Coronavirus in wastewater – **Rushing for answers**

Current research addresses the occurrence of coronavirus in wastewater and effective inactivation of the virus in existing wastewater treatment processes. **Charles Gerba**, **Walter Betancourt**, and **Ian Pepper** at the United States' (US) University of Arizona Water and Energy Sustainable Technology (WEST) Center report on current research findings.

One important lesson health-related environmental microbiologists have learned is that microbes never give up in their quest to survive and propagate in humans. Pathogens are always evolving and are the ultimate opportunists. The coronavirus – specifically SARS-CoV-2 virus, which causes COVID-19 – is just another example that serves as a reminder to always remain vigilant to threats posed by pathogens transmitted into and through the environment.

Only recently did this virus evolve from animals, making it capable of infecting humans. Without previous exposure to the virus, the human population had not developed antibody resistance to it, so the virus is able to spread rapidly.

The virus that causes COVID-19 is related to the Severe Acute Respiratory (SARS-CoV-1) virus, which moved into the human population around 2002. Fortunately, the spread of this virus was limited, but pointed out the threat of emerging pathogens to the human population. These two viruses are relatively large (120 to 140 nanometers [nm]) when compared to enteric viruses (18 to approximately 70 nm). These two coronaviruses also are surrounded by a lipid envelope.

The potential for coronaviruses to be transmitted by water has not received much attention because it was believed that such viruses would not survive long in water and be easily inactivated by wastewater treatment and disinfection processes. No current evidence exists for the transmission of SARS-CoV-2 by the fecal-oral route (ingestion). Further, while aerosolization of the virus may occur during wastewater handling and treatment, the current guidance by the US Centers for Disease Control and Prevention states that "standard practices associated with wastewater treatment plant operations should be sufficient to protect wastewater workers from the virus that causes COVID-19."

All the viruses known to be transmitted by water are non-enveloped (do not contain a lipid layer around their protein capsid) and are largely transmitted to humans through airborne droplets and contact with contaminated surfaces. These heartier non-enveloped viruses are known to generally be sensitive to common disinfectants used to decontaminate surfaces, but little is known about their sensitivity to disinfectants in water.

Recent studies have shown that infectious SARS-CoV-2 virus is excreted in both the urine and feces. Research is underway to determine if the virus remains infectious in wastewater. Studies with human coronavirus 229E (one of the causes of the common cold) and SARS-CoV-1 have shown these viruses can remain infectious for several days in both tap water and wastewater, which is much less than the non-enveloped viruses.

The SARS-CoV-2 genome can be detected in wastewater using polymerase chain reaction (qPCR), which can provide information on the concentration of the virus' genetic material in water, but not infectivity. The concentration of the genetic material in wastewater will vary depending on the incidence of infection in the community, with both symptomatic and asymptomatic infected individuals excreting the virus. During a pandemic, high concentration of the virus can be found in untreated wastewater. Concentrations (copies of genome) as high as approximately 3 million per liter of untreated wastewater and 46,000 per milliliter in primary sludge have been reported. This finding has led to wastewater surveillance or wastewater-based epidemiology, as it has recently been termed, being used to track pandemics.

Wastewater surveillance is particularly effective as an early or leading indicator of the virus because it can be found in wastewater 7 to 10 days prior to the onset of symptoms in individuals. These measurements can be used also to evaluate the effectiveness of interventions used to mitigate the virus. However, standardized methods have yet to be agreed upon.

Recent studies are confirming that coronaviruses are eliminated more easily by current wastewater treatment processes than viruses traditionally associated with waterborne disease.

Research conducted at the WEST Center has followed the decrease in concentration of SARS-CoV-2 genetic material in untreated wastewater when stay-at-home orders went into effect in Arizona and tracked the increase in concentration as cases surged after the lifting of the stay-at-home orders. This shows that monitoring wastewater can be used as a tool for tracking trends of infections within a community or area.

The researchers detected the virus by qPCR in wastewater before chlorine disinfection, but not after indicating that the genome (nucleic acid) is destroyed by the action of chlorine. The virus is considered to be sensitive to inactivation by ultraviolet disinfection (UV). Currently, dosing studies are being conducted at the center to determine the concentration and time (Ct value) needed for chloramines and UV light to inactivate coronaviruses.

This research indicates that coronaviruses readily associate with solids in untreated wastewater and significant removal may occur during primary sludge settling. This was confirmed by a recent study in 2020 that identified significant numbers of SARS-CoV-2 genome in primary sludge. However, the researchers have not been able to detect the virus' genetic material by qPCR in anaerobically digested biosolids.

Recent studies at the WEST Center are confirming the assumptions that coronaviruses are eliminated more easily by current wastewater treatment processes than viruses traditionally associated with waterborne disease. The data indicates that greater reductions of this virus will occur compared to enteric viruses, and that current treatment processes in water resource recovery facilities are more than adequate to eliminate this virus.

Authors' Note

Both Charles Gerba and Walter Betancourt are environmental virologists and Ian Pepper is an environmental microbiologist, who all work for the Water and Energy Sustainable Technology Center at the University of Arizona in Tucson, Arizona, US.

Reference

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