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Considerations on water quality and the use of chlorine in times of SARS-CoV-2 (COVID-19) pandemic in the community

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A R T I C L E I N F O

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A B S T R A C T

This review goal is to reflect on the challenges and prospects for water quality in the face of the pandemic caused by the new SARS-CoV-2 coronavirus (COVID-19). Based on the information available so far, the detection of SARS-CoV-2 RNA in wastewater has raised interest in using it as an early warning method, to detect the resurgence of infections and to report the risk associated with contracting SARS-CoV-2 in contact with untreated water or inadequately treated wastewater is discharged. The wastewater-based epidemiological approach can be used as an early indicator of infection within a specific population. On the other hand, it is necessary to collect information from the managers of drinking water supply companies and professionals who are related to water quality, to know SARS-CoV-2 data and information, and its influence on drinking water quality. The basic purpose of this review article is to try to provide a valuable and quick reference guide to COVID-19. Important topics were discussed, such as detection of SARS-CoV-2 in wastewater in various parts of the world; wastewater screening to monitor COVID-19; persistence of SARS-CoV-2 in aquatic systems; the presence of SARS-CoV-2 in drinking water; clean water as a mechanism to deal with the COVID-19 pandemic; chlorine as a disinfectant to eliminate SARS-CoV-2 and damage to ecosystems by the use of chlorine. Currently does not exist extensive literature on the effectiveness of water and wastewater treatment processes that ensure the correct elimination of SARS-CoV-2. Excessive use of disinfectants such as chlorine is causing effects on the environment. This document highlights the need for further research to establish the behavior of the SARS-CoV-2 virus in aquatic systems. This study presents an early overview of the observed and potential impacts of COVID-19 on the environment.

1. Introduction

The advance of the novel coronavirus (2019-nCoV), which initially started in China, has spread to most countries, increasing the number of confirmed cases daily. The number of deaths from (2019-nCoV) is higher than the SARS-CoV outbreak that occurred in China during the 2002–2003 [1-3]. The 2019-nCoV pandemic has sparked a public health emergency of international concern, putting all health organizations on high alert [4,5]. Transmission of the disease generally occurs through the air or direct contact with people primarily through close contact with respiratory drops, direct contact with infected people, or contact with contaminated objects and surfaces [6,7].

Several infected with Covid-19 have shown gastrointestinal symptoms, so several related studies have been conducted on the presence of viral RNA in the feces of some patients, but the transmission of the virus through the fecal-oral route has not yet been demonstrated [5,8,9]. As one of the top tips for fighting this virus, the WHO has advised washing your hands regularly, which means more than ever, that there must be a clean, and safe water supply to stop the spread of the disease [10].

Water services are an essential part of preventing and protecting

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human health during infectious disease outbreaks, including the current COVID-19 pandemic [7,11]. This SARS-CoV-2 virus has been detected in fecal samples as in untreated wastewater, determining the potential for fecal-oral transmission of the virus. Concerns have been raised in recent months regarding the transmission of this coronavirus into the environment; especially due to the risk associated with becoming infected with SARS-CoV-2 in waters where untreated or inadequately treated wastewater is discharged [12,13]. The water for human consumption is treated by conventional methods and with correct chlorine-based disinfection and ensuring a residual chlorine level ˃ 0.5 mg/L in the distribution network allows to combat SARS-CoV-2 and can be used for its uses usual [14]. The SARS-CoV-2, being an enveloped virus, does not survive easily in the water, being able to eliminate and inactivate itself efficiently. Water systems are essential, especially during the SARS-CoV-2 (COVID-19) pandemic [15]. It is important to emphasize that there is no extensive literature on the effectiveness of water and wastewater treatment processes that ensure the correct elimination of SARS-CoV-2.

Local and international regulations, as well as the WHO, have established treatment requirements for public water systems that prevent waterborne pathogens, such as viruses, from contaminating drinking water. COVID-19 is a type of virus that is particularly susceptible to disinfection, and conventional treatments and disinfection processes are expected to be effective. These treatment requirements include filtration and disinfectants like chlorine that removes or kills pathogens before they reach the tap [16]. The SARS-CoV-2 pandemic continues to expose countless unforeseen problems at all levels of the world's complex and interconnected society: global domino effects involving public health and safety, food security, the stability of economies, as well as the environment [17].

The information obtained so far highlights the need for more research to determine the presence of SARS-CoV-2 in aquatic environments [13,18]. The small number of studies on methods of detecting coronaviruses in water is probably motivated by the assumption that they are not considered to be waterborne [19].

Therefore, the objective of this paper was to review available information on the presence of SARS-CoV-2 in the aquatic environment, the wastewater surveillance used to establish a potential relationship with the COVID-19 pandemic, as well as the effectiveness of chlorine in treatment systems to eliminate this coronavirus and the effects of the excessive use of this disinfectant in the environment.

2. Detection of SARS-CoV-2 in wastewater in various parts of the world: tracking sewage to surveillance COVID-19

Detection of the presence of the SARS-CoV-2 in wastewater as an environmental surveillance mechanism is in preliminary stages of an investigation, the results will warn if the virus is circulating in a city [20,21]. In an investigation carried out in France, samples were taken from three wastewater treatment plants (WWTP), which were linked to more than 100000 inhabitants in the Parisian area since the beginning of the epidemic (March 5, 2020). The samples were kept at 4 °C and were processed in less than 24 h after sampling. It was shown that the quantitative detection of SARS-CoV-2 in water treatments can reflect the dynamics of the virus in the human population of the Parisian area. There is an increase in SARS-CoV-2 genome elements in wastewater as human cases of Covid-19 in the city of Paris increased [22].

To detect the presence of the novel coronavirus in untreated wastewater, in Australia, Ahmed [23] used two different methods. The first one consisted of the direct extraction of RNA from electronegative membranes because they have greater adsorption of viruses enveloped to the solid fraction of wastewater. The second method used was ultrafiltration, which consisted of obtaining a concentrated sample to extract RNA from it. Two positive detections were obtained over six days from the water sample from the same WWTP [23].

In the cities of Milan and Rome (Italy), 12 raw sewage samples were collected over two months, the presence of SARS-CoV-2 in RNA was analyzed using reverse transcription-polymerase chain reaction (RT-PCR) and a quantitative assay of real-time polymerase chain reactions (qPCR). As a result of the assays, it was found that 50% of the samples were positive for SARS-CoV-2 RNA, being useful for the detection of this virus. Also, it was found that the PCR assay did not obtain quantitative data for positive samples. Other studies have shown that this type of essay has low sensitivity compared to other assays [24]. In Yamanashi, Japan, four quantitative assays and two nested PCR assays were performed to assess DNA for the novel coronavirus in wastewater and river water. The samples obtained were processed using the electronegative membrane vortex (EMV) and the direct extraction of RNA by membrane adsorption methods. It was determined that the EMV method was better compared to the direct membrane extraction method in all the trials, it was possible to determine SARS-CoV-2 RNA in wastewater in communities that report a low number of COVID-19 cases [25].

Furthermore, the presence of SARS-CoV-2 has been analyzed in composite wastewater samples taken at WWTP entry for 24 h in the Netherlands. Samples were taken on February 6, 2020 (3 weeks before the first case was reported in the Netherlands). Samples were also taken on March 4 and 5 (1 week after the epidemic). No SARS-CoV-2 was found in samples from February 6. However, samples from March 4 and 5 showed fragments of the virus (with 38 and 82 cases of COVID-19 reported respectively) [26]. In another investigation, to detect SARS-CoV-2 in sewage, water samples were collected from a water treatment plant in Massachusetts (USA). The samples were taken to the laboratory where viral inactivation and enrichment, nucleic acid extraction, and RT-qPCR were performed. The 10 samples taken from March 18 to 25 were positive [27].

The presence of SARS-CoV-2 RNA was detected in the municipalities of the Region of Murcia (Spain). Six WWTPs were monitored by sampling in the influent, secondary, and tertiary treatment from March 12 to April 14, 2020. It was found in untreated wastewater samples of 5.4 ± 0.2 log10 genomic copies/L on average. In the secondary water samples, 2 of 18 were positive and of 12 tertiary water samples all were negative [28]. A study by researchers at the University of Barcelona, Spain, detected in mid-April 2020, the presence of SARS-CoV-2 in wastewater samples collected on March 12, 2019 and stored until the date of analysis. These results suggested that the infection was present before any case of COVID-19 was known anywhere in the world. From April 13, wastewater is being analyzed in two large WWTPs. The results determined that the levels of the SARS-CoV-2 genome increased with the evolution of the confirmed cases of Covid-19 in the population [29].

Mallapaty [30] and Nghiem [31] indicate that detection of SARS-CoV-2 could be used to detect if the coronavirus returns to communities and that traces of the virus have been found in the Netherlands, the United States, and Sweden.

In the city of Quito (Ecuador), a high SARS-CoV-2 viral load was detected in urban rivers in that city. These viral loads found indicate that possibly the cases of COVID 19 existing in this place are much higher than the official data. This finding allows us to foresee that the spread of this coronavirus in developing countries, with low levels of sanitation, with rivers contaminated by untreated or poorly treated wastewater could be a factor of higher risk of a COVID-19 pandemic [32]. Suggesting, avoid people's interactions with rivers where sewage discharges have occurred.

Currently, in several countries a campaign has been launched to detect the presence of SARS-CoV-2 in wastewater treatment plants, the detection of the novel coronavirus could be used in communities as an early warning system, determining if SARS- CoV-2 has returned to the population, after having detected a reduction in infected people [26,33]. This technique, known as "wastewater-based epidemiology" (WBE), has been recognized as a tool to track and control possible increases in cases of contagion or if the virus is re-emerging in communities, thereby identifying pathogenic infections that could threaten public health in the future [34].

The identification of the coronavirus, especially SARS-CoV-2 in wastewater, as well as the knowledge of survival and elimination through different treatment techniques, would allow evaluating and managing potential risks caused by this virus [19]. Therefore, it is essential to continue conducting studies on these issues to avoid a greater number of infections.

A crucial strategy for environmental monitoring to be efficient is to define an optimized and standardized protocol for the sampling and quantification of SARS-CoV-2 in wastewater [20].

3. Persistence of Covid-19 (SARS-CoV-2) in aquatic systems

Studies of the behavior of viruses enveloped in wastewater conclude that these viruses are inactivated faster than other viruses [35]. Currently one of the biggest concerns is studying the survival of Sars Cov 2, so it survives even for a limited time in sewage treatment plants and drinking water supplies [1,9,31].

In the study by Venugopal [21] it was shown that the virus has a prolonged survival at low temperatures, therefore, the excreted coronavirus can reach the residual treatment plants. However, in the research by Gundy [36], it was shown that the coronaviruses, being more sensitive to the variation in temperature, inactivate at 2 or 3 days around 99.9%, because the viruses involved are less stable in the environment.

Various studies have shown that the coronavirus can survive in hospital wastewater, household wastewater, and tap water for up to 14 days at 4 °C, but at a temperature of 20 °C, it survives for only 3 days. Free chlorine has also been shown to be more effective in inactivating SARS-CoV than chlorine dioxide [20].

Recently, Shutler [37], quantified the survival of SARS-COV-2 virus in some aquatic systems. Furthermore, it suggests that the SARS-CoV-2 virus can survive in untreated sewage systems and viral loads can be high, making it a potential route of fecal-oral transmission, the detection time is up to 25 days. The survival of the virus is dependent on temperature, so the risk in the wastewater increased in the winter months, since the temperature, being lower, allows a longer viral survival [7,15]. In the ocean, being large enough and in constant movement can dilute and eliminate viruses quickly, also the salt in the water can help decrease the survival of the virus [38,39]. Also, it has been identified that there is bioaccumulation of the SARS-CoV-2 virus by mollusks and other aquatic organisms, it is known that bivalves are capable of accumulating waterborne viruses such as norovirus, this information is important since it was detected in a seafood market which is one of the suspicious sources of the origin of the SARS-CoV-2 virus, so any viral transmission from land to sea can be a circular process [39-41].

In seawater from countries such as the United Kingdom, Spain and Morocco where untreated wastewater is discharged, the virus was found to remain stable over a pH range and in sterile saline and at low temperatures. To estimate the water temperature necessary for virus survival, it was calculated from a global temperature data set, the estimated temperature was 4 °C [37]. Finally, the study recommends avoiding the interaction of the population with rivers and coastal waters where wastewater is discharged to avoid or minimize the risk of infection.

It was recently reported that SARS-CoV-2 RNA can be detected for a longer time, with an average time of 22 days in feces, 18 days in the airways, and 16 days in serum samples [42]. Although the persistence of SARS-CoV-2 in wastewater remains to be studied in detail, it was reported that the time to reach 99.9% death at 23 °C for other coronaviruses (feline infectious peritonitis virus and coronavirus 229E) was 2–3 days in wastewater [25,36]. Furthermore, there is no evidence that the virus has been transmitted through sewage systems, through wastewater with or without treatment. Two studies demonstrated the existence of SARS-CoV-2 fragments in the stool of patients with COVID-19 [43].

In tropical, subtropical and temperate climatic zones, it is necessary to determine the persistence of SARS-CoV-2 in both sewage and environmental waters, since the persistence of this virus can vary at different temperatures [44]. The SARS-CoV-2 virus is susceptible to the application of standard disinfectants, in tests using household bleach in dilutions of 1:49 and 1:99, the virus was not detected after 5 min of contact [45]. It would be valuable to integrate viral detection methods in aquatic systems, in this way establish the retention time of SARS-CoV-2, allowing to give security in the different uses of water taken from aquatic systems, which could be carriers of the virus and be transmitters of this.

4. Presence of Covid-19 (SARS-CoV-2) in drinking water: clean water as a mechanism to face the COVID-19 pandemic

Due to the current health situation in the world due to SARS-CoV-2, the availability of clean water has become a fundamental element to combat this coronavirus, washing hands, showering, as well as cleaning and disinfecting households require of this vital liquid [7]. According to the EPA [16] in the case of drinking water, the presence of the virus has not been detected, they ensure that you can continue to use and drink tap water regularly.

On the other hand, people infected with the virus and the human team in charge of the health area must carry out daily actions to provide adequate care to the patient, such as cleaning and disinfecting the site and work material, handling excreta (feces and urine) safely, proper management of sanitary waste produced by COVID cases, among others [7,10]. To do all this, water is the fundamental resource that allows adequate cleaning; therefore, it is of utmost importance to provide safe water, sanitation and hygienic conditions that protect human life during any outbreak of infectious or viral diseases, such as what is happening with the current pandemic [10].

SARS-CoV-2 is known to be an enveloped virus, with a fragile outer membrane and is, therefore, less persistent in water than other enteric viruses, thus being more susceptible to chemical inactivation, such as with solutions based on chlorine and other disinfectants [15,20,46]. Other disinfectants such as quaternary ammonium, ozone and UV-C (short wave ultraviolet light); in addition, alcohol is an effective disinfectant in concentrations of 62 to 71% ethanol. The action of alcohols and surfactants are based mainly on the dissolution of lipid envelopes. Also hydrogen peroxide and peracetic acid use their oxidizing capacity to inactivate viruses. Disinfectants/sanitizing agents such as povidone-iodine, aldehydes, and oxidizing agents that inactivate viruses by chemically modifying their surface groups have been found to be fast-acting and very potent against most viruses, but their application is also often limited by its higher toxicity [47]. Water treatment techniques for human consumption use processes that consider virus removal even more robust than COVID-19 [48]; these elimination techniques are considered in the standard purification processes.

Enveloped viruses have a lipid membrane that surrounds a protein capsule consisting of protein and glycoprotein. Once the chlorine penetrates the lipid membrane it reacts with the internal proteins causing the virus to be inactivated [49]. Recent data indicate that the stability of SARS-CoV-2 is similar to that of SARS-CoV in aerosols and on surfaces [50].

Shutler [33] and Vammen [37] suggest that the survival and transport of SARS-CoV-2 in rivers may affect drinking water supplies in places where rivers or reservoirs are the main sources of water. It recommends filtering water, followed by ultraviolet disinfection or chlorination. The filtrate is used for large particles, while the ultraviolet dose is effective to disinfect SARS-CoV-2; apparently, the dose can be very variable depending on the surface on which the virus is found. Although most drinking water supplies are believed to be safe, there could be a risk when sewage enters distribution systems that do not disinfect water with chlorine [51].

EPA [16] has implemented treatment requirements, which aim to prevent waterborne pathogens, such as viruses, from contaminating drinking water. Processes that remove pathogens from the water before they reach the tap such as filtration and disinfection using chlorine are the recommended requirements. WHO [7] and Kitajima [20] notes that conventional water treatment methods including filtration and disinfection should inactivate the SARS-CoV-2. Besides, coronaviruses have large single-stranded RNA genomes and are considerably more sensitive to UV disinfection.

The health emergency caused by COVID-19 has demonstrated the importance of disinfection in the treatment of drinking water, which is why it is necessary to maintain the optimal dose of residual chlorine in drinking water systems to protect public health. The SARS-CoV-2could enter the drinking water distribution network if the residual chlorine level is at a lower concentration than that established in the regulations. It is suspected that the stability of the virus could continue through the colonization of bacteria that are present in biofilms in the piping system and thus enter individual houses through transmission as aerosolization of showers [33,52].

Efficacy to remove viruses at a laboratory scale has been demonstrated using a filtration system. The water was previously coagulated using three different coagulants (zirconium, chitosan, and polyaluminum chloride) to reduce three viral pathogens and the model MS2 virus. The results indicated that the viruses were reduced by 99.9% [19,53]. Gundy [36] in his research, determined coronavirus in drinking water; for which, filtered tap water to reduce or eliminate the influence of particulate organic matter and bacteria. At room temperature, the coronavirus in filtered tap water decreased by 99.9% in 10 days. Meanwhile, at 4 °C, to achieve this level of inactivation, the virus required more than 100 days. In this same study, it is mentioned that the inactivation of the coronavirus was greater in filtered tap water than in unfiltered tap water.

There is no evidence to date on the survival of the virus in drinking water, the virus is likely to inactivate significantly faster than enteric viruses. Heat, low or high pH, sunlight, and common disinfectants make it easy to deactivate the virus. The effective inactivity of the coronavirus could be achieved in 1 min using common disinfectants, such as sodium hypochlorite (NaClO) [5,7].

5. Chlorine as a disinfectant to remove SARS-CoV-2

SARS-CoV-2 bears similarity to SARS-CoV-1, therefore, disinfection technologies used in wastewater treatment during a COVID-19 health emergency could be used to combat the novel coronavirus. When a septic tank is disinfected, the disinfection efficiency with chlorine is guaranteed by applying a dose higher than 6.5 mg/L and a contact time of at least 1.5 h. For the disinfection of wastewater in hospitals that care for patients with COVID-19, it is recommended to use UV radiation due to the disinfection efficiency and the lower amount of by-products [14,54].

The virus contained in the wastewater can reach other bodies of water (surface, marine, underground), generating aerosols, for example, the wastewater from hospitals, can contain the epidemic virus, which requires efficient disinfection before it's poured into natural waters [14,19].

For the WHO at the hospital level, environmental cleaning and disinfection procedures must be followed consistently and correctly, performing a thorough cleaning of environmental surfaces with water, detergent and the application of commonly used disinfectants such as NaClO are procedures effective and sufficient. Hypochlorite 5% in a dilution of 1: 100 is suitable [10,55].

Disinfection of water in sanitary emergencies was addressed by [56], who analyzed the resistance of SARS-CoV and phage f2 sown in domestic wastewater against different chlorine solutions. By applying 10 mg/L of chlorine or 20 mg/L of chlorine dioxide, and after 30 min, the SARS-CoV was completely inactivated.

An antimicrobial activity using ClO_2 was shown to be based on the denaturation of certain proteins, mainly an oxidative modification of tryptophan and tyrosine residues [57]. Later this researcher Ogata [58] showed that the inactivation of the influenza virus with ClO_2 was caused by the oxidation of a tryptophan residue in hemagglutinin (a virus spike protein). SARS-CoV-2 contains 54 tyrosine, 12 tryptophan, and 40 cysteine residues. By assuming that all these residues can react with ClO_2 in an aqueous solution, virus inactivation can be extremely rapid [59].

According to the WHO, the presence of residual chlorine of 0.5 mg/L, measured at the endpoints of the water distribution system, must be guaranteed in all water systems. Lipid-enveloped CoV viruses are often more sensitive to disinfectants such as chlorine, chloramine, and chlorine dioxide. For example, the virus most closely related to SARS-CoV-2, which is SARS-CoV, was found to be highly sensitive to disinfection with chlorine and chlorine dioxide (as sensitive as Escherichia coli and coliphage) [60].

NaClO solutions are widely used for surface disinfection, have a wide spectrum of activity, are bactericidal, virucidal, fungicidal, and sporicidal. The persistence of the endemic strain of human coronavirus on inanimate surfaces such as metal, glass, or plastic can last from 2 h to 9 days [10,55,61]. At temperatures above 30 °C, the persistence is shorter. So for its inactivation on surfaces, biocidal agents such as 0.1% NaClO are used for 1 min of exposure to be effective. A similar effect is expected against SARS-CoV-2 [15,55]. Recent studies have determined that the SARS-CoV-2 virus remains stable and survives in different materials for up to 72 h, as is the case with plastics [50].

In disinfecting healthcare and non-healthcare environments potentially contaminated with SARS-CoV-2, the use of 0.05% NaClO is suggested for surface cleaning to reduce irritating effects on the mucosa [62,63]. Free chlorine was more effective in inactivating SARS-CoV than chlorine dioxide [20,54]. A level of free chlorine >0.5 mg/L or chlorine dioxide of 2.19 mg/L in wastewater allows the complete elimination of SARS-CoV [20,56].

To prevent SARS-CoV 2 from spreading through wastewater, China has requested to strengthen its disinfection processes for wastewater treatment plants, through increased use of chlorine [64].

According to Wang [14], residual chlorine of 6 mg/L should be maintained as a performance indicator for the disinfection of wastewater in hospitals. As for tap water, the WHO recommends residual chlorine of 5 mg/L.

6. Impact of ecosystems by the use of chlorine

Chlorine solutions are oxidative chemicals and have broad-spectrum activity against a wide variety of microorganisms, from viruses to protozoa, they have been tried and tested as effective in killing viruses or against another human coronavirus similar to SARS-CoV-2 [54].

Chlorine is not the only option for water disinfection, but it is the cheapest and requires the least qualified personnel in its application [62,65]. However, it is known that chlorine inevitably generates by-products resulting from its reaction with the natural organic matter of the waters, which comes from its contact with the soil and plant material [47,65]. The waters thus reach urban drinking water treatment plants where, in contact with chlorine, this organic matter produces small molecules, whose continued consumption throughout life could have some responsibility in certain types of cancer or affect reproduction in some cases [47,66,67].

Different international entities and scientists have warned about the potential impacts of excessive, inappropriate, and outdoor use of disinfectants [68,69]. This practice not only has little or no effect on open space surfaces but also increases the accumulation and distribution of these substances in the environment [68]. In this way, it could have more negative consequences than benefits in a scenario where good decisions are fundamental to face this pandemic in the best way [70].

In this sense, the experts point out that the selective use of these disinfectants is only justified in specific areas that can become virus reservoirs, such as handrails, handles, public transport, among other spaces in closed areas [62,71]. Recently, regarding the massive applications of these products, the WHO recommended their use only in essential areas; indicating that the application in public areas (parks, squares, streets) was very inefficient because the surfaces must be cleaned very well before disinfecting them and that does not necessarily happen in said spaces [10,62].

Indeed, in mid-May, the WHO advised against spraying outdoor spaces, such as streets or markets, since the disinfectant is inactivated by dirt and debris, and it is not feasible to manually clean and remove all the organic matter from these spaces [10]. As for the environment, one of the greatest risks lies in the fact that all substances applied, whether at the household level, outdoors and in a massive way, will inevitably be carried by the water, arriving sooner or later to ecosystems such as rivers, wetlands, among others.

Chlorine (NaClO) has been one of the highly demanded elements to avoid the spread of COVID-19, also leading to its use in open spaces. It is widely known that chlorine produces an irritating effect on the mucous membranes, so it can also cause respiratory problems in both the workers who apply it and in passers-by, increasing their susceptibility to respiratory diseases [7,64].

Chlorine is transformed into the environment into highly dangerous substances for aquatic organisms and the species that live there. When chlorine reacts with organic matter, it is capable of producing halogenated organic compounds, which are highly toxic to aquatic species and, unlike chlorine, can remain in the environment for a long time [47,72].

When the chlorine reacts with the organic matter present in the water, it generates disinfection by-products (DBP), which can become toxic and can have a detrimental effect on the aquatic organisms that are exposed to them. Therefore, excessive chlorination may be inappropriate treatment strategies for the protection of receiving waters [68]. DBPs have a high ecological risk for green algae and other aquatic organisms in chlorinated effluents from wastewater [47].

Within DBPs there are THMs, and to a lesser extent haloacetic acids (HAA), which are currently used as indicator chemicals for all potentially harmful compounds formed by the addition of chlorine to water [73].

Of the four primary trihalomethanes, we have Chloroform - CHCl3, Bromodichloromethane (BDCM) - CHCl2Br, Dibromochloromethane (DBCM) - CHClBr2, Bromoform - CHBr3. Chloroform and BDCM are classified as possible human carcinogens. The classifications of possible human carcinogens are derived from extrapolated data from animal research that may or may not be relevant to human cancer. Regarding DBCM and bromoform, there is no evidence to support these two compounds as carcinogens. There is no adequate epidemiological evidence of human carcinogenicity for the four compounds [74].

HAAs as one of the most abundant DBP groups have raised public concern due to their high frequency of occurrence, considerable concentrations, and potent toxicity [75]. There have been abundant animal cancer statistics to support the carcinogenic potential of HAAs in chlorinated drinking water [76]. However, more epidemiological studies are needed to analyze the possible association between exposure to HAA and adverse effects on human health.

Good hygiene can be universally considered to be one of the simplest and most effective measures to prevent disease transmission [77]. The current Covid 19 pandemic has changed the sanitary habits of the population, which may have adverse effects on surfaces highly exposed to disinfectants such as chlorine, for example. A potential corrosion problem could arise if the sudden increase in the use of chlorine on certain surfaces accelerates the corrosion mechanisms in the short and medium-term [78,79].

A real effect of chlorine in the environment is related to ozone depletion, which has far-reaching environmental effects in terms of global warming [80-82].

Over a five-year period, the overall impact of coal-fired power plant cooling processes on entrained copepods and the local plankton community on the west coast of Korea was examined. Using excess chlorine to avoid condenser contamination was determined to negatively affect plankton, even at lower concentrations, chlorine can be harmful when combined with thermal stress [83].

When chlorine forms other compounds, it can also be harmful, so chlorine is an important ingredient in the organic compound DDT, the chemical that caused population levels in several species of birds to plummet in the 1950s in the USA and led to Rachel Carson's seminal work "Silent Spring [84].

The disinfectants that are applied to the surfaces will reach the water bodies because the water transports them [85]. Chemical contamination moves in conjunction with the water cycle, it rains, falls again, is carried by the rain, etc. For this reason, the potential risks to the environment take on special relevance in the current context of the global socio-environmental crisis, which is linked to the COVID 19 pandemic.

7. Conclusions

This health crisis is showing that both the economy and businesses require a healthy environment and population to produce and prosper. As the COVID 19 pandemic spreads across the globe, people with less access to essential services like clean water are expected to feel the most dramatic effects. Untreated wastewater should also be considered further. Monitoring of wastewater to detect SARS-CoV-2 can serve as an early warning system that warns the population of when and where infections are prevalent and whether the virus is re-emerging in communities.

Clean water is the most important resource to fight infections in populated centers worldwide. It is urgent to guarantee access to good quality water, which is why it is necessary to implement immediate actions to ensure the water supply where there are not safely managed to drink water services. The novel coronavirus strain is not resistant to disinfection processes, so conventional disinfection methods are expected to easily inactivate SARS-CoV-2.

It must be emphasized that the ideal doses of residual chlorine must be carefully considered to efficiently disinfect the water in the distribution system.

Ensuring that drinking water and wastewater services are fully operational is essential to combat COVID-19 and protect the population from other risks to public health.

The survival of SARS-CoV-2 in environmental media, including sewage and drinking water, remains unknown; being necessary to generate more knowledge about the persistence of SARS-CoV-2 in different compartments of the environment and especially about its inactivation mechanisms.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

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