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SARS-COV-2 IN WASTEWATER AND SURFACE WATER: HOW TO DEAL WITH THE PROBLEM?

SARS-CoV-2 en aguas residuales y superficiales: ¿cómo lidiar con el problema?

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Abstract

Introduction: Today, humanity suffers one of the worst episodes due to a pandemic caused by the SARS-CoV-2. Its high infectivity and rapid spread combined with its persistence on certain surfaces difficult to fight this virus. Its presence in wastewater and possible fecal-oral transmission could be a new public health threat.

Objective: To alert the international scientific community and governments about the presence of SARS-CoV-2 in wastewater, and what to do to prevent its spread by this means.

Methods: A review of articles referenced in SCOPUS and Web of Science since 2019 related to the presence of the virus in wastewater and surface water was performed.

Results and discussion: It is necessary to establish monitoring systems with the use of sensitive and rapid analytical methods for the on-site detection of viruses in wastewaters and surface waters. It should be established virus inactivation

Resumen

Introducción: hoy la humanidad sufre uno de los peores episodios debido a la pandemia causada por el SARS-CoV-2. Su alta infectividad, rápida propagación y persistencia en ciertas superficies dificultan el combate de este virus. Su presencia en aguas residuales y posible transmisión fecal-oral podría ser una nueva amenaza para la salud pública.

Objetivo: alertar a la comunidad científica internacional y a los gobiernos sobre la presencia de SARS-CoV-2 en las aguas residuales y sobre qué hacer para evitar su propagación por este medio.

Métodos: se realizó una revisión de artículos referenciados en SCOPUS y Web of Science desde el año 2019 relacionados con la presencia del virus en aguas residuales y superficiales.

Resultados y discusión: es necesario establecer sistemas de monitoreo, utilizar métodos analíticos sensibles y rápidos para la detección del virus en las aguas residuales y superficiales. Asimismo, implantar protocolos de inactivación

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protocols at the health units, and water treatment plants, where are recommended processes with chemical oxidants, ultraviolet radiation, photocatalysis, photo-Fenton, ozone, or membrane filtration. It is necessary to alert the population about the importance of washing and disinfecting agricultural products, mainly vegetables and fruits, as well as the care in its handling by agricultural workers.

Keywords: SARS-CoV-2; COVID-19; wastewaters; surface waters; wastewater treatment.

del virus en las unidades de salud y en las plantas de tratamiento de aguas. Se recomiendan procesos con oxidantes químicos, radiación ultravioleta, fotocatálisis, foto-Fenton, ozono o filtración por membrana. Además, se debe alertar a la población sobre la importancia del lavado y de la desinfección de productos agrícolas, así como del cuidado en su manejo por parte de los trabajadores agrícolas.

Palabras clave: SARS-CoV-2, COVID-19; aguas residuales; aguas superficiales; tratamiento de aguas.

Introduction

The precedents and investigations that clearly warned coronaviruses emergence was an event that should have to be foreseen[1,2]. Today, humanity is experiencing a pandemic of viral etiology caused by the SARS-CoV-2. This novel coronavirus is the seventh able to infect humans, including severe acute respiratory syndrome CoV (SARS-Cov) and Middle East respiratory syndrome CoV (MERS-CoV), lethal zoonotic pathogens with the potential to produce a pandemic[3,4].

Although the mortality produced by SARS-CoV-2 seems to be much lower to the one associated with SARS-CoV (> 10%) and MERS-CoV'(> 35%)[5], their ability to spread quickly and quietly among the population has made the number of deceased very high. The outbreak was originally located in Wuhan, Hubei Province, China, but the disease has spread worldwide, severely affecting the world, having not only serious health but devastating economic consequences.

As in other coronaviruses, the main mode of transmission is considered to be respiratory by direct contact with infectious aerosols at a distance of fewer than two meters and through contaminated hands in contact with the mucosa of the mouth, nose, or eyes. However, due to gastrointestinal involvement in some patients[5], since the beginning of the pandemic, there has been speculation of alternative and minor fecal transmission and this question is not closed yet[6,8] Additionally, the ability of the virus to replicate in vitro in human intestinal organoids has been demonstrated[9], suggesting that SARS-CoV-2 can produce enteric infections in addition to those it causes in the respiratory tract, kidneys, liver, heart and brain[10]. Recently, in Australia, the SARS-CoV-2 ribonucleic acid (RNA) has been detected in wastewaters[11].

Similarly, wastewater samples collected at Schiphol Airport in Amsterdam (Netherlands) tested positive for the RNA of the virus by quantitative Reverse Transcription Polymerase Chain Reaction (RT-PCR methodology)[12]. In other countries, such as France and Italy, the SARS-CoV-2 also had been detected in sewage waters[13]. At the same time, the presence of the SARS-CoV-2 in the urine of people infected was confirmed[14], therefore it would then enter the wastewater treatment system. Besides, this virus can typically survive for up to several days in an appropriate environment after exiting the human body[15]. Furthermore, concentrations of the norovirus in wastewater samples accurately reflect the infection in the watershed, suggesting that this approach can serve as a warning of a public outbreak[16].

All these results are essential due to the insufficient wastewater treatment in several countries (mainly underdeveloped, but some developed can have

similar situations). Besides, many of these waters are incorporated into rivers, lakes, or seas without prior treatment, therefore, it can become a potential risk for virus spread. However, it is not clear which are the environmental conditions that can favor the fecal-oral spread of SARS-CoV-2[12]. Another important factor to consider is linked with the wastewater plumbing system or sewer system, in combination with the potential for airborne transmission due to aerosolization of the virus. Concerning the transmission through SARS CoV-2 infected aerosols, it has been established that this virus is remarkably resistant in aerosol form, even after 12 hours[17]. This last can be considered as a potential transmission pathway for COVID-19[18]. At the moment, it is known that SARS-CoV-2 can survive in stool samples for four days and in turn can stay infectious in water and sewage for days to weeks[19].

Another factor that will have to be studied quickly is that related to the reproduction of the virus in waters, mainly in wastewaters. Of course, the chemical and microbiological composition of the wastewater, where the virus is present, will be decisive in the reproductive stage of the virus.

The main objective of this work is to alert the international scientific community and governments about the presence of SARS-CoV-2 in wastewater, and what to do to prevent its spread by this means.

Risk of exposure to SARS-CoV-2 through wastewater

Several groups in Australia, the Netherland, Sweden, and The United States have reported the detection of SARS-CoV-2 in wastewater[11,20]. The survival of coronaviruses in water depends on several factors, including temperature (coronaviruses are very sensitive to temperature), light exposure (solar or UV inactivation), organic matter (viruses can be adsorbed onto particles of organic matter, affecting settling behavior or light-shielding), and the presence of antagonist microorganisms (increasing the extent of inactivation)[21]. The use of wastewater as an infection indicator of SARS-CoV-2 has been recommended in several papers[12,13,16]. This topic is crucial due to the results provided can be used for obtaining information related to virus spread and, besides, helping to control the affected communities. It is also known that SARS-CoV-2 survives in stool samples for 4 to 22 days, more than in the respiratory and serum samples, collected from hospitalized patients[13].

The polluted with coronavirus wastewater can generate other transmission pathways through aerosols formation during wastewater treatment or due to the discharge to the environment, specifically to surface waters. Then, we have to take into account that the use of surface waters for irrigating agro in agriculture is a known source of vegetables and fruit contamination with viruses[22], and the alert to sanitary authorities of this possibility is an important issue. Therefore, the human direct contact with wastewaters or aerosols or surface waters with the virus may also be considered as a risk, especially in countries where the number of infected increases daily, and the viral load in surface waters may also increase.

Monitoring and analysis of SARS-CoV-2 in wastewater

The wastewater monitoring could well become a useful tool to monitor and assess the incidence of COVID-19 disease within populations to inform related public health policy[23]. Molecular biology techniques have helped identify the presence of viruses in wastewater and surface water since their first uses in science and technology[24-27]. For the SARS-CoV-2 detection in wastewater is necessary to use a rapid analytical method for the on-site detection of viruses at the wastewater collection point. The most used currently is an RT-PCR method due to high sensitivity and specificity. But this has the drawback that it cannot be used on-site, requires complicated sample handling in the laboratory, skilled personnel, and a long period of data

processing and analysis (4-6 hours). Therefore, it has been proposed the method based on the paper-based device. This last has the potential to be used as a small, portable device to detect SARS-CoV-2 in wastewater on-site and to track virus carriers in the community[28]. These devices are powerful, cheap tools for the rapid pathogen diagnosis and determination transmission infection. Besides, the testing process is extremely fast and sensitive, beating the limitations of PCR. This last had been used for a variety of infections such as malaria and several other pathogens[13].

Currently, RT-qPCR assays developed for testing clinical samples are being used for the detection of SARS-CoV-2 RNA in wastewater samples. However, the assays can produce conflicting results when the concentration is low in wastewater, so techniques such as digital RT-PCR (dRT-PCR) should be implemented. This technique is suggested due to its more sensitive and suitable for the detection of SARS-CoV-2 in clinical samples with low viral loads[29]. The method for virus concentrating is another essential factor that requires attention to improve the sensitivity of SARS-CoV-2 detection in wastewater[11].

Everything mentioned above suggests the urgent needs of the development and implementation of new methods for SARS-CoV-2 analysis in wastewaters and surface waters.

Treatment of wastewater with SARS-CoV-2

It is of great significance to reduce the health risks to the public and the environment. Thus, it is necessary to establish wastewater treatments that guarantee the elimination of the virus. Recently, Wang et al. (2020) published a review on wastewater disinfection strategy, during coronavirus disease 2019 (COVID-19) pandemic[4]. The suggestions for disinfecting hospital wastes and wastewater during the SARS-CoV-2 pandemic in China include the use of chlorine, UV radiation, and heating. Furthermore, membrane bioreactors are also recommended for treating the wastewater with viruses such as coronaviruses[21]. For avoiding the risk, it is necessary to guarantee the efficiency of wastewater treatment. The risk assessment is possible for identifying the negative impact associated with the wastewater plant operation and the probability of occurrence of the associated impact. These results support the control measures for accurate operation and avoiding contamination.

Specifically for tourism, sector the WHO (2020), concerned with Operational considerations for COVID-19 management in the accommodation sector 2020, emphasizes the necessity to maintain the concentration of disinfectant in water for consumption and in pools or spas within the limits recommended according to international norms and standards, preferably at the upper limits of the range[30].

Some aspects to consider

From our point of view, there are three main actions to follow facing the pollution with coronavirus of wastewaters and surface waters:

- Monitoring wastewater and surface water. In the first instance, it should establish monitor wastewaters at the exit of health units, where coronavirus patients are being treated. Likewise, it should establish monitoring of the areas where epidemiological studies show the highest concentration of patients. Furthermore, it should be noted that more general monitoring of surface waters, when possible, is a great opportunity to identify areas where there may be patients with COVID-19.

- Also, they could establish virus inactivation protocols at the health units exit, and beef up water treatment units, with secondary and tertiary treatment processes. The experience demonstrated in wastewater treatment and water disinfection shows that the most efficient

processes for virus inactivation are: treatment with chemical oxidants, mainly chlorine-derived products; ultraviolet radiation processes, including photocatalysis and Fenton-photo, ozone and membrane filtration[25,31-34]. Some publications cite thermal sterilization as an alternative for virus disinfection[4], but we consider that this practice is not sustainable when handling large volumes of water.

- It is necessary to alert the population and the health authorities about the importance of washing and disinfecting agricultural products, mainly vegetables and fruits, as well as the care in its handling by agricultural workers. In this sense, the irrigated waters can be a contamination source when they come from contaminated aquifers[35].

These measures may be more important in areas and countries where there are no centralized systems for water treatment, mainly in developing countries and those in geographical areas such as the Greater Caribbean and Africa.

Conclusions

There are three main actions to face the pollution with coronavirus of wastewaters and surface waters. In this sense, these should be monitoring in points at the exit of health units, where patients are being treated, as well as in areas where epidemiological studies show the highest concentration of patients should establish. On the other hand, it is necessary to establish virus inactivation protocols at the health units exit, and beef up water treatment units, including chemical oxidants, ultraviolet radiation processes, photocatalysis, photo-Fenton, ozone or membrane filtration whenever possible. The irrigation waters can be a virus source when they come from contaminated aquifers. It is mandatory to alert the population and the authorities about the importance of washing and disinfecting agricultural products, mainly vegetables, and fruits, as well as the care in its handling by agricultural workers. All these safety measures may be more important in areas and countries where there are no centralized systems for water treatment, mainly in underdeveloped and developing countries such as those located in the Greater Caribbean and Africa, respectively.

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