update. Visit in 6 hrs.

Data is reviewed daily by Cambridge Department of Public Health and CPIS.

The metrics used to inform decision-making will be reviewed on a regular basis to consider recommendations from scientific advisors based on emerging knowledge. The next planned update is January 2021 and March 2021.

Questions or feedback about the metrics or this dashboard? Send a message to covid19@cpis.org. Messages are monitored and passed to the appropriate staff person or scientific advisor for responses.

Please visit hhs.com/covid19 for the latest information about COVID-19.

CPIS will also launch a daily email newsletter with a metrics update. Visit in 6 hrs.

Questions or feedback about CPIS COVID-19 cases or concerns?

Details of individual cases will not be shared publicly in accordance with HIPAA privacy laws.

- Media questions about COVID-19 cases or case totals should be directed to Health Communications and Public Affairs at Cambridge Public Schools.
- Staff and teacher/staff should contact their principals with questions about their school.
- Questions about the metrics or this dashboard should be sent to Chief Financial Officer, Michaela Toomey. Questions about COVID-19 cases should be directed to the Office of Public Health.
- Questions about what to do in the case of a surge can be found in the link to "What Should I Do During a Pandemic" for guidance.

For each metric below, use the definition, recommended threshold, and current status. If any metric surpasses recommended thresholds it will be displayed as orange. Two or more metrics exceed thresholds, metrics will be displayed as red and learning will shift to remote only.

**Metric 1: Daily New Cases**

- **Definition:** Weighted average of new confirmed cases per day, per 100,000 people in Cambridge.
- **Threshold:** Fewer than 25 new cases per day, per 100,000 people (7-day average).
- **Current Status:** 19.2 new cases per day (As of 11/15/2020)

**Metric 2: Test Positivity Rate**

- **Definition:** Rate of positive COVID-19 tests in Cambridge.
- **Threshold:** Less than 5% of COVID-19 tests are positive.
- **Published by:** The state weekly. Updates can be affected by the number of tests performed.
- **Current Status:** 0.32% (As of 11/12/2020)

**Metric 3: Wastewater Monitoring**

- **Definition:** The level of COVID-19 found in sewage wastewater in MASH.
- **Threshold:** COVID-19 in wastewater detected at less than 100 copies viral genomes.
- **Current Status:** 255.5 (As of 11/10/2020)
Data insights are our core value proposition

Early indicator of spikes for early intervention
Wastewater data is a leading indicator for new Covid-19 cases with 5-10 days of advance.

Estimate COVID-19 incidence
We have built a proprietary model to estimate the number of new Covid-19 infections in a community.

Ranking amongst nationwide database
We contextualize if the level of infection is low or high, by comparing against our nationwide database of communities.
We can build hundreds of applications with our platform.
Opportunities for WBE

- Government: 16,000 WWTPs
- Assisted Living: 32,000 homes
- Places of work: 900,000 offices
- Prisons: 5,000 prisons & jails
- Universities: 5,300 colleges
- Schools: 110,000 schools
- Aircrafts: 10 million flights / year
- Ships: 2,000+ ships
A permanent pillar of pandemic preparedness
Thank you!

Newsha Ghaeli
PRESIDENT & COFOUNDER
newsha@biobot.io