Measuring SARS-CoV-2 in wastewater to supplement COVID-19 surveillance in BC communities

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The Team

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In the beginning: Enteric Viruses



- 1. What is the viral load in influent?
- 2. How much virus is removed through the treatment process?
- 3. How much virus is in the effluent?
 - Is the virus in the effluent intact or damaged?

Viral Load in Influent Wastewater



End of 2019, early 2020

- Longitudinal data
- Developing methods to distinguish between live vs. dead using PMA



March 11, 2020

WHO declares coronavirus outbreak a pandemic

After infecting over 121,000 and causing more than 4,300 deaths, the World Health Organization declares the outbreak a pandemic.



All non-COVID research put on hold



Medical personnel in Germany wait at a new drive-in test station in former barracks set up for coronavirus tests.

Peter Kneffel/Picture Alliance via Getty Images

SARS-CoV-2 RNA detected in feces





- SARS-CoV-2 primarily affects the lungs but it is also shed in feces
 - > Up to 67% of infected individuals
 - ≻~10⁸ copies/ml of stool
 - Shedding for 4-7 weeks
- SAR-CoV-2 RNA has been detected in wastewater

SARS-CoV-2 can persist in feces even when cleared from respiratory system



Xu et al. 2020

Scant evidence of live infectious virus in fecal material

- SARS-CoV-2 in stool has not been proven infectious
- No evidence of fecal-oral transmission
- Wastewater as an unlikely transmission pathway
 SARS-CoV-2 is unlikely to stay intact in the environment



Using wastewater as a surveillance tool



Choi *et al.* 2018

Previous examples

- Polio virus in Israel
- Monitor illicit drug use
- Monitor enteric viruses

 Can provide data on changes in disease occurrence and trends in communities

 Wastewater testing is independent of healthcareseeking behaviors and access to clinical testing

The Netherlands were the first to report the use of wastewater for COVID-19 surveillance

Environmental Science & Technology	This article is made available via the <u>ACS COVID-19 subset</u> for unrestricted RESEARCH re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for the duration of the World Health Organization (WHO) declaration of COVID-19 as a global pandemic.	ACS
pubs.acs.org/journal/estlcu		Letter
Presence of SARS-Coronavirus-2 RNA in Sewage and Correlation with Reported COVID-19 Prevalence in the Early Stage of the Epidemic in The Netherlands		
Gertjan Medema,* Leo Heijnen, Goffe Elsinga, Ronald Italiaander, and Anke Brouwer		
Cite This: Environ. Sci. Technol. Lett. 2020, 7,	511–516 Read Online	

- Demonstrate a correlation between SARS-CoV-2 and COVID-19 cases
- Detected SARS-CoV-2 in wastewater 6 days before the first cases were reported
- Providing a useful tool to monitor transmission of COVID-19 in communities

Research objectives

- Optimize existing methods to develop methods for the concentration, detection and quantification of SARS-CoV-2 in wastewater samples
- Implement these methods to conduct a prospective study to detect and quantify SARS-CoV-2 in wastewater samples from multiple wastewater treatment plants in Metro Vancouver

Study design for method development

 24-hr composite raw influent samples were collected weekly, for 5 months (May – September, 2020)



- Samples come from Annacis Island WWTP
- Located in Delta
- Wastewater treatment for >1 million residents in 14 municipalities
- Treats 175 billion liters of wastewater per year



Processing wastewater to concentrate viruses



Nucleic acid extraction and quantification of SARS-CoV-2 RNA



Optimized BCCDC PHL's COVID-19 Panel

Normalize using pepper mild mottle virus

Pepper mild mottle virus is ingested in large quantities by people consuming processed pepper products. Subsequently, pepper mild mottle virus pass through the human digestive system.



Pepper mild mottle virus is found in high concentrations in domestic wastewater streams.

Symonds et al. 2018, adapted

Prospective study design

- 24-hr composite raw influent samples
- Collected weekly
- Annacis Island WWTP
- 8 month duration (May December, 2020)

During method development (May – September), extra influent wastewater samples were processed and frozen, to later include in the study

Following development, add 4 additional WWTPs

Regional Liquid Wastewater System Map





BC COVID-19 Case Counts



Longitudinal analysis and modeling





BCCDC and Metro Vancouver, along with regional health authorities, are working to develop a surveillance system for Vancouver and BC

Dr. David McVea

Canadian Field Epidemiologist Public Health Agency of Canada





Public Health Agency of Canada

BC Centre for Disease Control

Increase sampling to expand surveillance





Next Steps

- Analyze regional case counts and SAR-CoV-2 RNA quantities to include additional Metro Vancouver WWTPs:
 - ≻lona
 - ≻Lulu
 - Lions Gate
 - Northwest Langley
- Use postal codes to refine the regions for each WWTP serves
- Data modeling and dissemination
- Solid and sludge



- Developed and implemented methods for the detection and quantification of SARS-CoV-2 RNA in Metro Vancouver wastewater
- Data which can be used to:
 - Detect the presence (yes/no) of community cases
 - Detect the trends (increasing, decreasing, or stable) in the incidence of community cases
 - Understand occupational health risks associated with SARS-CoV-2
 - Potentially limit the spread of the disease, in BC communities

Metagenomic sequencing of SARS-CoV-2 in wastewater



Dr. Ryan Ziels Assistant Professor Civil Engineering University of British Columbia





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Canadian Inter-Laboratory Study



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Questions ?

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