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Rapid Evidence Summary

Where are the centres of expertise in wastewater surveillance and testing in Canada? What proven methods and approaches are being implemented? Who is applying the results to inform public health action?

Summary:

The following is a summary of the available evidence from trusted sources on the nature of SARS-CoV-2 wastewater surveillance. For additional information about each of the sources, see the Table below. The comprehensiveness of this summary may be limited given the rapid timeline for our search and documents retrieved, and it is possible that we may have missed potentially relevant evidence.

The Wastewater surveillance for population-wide Covid-19: The present and future literature review mentions that the detection of SARS-CoV-2 in wastewater may be a useful tool for inferring prevalence of COVID-19, and to detect early signs of increased transmission at community levels [10]. In its Wastewater Surveillance guidance, the Centers for Disease Control and Prevention (CDC) highlights that data from wastewater testing can complement and enhance existing COVID-19 surveillance systems by providing data from communities where timely COVID-19 clinical testing is limited [3]. The Wastewater surveillance for COVID-19 evidence synthesis noted that countries including Australia, Spain, Italy, Netherlands, China, the United States of America, Germany, Japan, India, Czech Republic, Brazil, and Ecuador detected SARS-CoV-2 in wastewater samples [1]. The government of Australia implemented a system where once a COVID-19 outbreak is detected in a region's sewage, people are to report to public health officials to be tested through nasal swab tests [1]. The What is known about using wastewater surveillance to monitor the COVID-19 pandemic in the community? rapid review reported that although wastewater-based surveillance is possible, no guidelines report the effectiveness of this method for ongoing surveillance or to inform decisions about lifting or imposing lockdown restrictions [2]. Currently, no best-practises for wastewater surveillance have been identified [2].

Ottawa Public Health is one of the first public health units in North America to conduct daily wastewater readings from 91.6% of Ottawa's population to detect and measure the presence of SARS-CoV-2 genetic

material (ribonucleic acid or RNA) [7]. However, the municipality has noted that wastewater is a harsh environment which may breakdown the viral RNA and lead to lower readings of the virus [7]. In its Phase 1 Inter-Laboratory Study: Comparison of Approaches to Quantify SARS-CoV-2 RNA in Wastewater report, the Canadian Water Network initiated the first phase of the Canadian COVID-19 Wastewater Coalition's proof of concept pilot to understand laboratory variability resulting from different lab techniques, to facilitate national and international data comparisons, and to inform Canadian public health [8]. While a rapid review in May 2020 indicated that variations in methodology may contribute to inconsistency of findings and quality of evidence, although SARS-CoV-2 has been detected in untreated wastewater around the world [2], the review of results with different laboratories found that various approaches generally yielded comparable results with a critical caveat that sufficient quality assurance protocols must be in place and reported in adequate detail [8]. The Canadian Water Network proposed the following recommendations to help characterize the variability of results expected using different methods deployed across Canada: 1) focus on how standard curves for quantification are generated; 2) address inhibition; 3) process controls; and 4) use faecal biomarkers to assist normalizing results [8].

The Sewage analysis as a tool for the COVID-19 pandemic response and management: the urgent need for optimised protocols for SARS-CoV-2 detection and quantification suggested the need to develop a methodological protocol to detect and quantify COVID-19 RNA in wastewater [9]. Two single studies have displayed that SARS-CoV-2 genetic traces can be detected in different raw wastewater [11,12]. The Quantitative analysis of SARS-CoV-2 RNA from wastewater solids in communities with low COVID-19 incidence and prevalence study in Ottawa and Gatineau, Canada found that primary clarified sludge, compared to solids collected from post-grit sludge, showed a higher frequency of SARS-CoV-2 especially when COVID-19 incidence is low in the community [12]. The authors recommend using primary clarified sludge processing as an effective tool for monitoring trends during decreasing and low incidence of infection of SARS-CoV-2 in communities [12].

The Public Health Agency of Canada (PHAC) is providing laboratory analysis, result reporting and logistical support for the detection and monitoring of SARS-CoV-2 in wastewater from five high population centres (Vancouver, Edmonton, Toronto, Montreal, Halifax; representing 22% of the Canadian population) [13]. Results from the testing will be communicated back to the wastewater authorities who will share this with their local public health department [13]. These data are being used to not only inform local public health, but also serve to help develop data structures and models that can be used across the country [13]. Key collaborators include Statistics Canada (STC), Environment and Climate Change Canada (ECCC), and FPT public health counterparts [13].

To supplement recommendations for wastewater surveillance, the CDC reports guidelines for sampling strategies, testing methods, public health interpretation, and use of wastewater detection of COVID-19 viral RNA [4,5,6].

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APPENDIX

▼ Review of Evidence

Type of Evidence	Author	Resource	Last Updated	Summary
(1) Evidence Synthesis	NSW Government & Agency for Clinical Innovation	Wastewater surveillance for COVID-19	November 11, 2020	• This evidence synthesis describes that wastewater surveillance can be an efficient, cost-effective way to monitor transmission dynamics as a complementary approach to current surveillance programs. In regions where SARS-CoV-2 has been detected in wastewater samples, wastewater surveillance often reported positive COVID-19 cases before other surveillance programs did. • In Australia, a method has started that monitors sewage for COVID-19 and once an outbreak is detected in a particular region, people are to report to public health officials to be tested through nasal swab tests. • Countries including Australia, Spain, Italy, Netherlands, China, the United States of America, Germany, Japan, India, Czech Republic, Brazil and Ecuador have detected SARS-CoV-2 in wastewater samples.
(2) Rapid Review	National Collaborating Centre for Methods and Tools	What is known about using wastewater surveillance to monitor the COVID-19 pandemic in the community?	May 25, 2020	• This rapid review indicates that SARS-CoV-2 has been detected in untreated wastewater in a number of municipalities worldwide including the USA, the Netherlands, Spain, Italy, Turkey, Australia and Israel. Variations in methodology may contribute to inconsistency of findings and the quality of evidence should be confirmed by consulting an expert. • Retrospective analyses showed the presence of SARS-CoV-2 before community transmission had been identified. • Published studies have demonstrated that wastewater-based surveillance is possible, but no reports have been made on the effectiveness of this method for ongoing surveillance that monitors status of COVID-19 at a community level or to inform decisions about lifting or imposing lockdown restrictions.

				• Currently, no best-practises for wastewater surveillance have been identified.
(3) National Guidance	CDC: The Centers for Disease Control and Prevention	Wastewater Surveillance	October 23, 2020	• The Centers for Disease Control and Prevention (CDC) state that a National Wastewater Surveillance System (NWSS) has started in response to the COVID-19 pandemic. • The data generated by NWSS will help public health officials to better understand the extent of both symptomatic and asymptomatic COVID-19 infections in communities. • Data from wastewater testing are not meant to replace existing COVID-19 surveillance systems but are meant to complement them by providing data for communities where timely COVID-19 clinical testing is limited. • Community-level wastewater surveillance at a treatment plant will not capture homes on a septic-based system, decentralized systems (i.e. prisons, universities or hospitals) that treat their waste and sites that pre-treat sewage before it reaches the plant. • Low levels of infections in a community may not be captured by sewage surveillance and more research is needed to better understand the limits of detection.
(4) National Guidance	CDC: The Centers for Disease Control and Prevention	Developing a Wastewater Surveillance Sampling Strategy	Oct 23, 2020	• The CDC identifies 3 steps to developing a COVID-19 wastewater surveillance sampling strategy: • 1) identify public health data needs; 2) assess wastewater sampling and testing capacity; 3) develop a sampling plan that includes the following points: A) where to sample (I.e. community wastewater surveillance versus targeted wastewater surveillance); B) how often to sample (a minimum of three samples is required to detect wastewater trends over time); C) what to sample – (I.e. untreated water or primary sludge); D) how to sample: grab sampling or composite sampling (I.e. pooling multiple grab samples at a specified frequency over a set time); and E) how to safely collect, store and ship samples.
(5)		Testing Methods	Oct 30, 2020	

National Guidance	CDC: The Centers for Disease Control and Prevention			• The CDC has given the following guidance to implement wastewater-based disease surveillance:1) refrigerate samples at 4 degrees Celsius, process within 24 hrs and mix samples well before processing; 2) sample concentration methods vary in use based on the sample type, volume, processing time and availability of equipment; 3) RNA extraction/purification is an essential step that should select extraction kits that purifies RNA; and 4) follow proper lab controls practices to ensure standardization.
(6) National Guidance	CDC: The Centers for Disease Control and Prevention	Public Health Interpretation and Use	Oct 30, 2020	• The CDC indicates that wastewater surveillance data interpretation can help in monitoring, tracking trends and screening for COVID-19 infections within a community. • These interpretations can be used to inform to increase clinical testing in affected communities, increase public health communication for mitigation strategies to the community and to evaluate the impact of community mitigation strategies. • Lack of SARS-CoV-2 detection in wastewater alone should not be used to justify relaxing community mitigation measures.
(7) Municipal Guidance	Ottawa Public Health	WastewaterCOVID-19 Surveillance	November 2020	• Ottawa Public Health has indicated that tracking the number of individuals testing positive for COVID-19 provides a partial look at COVID-19 activity within a community because not everyone is tested, and it takes time to do so. • Studies have shown that a significant proportion of people with active COVID-19 infections shed SARS-CoV-2 in their stool, sometimes even before symptoms start. • Testing wastewater allows for a centralized measuring of the level of viral RNA and can shed light on COVID-19 infection rate trends while acting as an early indicator before traditional testing measures are employed (e.g. swabbing). • Ongoing research has observed a strong correlation with other established COVID-19 measures. However,

				limitations are presently attributed to variability in readings due to the harsh environment of wastewater that may break down viral RNA giving lower readings.
(8) Epidemiological Study	Canadian Water Network	Phase 1 Inter-Laboratory Study: Comparison of Approaches to Quantify SARS-CoV-2 RNA in Wastewater	November 2020	• The detection of SARS-CoV-2 ribonucleic acid (RNA) may be a useful tool for inferring COVID-19 prevalence within communities. • Wastewater-based epidemiology has the potential to detect increased COVID-19 infections in a community using spatial and temporal trends used to inform public health decisions and responses (i.e. targeted clinical testing or indicator of effectiveness of implemented public health measures). However, methods for extraction of viral RNA and subsequent quantification are not yet standardized making the results from different employed methods unclear. • The Canadian Water Network (CWN) has initiated an Inter-Laboratory Study to characterize inter- and intra-laboratory variability of results deployed across Canada to allow for broader inferences to be drawn related to differences in data generation and handling approaches. Findings displayed that different methods provided similar results overall. • However, surrogate viral measures that partitioned wastewater samples prior to analysis and used one phase (i.e. solid or liquid phase) to quantify viral RNA may not be representative of real wastewater samples and it is recommended to assess both phases of viral RNA in wastewater samples.
(9) Literature Review	Kordatou et al.	Sewage analysis as a tool for the COVID-19 pandemic response and management: the urgent need for optimised protocols	July 27, 2020	• This literature review indicates that wastewater testing in sewage systems seem to be a promising method to provide complementary and useful information to clinical testing. Sewer systems provide real-time outbreak data because they continually receive human excreta. • It is expected that collecting samples from sewer lines and wastewater treatment facilities will enable the tracing of

		for SARS-CoV-2 detection and quantification		viral outbreaks to a more accurate location and identifying the areas of concern. • Several studies have found circulation of low-level viral RNA in wastewater before cases have appeared. • An important feature of wastewater-based epidemiology is the fact that it can detect variations in the viral strains, providing a substantial advantage for identifying viral trees that have evolved over time across regions. • There are a few main considerations related to the development of a methodological protocol for detecting and quantifying COVID-19 RNA in wastewater. • Firstly, more information is needed on the transmission of alive virus through feces via the oral-fecal pathway and of its infectiousness in sewage. • Furthermore, personnel working with these specimens must be trained in Biological Safety Level 3 laboratory containment. • Few studies have also investigated the effects of different sampling methods, storage conditions, temperature, and sample pre-treatment on the vitality of SARS-CoV-2 RNA.
(10) Literature Review	Christian G. Daughton	Wastewater surveillance for population-wide Covid-19: The present and future	May 23, 2020	• This literature review indicates that developing standardized water-based epidemiology (WBE) methodology, that can be deployed within nationalized monitoring networks, can provide comparable data across nations. • Given early warning signs of increased infections, total suppression can be effective to limit community spread. • Currently, early warning of COVID-19 infections within a community is difficult because of the inability to rapidly and inexpensively monitor COVID-19 infections using clinical diagnostic testing for individuals. • WBE might be able to detect COVID-19 before possible with current surveillance, which could give a head-start for contact tracing and minimize surges. • Published data on targeted markers for SARS-CoV-2 in feces (primarily RNA) is insufficient for the modelling required for WBE without knowing the half-life of the market in wastewater.

				• Next steps to implement reliable WBE is standardization, optimization, and quality assurance.
(11) Single Study	Westhaus et al.	Detection of SARS-CoV-2 in raw and treated wastewater in Germany–Suitability for COVID-19 surveillance and potential transmission risks	August 18, 2020	• This study encompasses an extensive sampling campaign of several municipal wastewater treating plants close to the first peak of the pandemic. • Samples were analyzed for a set of SARS-CoV-2-specific genes. • Results have shown the presence of SARS-CoV-2 genetic traces in different raw wastewaters.
(12) Single Study	D'Aoust et al.	Quantitative analysis of SARS-CoV-2 RNA from wastewater solids in communities with low COVID-19 incidence and prevalence	October 23, 2020	• This study quantifies two SARS-CoV-2 gene regions in solids collected from post grit solids (PGS) and primary clarified sludge (PCS) in two Canadian national capital regions (Ottawa and Gatineau). • Higher frequency of detection was established in PCS compared to PGS samples especially and low COVID-19 incidence in the community.
(13) PHAC Input	PHAC: Public Health Agency of Canada	COVID-19 Urban Surveillance	December 15, 2020	• PHAC is providing laboratory analysis, result reporting and logistical support for the detection and monitoring of SARS-CoV-2 in wastewater from five high population centres (Vancouver, Edmonton, Toronto, Montreal, Halifax; representing 22% of the Canadian population). • Results from the testing are communicated back to the wastewater authorities who share this with their local public health department. • These data are being used to not only inform local public health but also serve to help develop data structures and models that can be used across the country. • Key collaborators include Statistics Canada (STC), Environment and Climate Change Canada (ECCC), and FPT public health counterparts.

(14) Organizational Scan	Victoria State Government	Wastewater Testing	October 29, 2020	
(15) Organizational Scan	Dr. Dominic Frigon & CanCOVID	Wastewater Detection: the Next COVID Frontier	June 9, 2020	

Disclaimer: The summaries provided are distillations of reviews that have synthesized many individual studies. As such, summarized information may not always be applicable to every context. Each piece of evidence is hyperlinked to the original source.

▼ Organizational Scan

The Department of Health and Human Services in Victoria, Australia released information on wastewater testing to provide early warning of COVID-19 by showing if SARS-CoV-2 is present in the local community [14]. The viral shedding may come from different sources such as used tissues, off hands and skin, or in stools. Find more information about wastewater testing here. The Canadian Water Network is bringing together Canadian experts to inform and guide SARS-CoV-2 wastewater surveillance. Find more information about this network here.

CanCOVID released a Speaker Series where Professor Frigon, from McGill University, discusses research on wastewater systems [15]. He has been developing metagenomics tools for the surveillance of antimicrobial resistance in municipal wastewater. Watch the series here.