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Evaluating the Risk of SARS-CoV-2 Occupational Transmission in Wastewater Treatment Plant Workers

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Abstract

This short literature review explores the level of risk of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) occupational transmissions in wastewater treatment plant (WTP) workers. Three main databases (PubMed, Google Scholar, and ProQuest) were searched to explore the level of infectivity of SARS-CoV-2 in wastewater, risk factors of transmissibility of the virus in wastewater, and reported cases for occupational transmission in WTP workers. The results show that SARS-CoV-2 can be shed in the feces of individuals with COVID-19, making its way to wastewater treatment plants (WTP). Multiple potential risk factors for SARS-CoV-2 transmission from wastewater to sewage workers have been postulated based in previous studies. However, no case report of occupational transmission of SARS-CoV-2 to wastewater workers was found, and studies suggest that the presence of the virus or its particles is not necessarily indicative of infectivity. Further research is warranted to reliably estimate the occupational risk to WTP workers and identify preventive measures.

Keywords: Wastewater Treatment Plant Workers; SARS-CoV2

Introduction

Wastewater plant workers (WTPWs) are exposed to chemical and biological occupational hazards. During the on-going Covid-19 pandemic, exposure to SARS-CoV2 poses another risk to these workers. It is an important public health concern as wastewater treatment plant workers are key workers for society's safe, effective and healthy functioning.

Evidence suggests that severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) can be shed in the faces of individuals with COVID-19. The evidence also shows the presence of viral particles in sewage, hence establishing SARS-CoV-2 wastewater monitoring networks in the global pandemic. In addition, there is a possibility of the feco-oral route of transmission to the environment matrix [1]. Hence internationally, concerns have been raised about the level of wastewater SARS-COV-2 transmission risk to wastewater treatment plant workers in the occupational context [2,3].

This article explores the documented literature on the level of risk of SARS-CoV-2 bio transmission in wastewater to wastewater treatment plant workers (WTPWs) in an occupational setting. While studies have postulated theoretical potential risk factors for SARS-CoV-2 to be transmitted in wastewater to sewage workers in an occupational setting, it is unclear if the occupational transmission has been documented in published literature and the actual level of risk.

Methods

A review of the literature till September 2021 was performed using three databases (PubMed, Google Scholar, ProQuest) to evaluate three main issues:

- Level of infectivity of SARS-CoV-2 in wastewater

- Risk factors of transmissibility of SARS-CoV-2 in wastewater
- Reported cases for occupational transmission of SARS-CoV-2 in WTPWs

Results

Level of Infectivity of SARS-CoV-2 found in Treatment Plant Wastewater

Several articles demonstrated that SARS-CoV-2 quantification and persistence in wastewater is not necessarily indicative of infectivity. Detection of viruses in environmental samples is extremely challenging. One study has shown that the infectivity of SARS-CoV-2 is null based on the absence of cytopathic effect in infectivity tests [4]. Although no infectious SARS-CoV-2 has been detected in wastewater so far, fragmented viral genetic material has been detected. Monitoring of wastewater for COVID-19 continues with standard techniques and methodology.

Concerning the level of infectivity, multiple factors were highlighted:

- A lot of modeling of the risk of SARS-CoV-2 transmission in wastewater is based on research on coronaviruses before the onset of SARS-CoV-2 [5,6]. During the SARS-CoV outbreak of 2002-2003, the closely related SARS-CoV-2 was detected in sewage discharged by two hospitals.
- Most coronaviridae that attack humans (though not certain about SARS-CoV-2) are often rapidly inactivated in water [4].
- Coronaviridae (Coronaviruses as a family of viruses) seem to have low stability in the environment and are very sensitive to oxidants such as chlorine [7].
- Coronaviridae appear to be inactivated significantly faster in water than non-enveloped human enteric viruses with known waterborne transmission
- The survival period of coronaviridae in water environments depends on
  - temperature [7]
  - property of water
  - the concentration of SARS-CoV-2 suspended solids and organic matter in wastewater
  - solution pH
  - dose of disinfectant [4,8]
  - humidity
  - virus surface hydrophobicity
  - dissolved salts
- There is no internationally agreed standardized protocol for SARS-CoV-2 detection and quantification in wastewater samples [5,9].
- Non-infectious, genetic traces of the virus can remain in the sewer system, but the infectious SARS-CoV-2 virus has not been detected.
- QMRA (Quantitative microbial risk assessments) estimations of SARS-CoV-2 in wastewater to which WTPWs are exposed have been based on models but not actual measurements of SARS-CoV-2 [5,10,11]. Furthermore, these models may have limited use as, unlike enteric viruses, coronaviruses are covered by a lipid envelope and can remain viable in sewage for up to 14 days depending on environmental conditions [6,8]. Nevertheless, dada concluded that the risk if accidental occupational exposure to SARS-CoV-2 in raw wastewater via inhalation of the wastewater treatment plant environment is negligible, particularly when less than 0.3% of the population served by the plant are actively infected [10,12,13]
- There are several phases in the standard wastewater treatment plant in which the SARS-CoV-2 can be degraded and inactivated [14]. The virus envelope can be damaged by detergent and solvents in wastewater [8].
- All the studies agree that more definitive research is required to focus on the operational survival of SARS-CoV-2 in wastewater in different working conditions (temperature, water matrix, etc.) [4] and the infectivity potential of SARS-CoV-2 in sewage.

Risk Factors for SARS-CoV-2 Transmission

Risk factors for SARS-CoV-2 transmission via wastewater to WTPWs based on modeling (including previous outbreak studies of other viruses). Several relevant articles were identified which postulated important risk factors, including [15,16]:

- The atmospheric loading of coronaviruses in water droplets from wastewater is not understood much. However, it could theoretically provide a direct respiratory route for exposure for WTPWs and at sewage pumping stations [6].
- Some wastewater treatment plant processes generate aerosols that can potentially transmit pathogenic microorganisms, including SARS-COV-2. However, there is limited data on the survival of SARS-CoV-2 in wastewater and risk when aerosolized [15].
- Coronaviridae (Coronaviruses as a family of viruses) seem to have low stability in the environment and are very sensitive to oxidants such as chlorine [7].
- Coronaviridae appear to be inactivated significantly faster in water than non-enveloped human enteric viruses with known waterborne transmission [9,16,17]. The additional lipid membrane surrounding the capsid results in increased susceptibility to disinfection and environmental stressors.
- Temperature is an important factor influencing the survival of the coronaviridae [9]
- Exposure level and volume of aerosolized water inhaled by the WTPWs during work

Published Case Reports of Confirmed Occupational SARS-CoV-2 Via Wastewater in WTPWs.

The searches did not identify any case reports of occupational transmission of SARS-CoV-2 via wastewater to WTPWs in the literature. It is important to note that such occupational cases may have been determined globally but not been reported in scientific literature. Furthermore, it is possible that such literature has been accepted for publication but not published as of this article's time.

Discussion

Understanding the potential for SARS-CoV-2 transmission is limited due to gaps in the knowledge of its occurrence, persistence, and removal in wastewater [7]. WTPWs need to adhere to the standard safety precautions against SARS-CoV-2.

The evidence summarized above supports the USA federal guidelines for protection measures against SARS-CoV-2 to mitigate occupational risk mitigation measures to protect the occupational health of WTPWs [16]. In the USA, OSHA (Occupational Safety & Health Administration) recommends no additional specific protections against SARS-CoV-2 for WTPWs employees involved in wastewater management operations with residuals, sludge, and biosolids at water resource recovery facilities [18]. Likewise, the US EPA (Environmental Protection Agency) guidance references a 2002 document outlining standard precautions to protect workers handling class B biosolids to minimize exposure to pathogens, including viruses [19].

Conclusion

There is currently no published epidemiological evidence demonstrating a clear link between the occupational risk for WTPWs of SARS-CoV-2 infection and exposure to wastewater sludge or biosolids [16]. The quantification if SARS-CoV-2 in wastewater is not indicative of infectivity, and the risk for exposure to SARS-CoV-2 or any pathogen decreases with increasing treatment measures [16,20,21].

The transmission of this virus through wastewater to WTPWs is yet to be established. The survivability, transmissibility, and infectivity of SARS-CoV-2 in wastewater treatment plants is a vital issue that needs to be definitively addressed [21]. More research into this novel area is indicated for more direct measurement and risk quantification of multiple aspects. It includes virus persistence in wastewater, level of active virus transmission by aerosolization in wastewater facilities, and occupational SARS-CoV-2 case rate in wastewater treatment plant workers.

Some suggested ideas to decrease viral loads in wastewater treatment plants (e.g. membrane bioreactors, emerging disinfection technologies) may not protect WTPWs it is important to definitively quantify the risks with sewage loading to ensure all possible control measures are identified and implemented to minimize the risk to WTPWs [6].

In conclusion, the risk of transmission of SARS-CoV-2 through wastewater to WTPWs in occupational settings appears to be low considering the absence of any confirmed evidence so far. Furthermore, adherence to standard safety procedures advised by organizations like USEPA and OSHA is likely to protect WTPWs substantially even if this risk is established.

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