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Short Communication: Is Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), the virus causing coronavirus disease 2019 (COVID-19), present in raw and in partially-treated sewage?

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SUMMARY

This WRI briefing explores the possible presence and transmission of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), the virus causing coronavirus disease 2019 (COVID-19), in raw (untreated) or partially-treated sewage ^{Note 1}. The key question we pose here is: **is there scientific evidence to support SARS-CoV-2 transmission and infection through raw or partially-treated sewage?** As of October 3, 2020, scientists have shown that the virus has been detected in stool and rectal samples of infected individuals. Consequently, SARS-CoV-2 has been detected in wastewaters all over the world. Two studies suggest that the virus was viable and/or infectious in stool samples. However, there are no reports of infection through the fecal-oral route to date. Based on our best effort to review the science, there is currently no evidence to suggest infection through contact recreation and professional interaction (sampling, monitoring, etc.). Regardless of the possible risk of exposure to SARS-CoV-2, caution is warranted any time there is possible exposure to untreated wastewater. For stakeholders concerned about the risk of COVID-19 infection associated with their personal and professional activities, and for people handling wastewater or coming in contact with surface water that might reasonably contain raw or partially treated sewage, we refer to existing guidance from public health experts and water professional organizations.

Key Definitions:

SARS-CoV-2: severe acute respiratory syndrome coronavirus 2 (referred to here as “the virus”)

COVID-19: coronavirus disease 2019 caused by SARS-CoV-2

Transmission: the passing of a pathogen causing a communicable disease from an infected host individual or group to another individual or group

Infection: likely transmission of a pathogen to people and other organisms through the environment

Risk (of exposure/infection): the likelihood of exposure/infection to occur during a specified period of time

Virus is detected: specific genetic material of the virus is detected using molecular diagnostic tests

Note 1: The terms “sewage” and “wastewater” are used interchangeably.

Updated October 3, 2020

SCOPE & FINDINGS

Starting January 2020, the scientific and medical community started mobilizing to understand the modes of transmission of SARS-CoV-2. The two primary modes of transmission identified were: respiratory and contact. However, early reports have cautioned that the virus might also be transmitted through the fecal-oral route¹. This preliminary notion is based on studies of previous coronaviruses (e.g., SARS-CoV and MERS-CoV) that have shown that in the absence of disinfection, the viruses can survive in sewage for a period of time under varying environmental conditions^{2, 8}.

The focus of this work is not on disinfected wastewater since the literature suggests that SARS-CoV-2 cannot survive the disinfection processes of water and wastewater treatment plants⁹. However, not all wastewater is disinfected - in fact, there are multiple pathways that untreated, or partially-treated sewage can enter waterbodies. For example, untreated or partially-treated sewage can be discharged by a wastewater treatment plant in the event of: 1) a combined sewer overflow (CSO) event, or 2) treatment plant malfunctions or failures (such as clogs or leaky sanitary sewer pipes). In addition to that, treated effluent that has not been disinfected can be legally discharged when a plant disinfects only seasonally or is not required to treat the effluent prior to release. Untreated wastewater can also enter a waterbody through pathways not related to wastewater treatment plants, including illegal sewage discharges and leaky septic systems.

In New York State, the Sewage Pollution Right to Know Law¹⁰ requires that publicly owned treatment works (POTW) must notify the public within two hours of discovery of a discharge of untreated or partially-treated sewage. However, this law does not cover discharges from privately owned treatment works or POTWs that are in compliance with a NYSDEC (New York State Department of Environmental Conservation) approved plan or permit. Due to these exemptions, and the non-POTW pathways laid out above, public knowledge of untreated wastewater in waterways and of the risk of exposure due to contact water uses is complex and incomplete.

The main question we pose here is: is there scientific evidence to support a route to infection of COVID-19 through raw or partially-treated wastewater? In an attempt to answer this question, we put forth a series of questions (see below), created a diagram with the possible pathway of infection, and color-coded the statements in that diagram according to the available literature (Figure 1). Based on our understanding, for SARS-CoV-2 to be transmitted from one person to another through wastewater: 1) the virus must be detected **and** be viable in the stools of patients, 2) the virus must be detected **and** be viable in raw sewage, and 3) the virus must be detected **and** be viable in surface waters that receive raw or partially-treated (not disinfected) sewage. In addition to this sequence of events, there are environmental factors to consider in addition to a viral load (quantity) that must be high enough to cause an infection. While we understand that these are these key components with regards to assessing the risk of infection, there is not enough information in the literature for us to present conclusive statements on these matters.

1. **Do individuals with COVID-19 shed the virus in their stool?**

Numerous studies have shown that **stool and rectal samples of infected individuals tested positive for the virus**^{e.g., 1, 11-24}. The positive results for some individuals came at a later stage of infection and often persisted even after the nasopharyngeal testing was negative^{1, 14-24}. This suggests extended viral shedding in feces of infected individuals, even after being cleared by nasopharyngeal testing.

2. **Is the virus viable in stools of COVID-19 patients?**

As of October 3, 2020, **two peer-reviewed studies successfully isolated live and/or infectious SARS-CoV-2 virus from stool samples of COVID-19 patients**^{12, 13}. While this suggests the possibility of fecal-oral transmission, there are **no reports of infection through the fecal-oral route to date**.

3. **Has the virus been detected in untreated wastewater?**

SARS-CoV-2 has been detected in untreated wastewater all over the world^{e.g., 14, 25-31 (Note 2)}. The samples tested positive for virus RNA using quantitative reverse transcription-polymerase chain reaction (RT-qPCR)^{14, 25-31}, a method that does not assess virus viability or infectivity. There is currently **no information on how long detectable virus can last in wastewater or under what environmental conditions**.

4. **Is the virus viable in untreated wastewater?**

The authors of **one peer-reviewed study evaluated the vitality of SARS-CoV-2 in wastewater** using non-human cells and concluded **that the ability of the virus to infect was insignificant**³¹. There is currently **no other information yet on whether or not the virus is viable in wastewater**. However, previous coronaviruses were known to be readily inactivated in water and wastewater at ambient temperatures compared to other groups of human enteric viruses^{32, 33}.

5. **Has the virus been detected in surface water that receives untreated or partially-treated sewage?**

In one peer-reviewed study, SARS-CoV-2 was detected in 3 out of 4 samples taken from two rivers in Italy that were sampled on two different dates³¹. The authors associated this detection with non-treated discharges into the rivers and with CSO events.

6. **Is the virus viable in surface water that receives untreated or partially-treated sewage?**

The authors of the same peer-reviewed study referenced in Question 5 reported that the ability of the virus to infect was negligible³¹. There is currently **no other information on the presence or the viability of the virus in surface waters**.

Note 2: Reference 28 is a preprint, i.e., it is a preliminary report that has not been peer-reviewed.

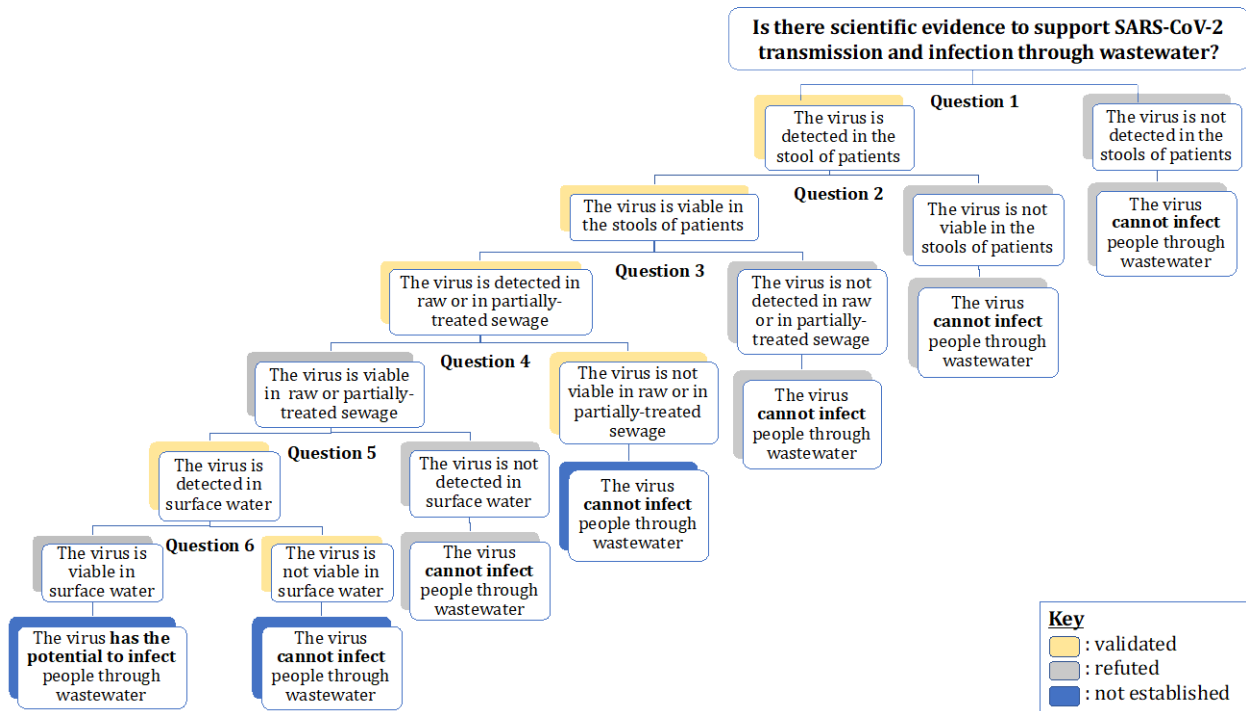


Figure 1. Diagram of possible viral transmission pathways and infection end points associated with untreated or partially treated sewage. The yellow, grey, and blue boxes indicate that this statement has been supported, refuted, or not yet established with scientific evidence, respectively.

CONCLUDING REMARKS

Given that the viability of SARS-CoV-2 in wastewater has not been demonstrated, there is currently no evidence to suggest infection through contact recreation and professional interaction (sampling, monitoring, etc.). However, given the rapidly evolving body of knowledge on this virus, and the public health implications of infection, it seems prudent to take a conservative approach. For people handling wastewater, or for those coming in contact with surface water that might reasonably contain raw or partially treated sewage, there are existing guidelines in place for doing so safely (see Current Guidance below). These guidelines prescribe a combination of best sanitation and hygienic practices, as well as personal protective equipment (PPE). A reasonable response to stakeholders interested in the questions addressed here could reference these existing guidelines, and act as a reminder that conservative approaches to protection are appropriate given the state of knowledge and the risks associated with COVID-19 infection. This document aims to increase dialogue and provide reference points regarding the current research on the presence of the virus in raw or partially treated sewage. For medical advice and other recommendations, please consult a medical professional or the Center for Disease Control and Prevention (CDC – see Current Guidance below).

Current Guidance:

- For general guidelines for people, visit the Center for Disease Control and Prevention (CDC) website at: <https://www.cdc.gov/coronavirus/2019-ncov/index.html>.
- For specific guidelines for wastewater management workers and employers, visit the Occupational Safety and Health Administration (OSHA) website at: <https://www.osha.gov/SLTC/covid-19/solid-waste-wastewater-mgmt.html>
- For specific guidelines for water professionals, visit the Water Environment Federation (WEF) website at: <https://wef.org/news-hub/wef-news/the-water-professionals-guide-to-the-2019-novel-coronavirus/>

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