National Collaborating Centre for Methods and Tools

Centre de collaboration nationale des méthodes et outils

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Rapid Review: What is known about using wastewater surveillance to monitor the COVID-19 pandemic in the community?

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Executive Summary

Background

Water-based epidemiology is an evolving methodology that uses samples collected from municipal wastewater to monitor exposure patterns at the community level. This methodology has been used previously to identify the presence of the Aichi virus in the Netherlands before cases were reported; for polio surveillance; for antimicrobial resistance; and has been proposed as a potential cost-effective method to monitor COVID-19. As a number of jurisdictions around the world begin to lift restrictions put in place to flatten the curve of the pandemic, wastewater surveillance has been proposed as a method to monitor levels of the virus within the community in real-time, possibly before individuals start to display symptoms.

This rapid review was produced to support public health decision makers' response to the coronavirus disease 2019 (COVID-19) pandemic. This review seeks to identify, appraise, and summarize emerging research evidence to support evidence-informed decision making.

This rapid review is based on the most recent research evidence available at the time of release. This version includes evidence available up to May 20, 2020.

In this rapid review, we provide the most recent research evidence to answer the question: **What is known about using wastewater surveillance to monitor the COVID-19 pandemic in the community?**

Key Points

- The virus that causes COVID-19 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 the evidence should be confirmed through consultation with a content-area expert.
- In some cases, retrospective analyses showed the presence of the virus before community transmission had been identified.
- To date, all published studies have demonstrated that wastewater-based surveillance is possible; however, there are no reports of the effectiveness of this method for ongoing surveillance.

Overview of Evidence and Knowledge Gaps

- There is no evidence available on the use of wastewater surveillance as a tool to monitor the status of COVID-19 at a community level or to inform decisions about lifting or imposing lockdown restrictions to slow the spread of the virus.
- One mathematical modelling study has predicted that a prevalence between 1 in 114 to 1 in 2 million is needed to detect the virus. Given limited current understanding of the virus that causes COVID-19 and its continuously evolving nature, confidence in this estimate is extremely low (see Warning section).
- Across studies, authors reported inconsistent correlations between levels of the virus detected in the samples and the number of cases identified in the community. It is not known whether this is due to inaccuracy of virus detection methods in wastewater, inaccurate data on the true number of cases in the community, or both.
- A variety of methodologies have been used to date, making comparisons across jurisdictions difficult and synthesizing the findings challenging; no best-practices for wastewater surveillance have been identified.
- This question should be reviewed again as more data become available.

Methods

Research Question

What is known about using wastewater surveillance to monitor the COVID-19 pandemic in the community?

Search

On May 13 and 20, 2020, the following databases were searched for evidence for the role of wastewater surveillance in monitoring COVID-19 in the community.

- Pubmed's curated COVID-19 literature hub: LitCovid
- Trip Medical Database
- World Health Organization's Global literature on coronavirus disease
- Joanna Briggs Institute COVID-19 Special Collection
- COVID-19 Evidence Alerts from McMaster PLUS™
- Public Health +
- COVID-19 Living Overview of the Evidence (L·OVE)
- Cochrane Coronavirus (COVID-19) Special Collections
- Oxford COVID-19 Evidence Service
- Cochrane Rapid Reviews Question Bank
- Oxford COVID-19 Evidence Service: Current Questions Under Review
- Prospero Registry of Systematic Reviews
- NCCMT COVID-19 Rapid Evidence Reviews
- MedRxiv preprint server

A copy of the search strategy is available on request.

Selection Criteria

The search first included recent, high-quality syntheses. If no syntheses were found, single studies were included. English-language, peer-reviewed sources and sources published ahead-of-print before peer review were included. Grey literature and surveillance sources were excluded.

	Inclusion Criteria	Exclusion Criteria
Population		
Intervention	Wastewater surveillance	
Comparisons		
Outcomes	Detection / monitoring of COVID-19	
Setting	Community setting	

Data Extraction and Synthesis

Data on study design, setting, location, population characteristics, interventions or exposure and outcomes were extracted when reported. We synthesized the results narratively due to the variation in methodology and outcomes for the included studies.

We evaluated the quality of included evidence using critical appraisal tools as indicated by the study design below. Quality assessment was completed by one reviewer and verified by a second reviewer. Conflicts were resolved through discussion.

Study Design	**Critical Appraisal Tool**
Synthesis	Health Evidence™ Quality Appraisal Tool

Completed quality assessments for each included study are available on request.

Findings

This document includes one completed syntheses, and eight completed single studies, for a total of nine publications included in this evidence review. The quality of the evidence included in this review is as follows:

		Total	Quality of Evidence
Syntheses	Completed Reviews	1	1 Moderate
	In Progress Reviews	0	-
Single Studies	Completed	8	Not appraised

Warning

Given the need to make emerging COVID-19 evidence quickly available, many emerging studies have not been peer reviewed. As such, we advise caution when using and interpreting the evidence included in this rapid review. We have provided a summary of the quality of the evidence as low, moderate or high to support the process of decision making. Where possible, make decisions using the highest quality evidence available.

A number of mathematical modelling studies are emerging related to COVID-19. While these studies may provide important estimates, their ultimate usefulness depends on the quality of the data that is entered into the model. Given the constantly evolving nature and changing understanding of COVID-19 around the world, a high degree of caution is warranted when interpreting these studies, and when presented, include the range of confidence intervals rather than single effect estimates.

Important to this question, we did not assess the methodological quality of field-based environmental studies. Due to the highly technical nature of these studies, we highly recommend consulting a content-area expert to inform decision making.

Table 1: Syntheses

Reference	Date Released	Description of included studies	Summary of Findings	Quality Rating: Synthesis	Quality Rating: Included Studies
Carducci, A., Federigi, I., Liu, D., Thompson, J., and Verani, M. (2020). Making Waves: Coronavirus detection, presence and persistence in the water environment: State of the art and knowledge needs for public health *Water Research*, 179:115907 Epub ahead of print	May 5, 2020 (Search completed Apr 20, 2020)	22 studies published between 1978 and 2020, including 6 studies analyzing the virus causing COVID-19. • 5 studies focused on community wastewater surveillance of the virus • All environmental surveillance studies were from Australia, the Netherlands, USA (2) and France	Detection of the virus causing COVID-19 in wastewater challenges previous knowledge that enveloped viruses are not viable in water. Five field studies, including 4 pre-prints, tested wastewater for the virus for the purpose of surveillance at the community level. Each study positively identified the virus causing COVID-19 in samples with varying viral loads. Various methods were used limiting comparability across studies. The correlations between results and the number of known cases in their respective communities was inconsistent across studies. Current knowledge on the potential for surveillance or transmission of the virus causing COVID-19 through wastewater is extremely limited.	Moderate	Not reported (4/5 studies are pre-prints that have not been peer reviewed)

Table 2: Single Studies

Reference	Date Released	Study Design	Setting	Summary of findings	Quality Rating:
Randazzo, W., Truchado, P., Cueves-Ferrando, E., Simon, P., Allende, A., and Sanchez, G. (2020). SARS-CoV-2 RNA in wastewater anticipated COVID-19 occurrence in a low prevalence area. *Water Research 181*: 115942. Epub ahead of print	May 16, 2020	Environmental surveillance	Murcia Region, Spain	Six wastewater treatment plants in Spain were surveilled from 12 March to 14 April, 2020. RNA of the virus causing COVID-19 was detected in untreated water before the first cases were reported in low prevalence regions. Discrepancies were noted amongst assays used.	Not appraised
Alpaslan Kocamemi, B., Kurt, H., Sait, A., Sarac, F., Saatci, A. M., & Pakdemirli, B. (2020). SARS-CoV-2 Detection in Istanbul Wastewater Treatment Plant Sludges. *Preprint*.	May 16, 2020	Environmental surveillance	Istanbul, Turkey	Nine wastewater treatment plants in Istanbul, Turkey were sampled on 7 May 2020. RNA from the virus causing COVID-19 was detected at various levels in each sample.	Not appraised
Hart, O. E., & Halden, R. U. (2020). Computational analysis of SARS-CoV-2/COVID-19 surveillance by wastewater-based epidemiology locally and globally: Feasibility, economy, opportunities and challenges. *Science of the Total Environment*, 730:138875	May 7, 2020	Predictive modelling	City of Tempe, Arizona, USA	Using recently available reports of fecal viral load of infected individuals, wastewater surveillance may detect the presence of COVID-19 in the community. Estimated minimum prevalence needed ranges from 1 in 114 to 1 in 2 million which may also vary based on environmental conditions. The authors note the wide range of estimates due to limited available data and that the model should be refined as more information is available.	Not appraised
La Rosa, G., Iaconelli, M., Mancini, P., Bonanno Ferraro, G., Bonadonna, L., Lucentini, L., & Suffredini, E. (2020). First detection of SARS-CoV-2 in untreated wastewaters in Italy. *Preprint*.	May 7, 2020	Environmental surveillance	Milan and Rome, Italy	Twelve wastewater treatment plants in Milan and Rome, Italy, were sampled between February 3 and April 2, 2020. RNA from the virus causing COVID-19 was detected at various levels in 6 of the 12 samples.	Not appraised
Alpaslan Kocamemi, B., Kurt, H., Hacioglu, S., Yarali, C., Saatci, A. M., & Pakdemirli, B. (2020). First Data-Set on SARS-CoV-2 Detection for Istanbul Wastewaters in Turkey. *Preprint*.	May 6, 2020	Environmental surveillance	Istanbul, Turkey	Seven wastewater treatments plants and two manholes in Istanbul, Turkey were sampled on April 21 and 25, 2020. RNA from the virus causing COVID-19 was detected at various levels in 7 of the 9 samples.	Not appraised

				Correlation of the virus' RNA concentration and number of COVID-19 cases in the surrounding communities was unclear.	
Rimoldi, S. G., Stefani, F., Gigantiello, A., Polesello, S., Comandatore, F., Mileto, D., Maresca, M., Longobardi, C., Mancon, A., Romeri, F., Pagani, C., Moja, L., Gismondo, M. R., & Salerno, F. (2020). Presence and vitality of SARS-CoV-2 virus in wastewaters and rivers. *Preprint.*	May 5, 2020	Environmental surveillance	Milan, Italy	Three wastewater treatments plants and two rivers in Milan, Italy were surveilled from April 14 to April 22, 2020. RNA from the virus causing COVID-19 was detected in 4 of 6 raw wastewater samples, not detected in any of the treated samples, and detected in 3 of 4 river samples. The concentration of the virus' RNA in samples decreased over time, correlating with a decrease in COVID-19 cases in the surrounding region.	Not appraised
Bar Or, I. et al. (2020). Regressing SARS-CoV-2 sewage measurements onto COVID-19 burden in the population: a proof-of-concept for quantitative environmental surveillance. *Preprint.*	May 1, 2020	Methodological report	Israel	This article reports on novel methods for detection of COVID-19 in wastewater in the community. Sewage samples from a COVID-19 isolation facility were used as positive control samples in the validation of this new test. The authors note extreme caution should be used in application of this method as 1) their previous work showed wide differences by location and 2) this work is preliminary and ongoing.	Not appraised
Randazzo, W., Cuevas-Ferrando, E., Sanjuan, R., Domingo-Calap, P., & Sanchez, G. (2020). Metropolitan Wastewater Analysis for COVID-19 Epidemiological Surveillance. *Preprint.*	Apr 29, 2020	Environmental surveillance	Region of Valencia, Spain	Samples of undertreated wastewater were taken from 22 sites from February to April 2020. Viral load was detectable at a community level at the same time as the first case was reported. This suggests that community transmission was occurring earlier than previously believed.	Not appraised

References

Alpaslan Kocamemi, B., Kurt, H., Hacioglu, S., Yarali, C., Saatci, A. M., & Pakdemirli, B. (2020). First Data-Set on SARS-CoV-2 Detection for Istanbul Wastewaters in Turkey. *Preprint* .

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Randazzo, W., Cuevas-Ferrando, E., Sanjuan, R., Domingo-Calap, P., & Sanchez, G. (2020). Metropolitan Wastewater Analysis for COVID-19 Epidemiological Surveillance. *Preprint.*

Randazzo, W., Truchado, P., Cueves-Ferrando, E., Simon, P., Allende, A., and Sanchez, G. (2020). SARS-CoV-2 RNA in Wastewater Anticipated COVID-19 Occurrence in a Low Prevalence Area. *Water Research 181*: 115942. Epub ahead of print

Rimoldi, S. G., Stefani, F., Gigantiello, A., Polesello, S., Comandatore, F., Mileto, D., Maresca, M., Longobardi, C., Mancon, A., Romeri, F., Pagani, C., Moja, L., Gismondo, M. R., & Salerno, F. (2020). Presence and vitality of SARS-CoV-2 virus in wastewaters and rivers. *Preprint.*