

Water contamination of SARS-CoV-2: Risks and preventions

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Abstract

The newly emerged SARS-CoV-2 has also shown enteric or diarrheal manifestations, including gastrointestinal shedding of the virus. Ample of studies have reported detection of SARS-CoV-2 in stool samples, and there are growing evidences on its occurrences in different water sources. Therefore, in countries with poor sanitation or water management, heavy rain and flood may further aggravate community spread of Covid-19. Because, in such a pandemic situation, diagnostic tests cannot suffice for mass-surveillance in high populations, wastewater-based virus surveillance can serve as an early-warning preventive measure in a given community. In view of this, sewages of housing complexes, hotels, hospitals, quarantine centers, prisons, railway stations, airports, malls, stadiums, and military cantonments could be well monitored.

Keywords: SARS-CoV-2; Covid-19; fecal shedding; waterborne transmission; wastewater surveillance

Introduction

Enteric viruses shed in the infected individuals' gastrointestinal tract and feces are primarily transmitted through ingestion of contaminated water, even at a low titer [1]. Most of such human infections are asymptomatic or self-limiting and are manifested as gastroenteritis, diarrhea or respiratory illness [2]. Of these, coronaviruses (CoVs) primarily cause respiratory infection in humans, including different symptoms in other mammals [3]. In addition, enteric manifestation and waterborne transmission of human CoVs through detection of CoV-like particles in fecal samples have been confirmed in symptomatic as well as asymptomatic individuals [4-6]. In humans, six CoVs viz., HCoV-OC43, HCoV-229E, HCoV-NL63, HCoV-HKU1, SARS-CoV-1, and MERS-CoV, including the seventh recently emerged SARS-CoV-2 are known to cause respiratory diseases [7,8]. Similar to SARS-CoV-1 and MERS-CoV, a proportion of SARS-CoV-2 disease (Covid-19) patients have shown a relatively 'asymptomatic' state before the onset of typical symptoms [9,10].

Gastrointestinal manifestations of HCoVs

Generally, the gastrointestinal manifestations of HCoVs include diarrhea and stool shedding. Of these, HCoV-OC43 and HCoV-NL63 have been shown digestive symptoms and fecal shedding in an equal proportion [11] as compared to a higher frequency in cases of HCoV-NL63 patients [12]. In addition, HCoV-HKU1 commonly associated with acute respiratory infection, has been also linked to the gastrointestinal symptoms [13,14]. Notably, diarrhea has been a common digestive manifestation of both SARS-CoV-1 and MERS-CoV [15,16].

Stool shedding of SARS-CoV-2

A proportion of SARS-CoV-2 infected patients have shown gastrointestinal and liver manifestations, such as abdominal pain, diarrhea, and hepatitis [17,18]. As compared to nasopharyngeal specimen, higher titer of SARS-CoV-2 RNA has been detected in the rectal and stool samples [18-20]. Notably, in a recent study, the

infectivity of stool-derived SARS-CoV-2 has been demonstrated in cultured cells [21].

Detection of SARS-CoV-2 in sewage and wastewater

Enteric or diarrheal viruses have been associated with drinking water sources such as wells and lakes, including raw wastewater. In view of this, the stool shedding of infectious SARS-CoV-2 further increases the risk of its waterborne or fecal-oral transmission [21]. Because, most underdeveloped or low-income countries have poor sanitation and inadequate water management, it potentially increase the risk of Covid-19 spread in a given community [22]. The SARS-CoV-2 contamination of water sources may occur through various pathways. The surface water, such as ponds, lakes and rivers where wastewater is often discharged directly without proper treatment, can further transport the virus through the water channels into the communities. In view of the highlighted plausible contamination and waterborne transmission of SARS-CoV-2, several wastewater surveillance studies have reported detection of viral RNA in raw and treated wastewater samples collected from wastewater treatment plants, river and hospital septic tanks [23-32]. Therefore, water surveillance has been recommended as an early-warning preventive measure for Covid-19 spread [33].

Inactivation of SARS-CoV-2 in wastewater

In wastewater, the half-life of SARS-CoV-2 has been reported to be significantly affected by various physical and chemical factors, such as temperature, UV ozone, and chlorine [34]. The World Health Organization (WHO) has suggested free chlorine (0.5 mg/L pH 8.0) and at least 30 min of contact time for centralized disinfection [35]. The half-life of SARS-CoV-2 in hospital wastewater was estimated to range between 4.8 and 7.2 h at 20°C [35]. Recently, a disinfection guideline, requiring free chlorine (6.5 mg/L) and contact time of 1.5 h for medical sewage has been initiated in China [34]. In view of this, there is a proposed measure that includes decentralization of wastewater treatment facilities, community-wide monitoring and testing of SARS-

CoV-2 in wastewater samples, improved sanitation, developing point-of-use decontamination devices, and implementation of more focused policy. Nonetheless, in some cases, even when the cause of water contamination is resolved, the drinking water still gets contaminated by the sewage through blockage of the drainage system, pipe leakage or pump failure. In other cases, inadequate or failing treatment processes also lead to partial removal of enteric viruses from water sources.

Wastewater surveillance for SARS-CoV-2

The provision of safe water, sanitation, waste management and hygienic conditions is therefore, essential for protecting public health during infectious disease outbreaks. In a pandemic situation like Covid-19, wastewater-based epidemiology (WBE) serves as an important tool to detect and monitor enteric viruses in a community [36]. WBE has been therefore, applied to a wide range of waterborne enteric viruses, including CoVs which are ultimately discharged into urban sewage [37]. WBE is an integrated technique that implies extraction and nucleic acid-based techniques to detect viral RNA or DNA from water samples, its quantification, data processing, and interpretation. In the present situation, WBE could be a valuable surveillance tool to monitor SARS-CoV-2, providing opportunities to estimate its prevalence, genetic diversity and geographic distribution. The WHO guidelines recommend a preventive management framework for sanitation and water surveillance for authorities who set the health-based targets for the protection of drinking water from waterborne infections [35]. This includes assessing the adequacy of systems, defining and monitoring control measures, and establishing management strategies for water safety. Such framework for safe water can be therefore, adapted according to environmental, socio-economic and cultural circumstances on the national, regional and local levels [38]. In addition, sewages of hostels, housing complexes, hotels, hospitals, quarantine centers, prisons, factories and warehouses, railway stations, seaports, airports, malls, stadiums, military cantonments and other confined areas should be monitored for SARS-CoV-2.

Future perspectives

Because SARS-CoV-2 is shed in high amount in patients' stools and been detected in various water sources, it provides a cautionary warning on the further spread of Covid-19 in underdeveloped or developing countries. In spite of this, the roles of infected excreta and water surveillance have not been widely endorsed yet. Nonetheless, the provision of safe water through sanitation, wastewater management and hygienic conditions is essential for protecting public health during such pandemic. Therefore, more experimental and clinical studies are further needed to show whether transmittable amounts of SARS-CoV-2 can be found in water sources. In addition to the ongoing global monitoring of SARS-CoV-2 in clinical and laboratory settings, wide implementation of WBE could be very useful in tracking the source of contamination, identifying the locations of potential carriers, and providing an indicator of Covid-19 within a community. However, tracking the source, spread, and mutational changes in SARS-CoV-2 in near real-time would be one of the most challenging aspects of water surveillance.

Conflict of interests

The author declares no conflict of interests.

References

1. Bidawid S, Farber JM, Sattar SA. Contamination of foods by food handlers, experiments on hepatitis A virus transfer

- to food and its interruption. *Appl Environ Microbiol.* 2000; 66: 2759-2763.
2. Desselberger U. Viral gastroenteritis. *Medicine (Abingdon).* 2017; 45: 690-694.
3. Macnaughton MR, Davies HA. Human enteric coronaviruses. *Arch Virol.* 1981; 70: 301-313.
4. Flewett TH, Boxall E. The hunt for viruses in infections of the alimentary system, an immunoelectronmicroscopical approach. *Clin Gastroenterol.* 1976; 5: 359-385.
5. Caul EO, Paver WK, Clarke SK. Coronavirus particles in faeces from patients with gastroenteritis. *Lancet.* 1975; 1: 1192.
6. Mathan M, Mathan VI, Swaminatan SP, Yesudoss S. Pleomorphic virus-like particles in human faeces. *Lancet.* 1975; 1: 1068-1069.
7. Wu F, Zhao S, Yu B, Chen YM, Wang W, et al. A new coronavirus associated with human respiratory disease in China. *Nature.* 2020; 579: 265-269.
8. Ren LL, Wang YM, Wu ZQ, Xiang ZC, Guo L, et al. Identification of a novel coronavirus causing severe pneumonia in human, a descriptive study. *Chin Med J (Engl).* 2020; 133: 1015-1024.
9. Parvez MK, Jagirdar RM, Purty RS, Venkata SKS, Agrawal V, et al. COVID-19 pandemic, understanding the emergence, pathogenesis and containment. *World Acad Sci J.* 2020; 2: 18.
10. Yu P, Zhu J, Zhang Z, Han Y, Huang L. A familial cluster of infection associated with the novel 2019 novel coronavirus indicating possible person-to-person transmission during the incubation period. *J Infect Dis.* 2020; 221: 1757-1761.
11. Furukawa NW, Brooks JT, Sobel J. Evidence supporting transmission of severe acute respiratory syndrome coronavirus 2 while presymptomatic or asymptomatic. *Emerg Infect Dis.* 2020; 26: e201595.
12. Jevšnik M, Steyer A, Zrim T, et al. Detection of humancoronaviruses in simultaneously collected stool samples and nasopharyngeal swabs from hospitalized children with acute gastroenteritis. *Virol J.* 2013; 10: 46.
13. Vabret A, Dina J, Gouarin S, Petitjean J, Corbet S, et al. Detection of the new human coronavirus HKU1, a report of 6 cases. *Clin Infect Dis.* 2006; 42: 634-639.
14. Kanwar A, Selvaraju S, Esper F. Human coronavirus-HKU1 infection among adults in Cleveland, Ohio. *Open Forum Infect Dis.* 2017; 4: ofx052.
15. Cheng VC, Hung IF, Tang BS, Chu CM, Wong MM, et al. Viral replication in the nasopharynx is associated with diarrhea in patients with severe acute respiratory syndrome. *Clin Infect Dis.* 2004; 38: 467-475.
16. Song JY, Cheong HJ, Choi MJ, Jeon JH, Kang SH, et al. Viral shedding and environmental cleaning in Middle East respiratory syndrome coronavirus infection. *Infect Chemother.* 2015; 47: 252-255.
17. Gu J, Han B, Wang J. COVID-19, Gastrointestinal Manifestations and Potential Fecal-Oral Transmission. *Gastroenterology.* 2020; 158: 1518-1519.
18. Parvez MK. Gastrointestinal and hepatobiliary manifestations of coronavirus disease-19, potential implications for healthcare resource-deficient countries. *Gastroenterol Hepatol Lett.* 2020; 2: 7-11.
19. Wang D, Hu B, Hu C, Zhu F, Liu X, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel

- coronavirus-infected pneumonia in Wuhan, China. *JAMA*. 2020; 323: 1061-1069.
20. Pan Y, Zhang D, Yang P, Poon LLM, Wang Q. Viral load of SARS-CoV-2 in clinical samples. *Lancet Infect Dis*. 2020; 20: 411-412.
 21. Xiao F, Sun J, Xu Y, Li F, Huang X, et al. Infectious SARS-CoV-2 in feces of patient with severe COVID-19. *Emerg Infect Dis*. 2020; 26: 1920-1922.
 22. Parvez MK. Gut feeling, the plausible faecal-oral transmission route of Covid-19. *J Infect Dis epidemiol*. 2020; 6: 141-143.
 23. Ahmed W, Angel N, Edson J, Bibby K, Bivins A, et al. First confirmed detection of SARS-CoV-2 in untreated wastewater in Australia, a proof of concept for the wastewater surveillance of COVID-19 in the community. *Sci Total Environ*. 2020; 728: 138764.
 24. Wurtzer S, Marechal V, Mouchel J-M, Moulin L. Time course quantitative detection of SARS-CoV-2 in Parisian wastewaters correlates with COVID-19 confirmed cases. *medRxiv*. 2020; 12: 20062679.
 25. Randazzo W, Truchado P, Cuevas-Ferrando E, Simón P, Allende A, et al. SARS-CoV-2 RNA in wastewater anticipated COVID-19 occurrence in a low prevalence area. *Water Res*. 2020; 181: 115942.
 26. Rimoldi SG, Stefani F, Gigantiello A, Polesello S, et al. Presence and vitality of SARS-CoV-2 virus in wastewaters and rivers. *medRxiv*. 2020; doi: 10.1101/2020.05.01.20086009.
 27. Lodder W, de Roda Husman AM. SARS-CoV-2 in wastewater, potential health risk, but also data source. *Lancet Gastroenterol Hepatol*. 2020; 5: 533-534.
 28. Medema G, Heijnen L, Elsinga G, Italiaander R, Brouwer A. Presence of SARS-Coronavirus-2 in sewage. *medRxiv*. 2020; doi: 10.1101/2020. 03.29.20045880.
 29. Nemudryi N, Nemudraia A, Surya K, Wiegand T, Buyukyork M, et al. Temporal detection and phylogenetic assessment of SARS-CoV-2 in municipal wastewater. *medRxiv*. 2020; doi: 10.1101/2020.04.15.20066746.
 30. Zhang D, Ling H, Huang X, Li J, Li W, et al. Potential spreading risks and disinfection challenges of medical wastewater by the presence of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) viral RNA in septic tanks of Fangcang Hospital. *Sci Total Environ*. 2020; 741: 140445.
 31. La Rosa G, Iaconelli M, Mancini P, Bonanno Ferraro G, Veneri C, et al. First detection OF SARS-COV-2 IN untreated wastewaters in Italy. *medRxiv*. 2020; 736: 139652.
 32. Wu F, Zhang J, Xiao A, Gu X, Lee WL, et al. SARS-CoV-2 titers in wastewater are higher than expected from clinically confirmed cases. *medRxiv*. 2020; doi: 10.1101/2020.04.05.20051540.
 33. Annalaura C, Federigi I, Dasheng L, Julian RT, Marco V. Making waves, coronavirus detection, presence and persistence in the water environment, state of the art and knowledge needs for public health. *Water Res*. 2020; 179: 115907.
 34. Wang J, Shen J, Ye D, Yan X, Zhang Y, et al. Disinfection technology of hospital wastes and wastewater, suggestions for disinfection strategy during coronavirus disease 2019 (COVID-19) pandemic in China. *Environ Pollut*. 2020; doi: 10.1016/j.envpol.2020.114665.
 35. WHO. [www.who.int/publications/i/item/water-sanitation-hygiene-and-waste-management-for-the-Covid-19-virus-interim-guidance]
 36. Adelodun B, Ajibade FO, Ibrahim RG, Bakare HO, Choi KS. Snowballing transmission of COVID-19 (SARS-CoV-2) through wastewater, Any sustainable preventive measures to curtail the scourge in low-income countries? *Sci Total Environ*. 2020; 742: 140680.
 37. Iaconelli M, Muscillo M, Della Libera S, Fratini M, Meucci L, et al. One-year surveillance of human enteric viruses in raw and treated wastewaters, downstream river waters, and drinking waters. *Food Environ Virol*. 2007; 9: 79-88.
 38. Mallapaty S. How sewage could reveal true scale of coronavirus outbreak. *Nature*. 2020; 580: 176-177.

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