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PANDEMIC COVID-19 AND WATER QUALITY: A REVIEW

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ABSTRACT

Coronavirus has set the world on red alert. It is an infectious disease with a deep concern over its alarming levels of inaction against it. COVID-19 pandemic is the greatest challenge we have faced after World War II. All the affected countries are racing to slow down the spread of the virus. It is a droplet transmission type of disease. Respiratory infections can be transmitted through droplets of different sizes. Earlier, however, SARS-CoV-2 has also been detected in the human faecal samples and anal swabs in some patients. Hence, it takes to the possibility of calling it a waterborne disease as well. Based on few data available, in summary, this study offers a powerful network that focuses on different aspects of coronavirus research, virus durability, multiplication factor, environmental effects, sanitization precautions and recent measures WHO has taken for the municipal authorities to make extra efforts in water sanitizsation. Drawn relevant conclusions based upon the same. Also, several articles reviewed and scientists still believe that currently, water is not a carrier of coronavirus.

1. INTRODUCTION

There are hundreds of viruses, some listed below in this review, most of which circulate from animals. Only seven of these infect humans and from them only four causes symptoms of a common cold. SARS COVID-19 a novel and deadly respiratory illness were originated in Wuhan, China. It has reportedly spread throughout the world at a much faster rate than expected.

Figure 1 depicts the detailed structure of the virus. Coronavirus is enveloped, spherical, and about 120 nm in diameter. Envelope proteins are involved in several aspects of the virus life cycle, such as assembly, envelope formation, and pathogenesis. The morphology of Corona is studied by electron microscopy for the detection of distinctive spikes. Figure 2 shows the transmission electron microscope image of the virus spots. These spikes bind to the receptors of the host body. It then fuses the viral envelope with cells of the membrane of the host. COVID group 2 has hemagglutinin–acetylesterase (HE) glycoprotein. The virus mutates itself after entering into the human body and RNA strands start to copy them. The SARS-associated coronavirus is neither a mutant of any known coronavirus nor a recombinant of known coronaviruses hence is awarded the title 'novel' [1].

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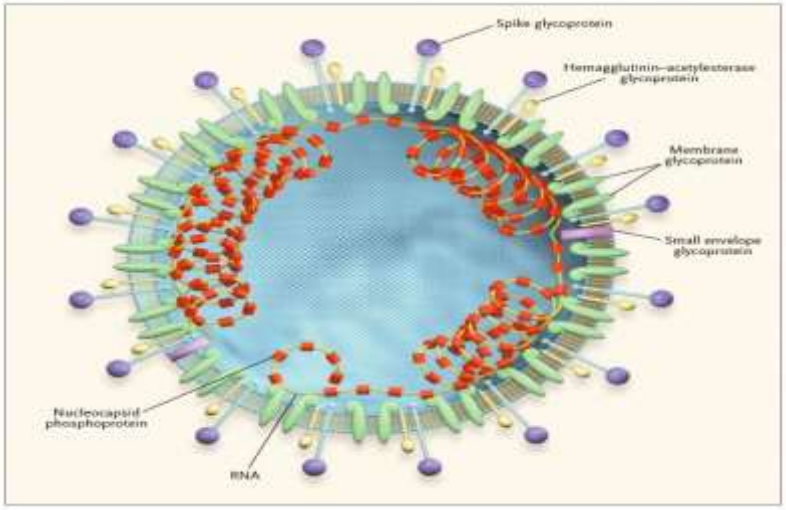

Figure 1: Structure of Corona Virion [1]

Primarily the virus is transmitted through large droplets and causes respiratory illness. The detailed information of figure 3 explains that the abnormal laboratory findings have included lymphopenia (70%), prolonged prothrombin time (58%), elevated lactate dehydrogenase (40%), and elevated AST and ALT (4–22%). CRP is increased by 61–86% and procalcitonin is 0.5 or higher in 5.5 percent of patients. Chest radiographs are abnormal in 60% of cases. Chest CT is abnormal in 86% of cases. Chest X-rays are characterized by bilateral patchy infiltrates and chest CT scans demonstrate ground-glass opacities. There is a peripheral distribution in over 50 percent of cases [2].

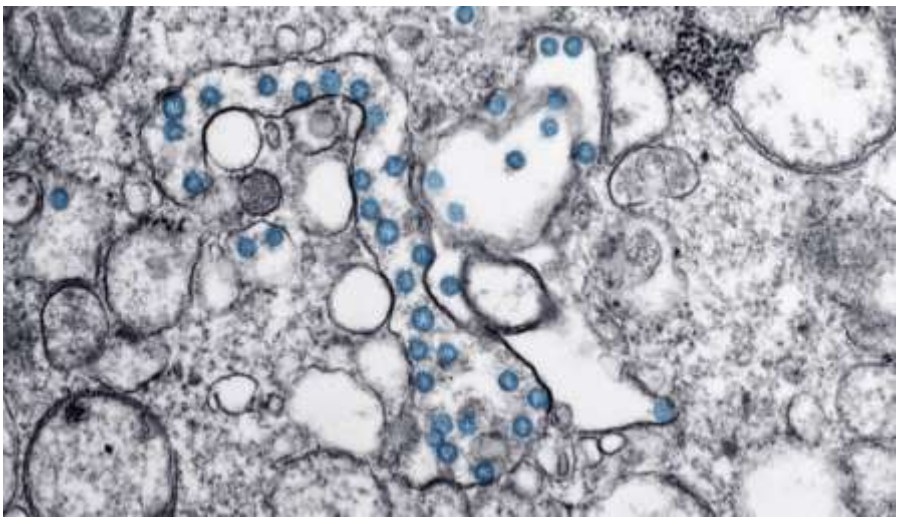

Figure 2: A transmission electron microscopic image of an isolate from the first US case of COVID-19. Credit:CDC [2].

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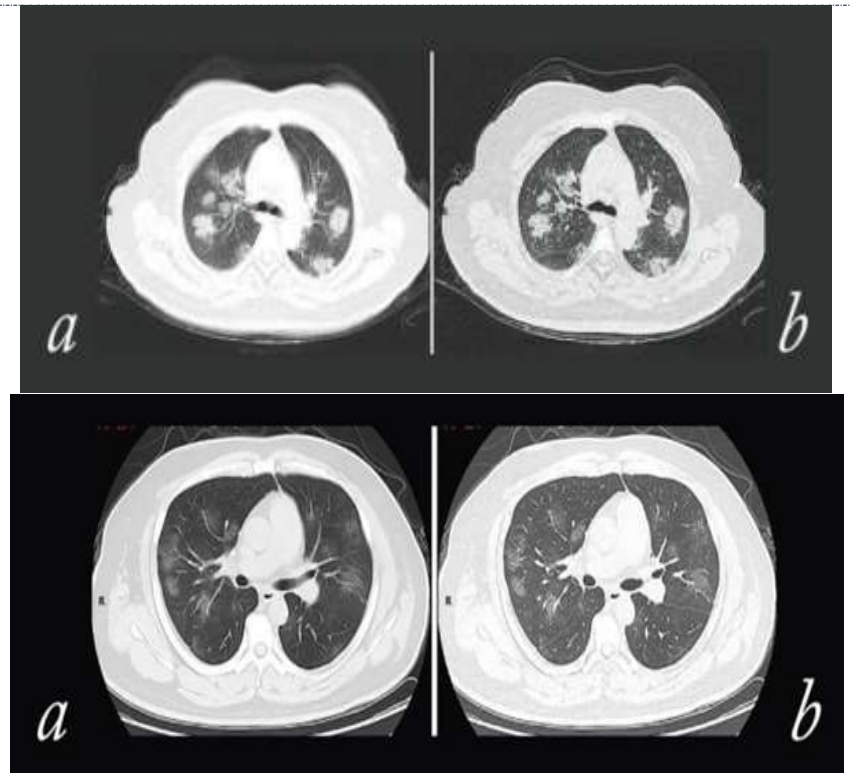

Figure 3: CT imaging of COVID-19 Top: a) Thin layer CT and b) high-resolution CT showing multiple patchy and light consolidations in both lungs of a 50-year-old woman with COVID-19. Bottom: a) Thin layer CT and b) high-resolution CT showing multiple patches in both lungs of a 38-year-old male with COVID-19. Credit: CDC [2].

Scientists are trying to establish a relationship between the Covid-19 and sewage water viruses. Since symptoms take at least 14 days to pop up or in some cases are asymptomatic, the fecal indicators can help detect the sewage samples and can warn public health authorities of any major outbreak in any cluster of the population serviced by specific sewage treatment plants. The ongoing pandemic offers an opportunity to field-test wastewater based epidemiology (WBE). The upcoming section of the paper provides a brief about already held experiments and results practiced on enhancing the relationship between coronavirus and wastewater.

1.1 Coronavirus and faeces (stool)

As soon as the coronavirus 2019 pandemic started spreading, urges and guidelines on how to wash hands and other sanitization measures intensified. With one of the primary steps of precautions to regularly wash hands to stop the transmission of CoV, it means more than ever that the use of clean and safe water is vital. A technical brief from WHO clarifies that there is no direct connection between survival of Cov and drinking water, emphasizing on two main routes including respiration and physical contact. These recommendations are highly important but are hard of value to a major section of approximately 40% of humanity which is lacking safe drinking water. More than one million deaths all over the world are attributed to unfit water quality. This silent water illness pandemic has been on for generations. The officers from The Environmental Protection Agency (EPA) narrated that wastewater treatment plant treats viruses and other pathogens regularly. WHO added to this that no evidence to date that the COVID-19 has been transmitted via sewage systems, with or without wastewater treatment [3]. Faecal contamination to water has always been recognized as an alarming situation and the federation also suspected and identified that the coronavirus can be transmitted through the faecal-oral route [4]. Regularly new symptoms of CoV are appearing and scientists noticed that RNA of the virus was detected in the patient's stool as he had been confirmed with diarrhea as an initial symptom rather than mild fever.

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1.2 Can the COVID-19 virus found in waster/sewage water?

The research from 2003 corona breakdown showcase that the SARS pandemic had a high potential link with water and wastewater. The fact that the virus replicates itself when entering into the human body makes it an extremely possible enteric pathogen and increases the number of cases of diarrhea. Leung et al [5] reported that viral samples from patients were recovered in higher yield from small intestine than expected from the lungs. The results showed that the infection was shown after 3 weeks of virus target [6]. The advent of COVID indicates the needs of some studies on its transmission, especially in water and wastewater.

Table 1 reports a brief analysis of the experiment performed for checking the survival of three viruses (namely HCoV, FIPV, PV-1) in filtered tap sample water and unfiltered sample tap water at different temperatures. The experiment is well mentioned in (Patricia M. Gundy 2008).

The log reduction in the concentration of virus in the water sample for each virus was calculated by the well-known Boltzmann distribution formula $\log_{10} N/N_0$. N: titer of the virus at the specific day, N_0: titer of the virus at day 0 i.e. initial day. The slope of the linear curved graph was used to determine the time required by the virus to change from 99% to 99.9% denoted as T_{99} and $T_{99.9}$ respectively.

Table 1: Study of viruses in days for tap water and wastewater

Virus	Tap water filtered 23°C		Tap water unfiltered 23°C		Tap water filtered 4°C	
	T_{99}	$T_{99.9}$	T_{99}	$T_{99.9}$	T_{99}	$T_{99.9}$
HCoV	6.76	10.1	8.09	12.1	392	588
HPV	6.76	10.1	8.32	12.5	87	130
PV-1	43.3[d]	64.9[d]	47.5[d]	71.3[d]	135[d]	203[d]

HCoV Human coronavirus, HPV Human papilloma virus
PV-1 Poliovirus

The factors which influence the rate of the virus in water are temperature, organic matter and microorganisms. Leading on the top is temperature [7]. It has been shown that survival of virus decreases with the increase in temperature hence temperature is the most critical factor as it leads to the denaturation of proteins and hampers the DNA of the virus. Though, there is no research approved yet which shows the life dependence of nCOVID-19 on temperature. According to the table 1 23°C it requires approximately 10 days for 99.9% reduction of human coronavirus in filtered tap water whereas it took almost more than 100 days for its reduction at the temperature of 4°C. Hence, the reduction rate is slow at low temperatures. The survival battle of PV-1 virus was quite different from HCoV, at 23°C the survival rate has changed to almost six times whereas at 4°C it was nearly similar. Coronavirus was found to be inactive in filtered water than unfiltered water as the suspended organic materials may protect the virus from external forces against it. However, PV-1 filtration made a minute difference [8]. The experimental results indicate that the PV-1 virus is less sensitive to temperature than coronavirus. Also, there is a difference in stability between coronavirus and PV-1 in the wastewater. This conclusion may be attributed to the fact that enveloped viruses are less stable in the environment than nonenveloped viruses. Coronavirus dies in the water at a faster rate.

A team of Wang and other members focused themselves in the study of presence and the longevity of SARS-CoV in wastewater samples from hospitals, sewage plants and dechlorinated tap water [9]. The results depicted the effect of some disinfectant chemicals like sodium hypochlorite and chlorine dioxide in inactivating the virus. The analysis showed that SARS-CoV was detected appreciable concentration in hospital wastewater, sewage water and tap water for 2 days duration at 20℃ and for 14 days at 4℃ which is in strong favor of the previous study mentioned that temperature has a high influence on the persistence of the virus [10].

Other different human pathogenic viruses also lead to waterborne diseases. Table 2 contains a list of the virus which shows some evidence of health significance related to their occurrence, its duration in water over weeks

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and months, resistance to chlorine. They have been detected in almost every water type including wastewater, seawater, freshwater, groundwater and drinking water [11].

Table 2: Waterborne pathogen and their significance in water supplies.

Viruses	Health significance	Persistence in water supplies	Resistance to chlorine	Relative infectivity	Important animal source
Adenoviruses	High	Long	Moderate	High	No
Enteroviruses	High	Long	Moderate	High	No
Astroviruses	High	Long	Moderate	High	No
Hepatitis viruses	High	Long	Moderate	High	No
Hepatitis E viruses	High	Long	Moderate	High	Potentially
Noroviruses	High	Long	Moderate	High	Potentially
Sapoviruses	High	Long	Moderate	High	Potentially
Rotavirus	High	Long	Moderate	High	No

2. PRECAUTIONS FOR THE PRESENT SCENARIO

2.1. Right Ideology: Social Distancing or Physical Distancing

It occurred from the beginning that this was an unfortunate choice of language to talk about 'social distance', when actually what was meant was 'physical distance'. Targeted social distancing to mitigate pandemic can be designed through simulation of the virus's spread within local community social contact networks. In the absence of vaccines and antivirals, we need to depend and rely on public health measures to curb the disease's effects [12]. Though Social Distancing terminology is widely used, it may send the wrong message of self-isolation in terms of thoughts, feelings and expressions. Rather than sounding like we have to socially separate from your family and friends, 'physical distancing' simplifies the concept with the emphasis on keeping 6 feet away from others, technically.

Staying in touch with people feeds the human connection we all need to thrive daily, but physical distance is vital to slowing down the spread of the COVID-19 virus. Keep your distance but stay close via minds. We live in a modern technological age which helps to connect with friends and family to strengthen connections and express emotions and words which will help everyone to get through this pandemic, but we need to be responsible about it and avoid personal physical contacts.

WHO expert move to use physical distancing. Saying social distancing or isolation is not good for mental wellbeing and interpersonal human connections. Social distancing makes it sound like people should stop communicating with one another, while instead, we should be preserving as much community as we can even while we keep our physical distance from one another [12].

2.2 Water Management

By and large, this virus identity has not been considered as a threat to water management due to its high degradation susceptibility in an aqueous environment. As per the new OHSA guidelines, the municipal workers need not take extra protections regarding regular water supply except for their safety and hygiene.

Table 3: Basic recommendations for treatment-plant operators when dealing with a potential virus outbreak [13].

Critical Control Point	Potential Risk	Risk Response
Wastewater treatment- open basins	Aerosols created during the wastewater treatment process	Communicate risk, provide signage, and PPE barriers to wastewater treatment operators.
Wastewater disinfection	Infectious coronaviruses persisting in domestic sewage	Ensure optimal contact time for chemical disinfection.

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Drinking water treatment	Infectious coronaviruses in water supplies impacted by wastewater effluents	Ensure continuous monitoring and performance of drinking water disinfection processes for systems with upstream wastewater impacts during, and after, and outbreak.

Haizhou Liu, an associate professor of chemical and environmental engineering at the University of California, and Professor Vincenzo Naddeo, director of the Sanitary Environmental Engineering Division at the University of Salerno, has suggested for more testing to check whether water purification techniques are effective in washing off coronavirus. The virus can be transported in microscopic water droplets, or aerosols, entering the air through evaporation. The virus could also colonize biofilms that line drinking water systems, making showerheads a possible source of aerosolized transmission. Biofilms are thin, slimy bacterial growths that line the pipes of many ageing drinking water systems. Reportedly, most water treatment routines are thought to kill coronaviruses in both drinking and wastewater. Oxidation with chemicals like hypochlorous acid or peracetic acid, and inactivation techniques like ultraviolet irradiation, as well as chlorine, are thought to kill coronaviruses. In wastewater treatment plants that use membrane bioreactors, the synergistic effects of beneficial microorganisms and the physical separation of suspended solids filter out viruses concentrated in the sewage sludge and makes it germ-free and fit for consumption [14].

2.3 Guidelines on disinfection issued by the Indian government against COVID-19

Hygiene is defined as the maintenance of cleanliness practices which carries utmost importance in the maintenance of health. Though the virus is highly contagious and survives in the environment for a noticeable period, it also gets inactivated by the use of some chemical disinfectants. For various public places, different norms are issued.

Public toilets are one of the most vulnerable places to be attacked by the virus and thus authorities are advised to keep an eye on cleanliness and water quality [15].

Table 4: List of Vulnerable areas and sanitization techniques [15]

AREAS	AGENTS & CHEMICALS	PROCEDURE
Toiletpot/ commode	Sodium hypochlorite 1%/ detergent Soap powder / long handle angular brush	Inside of toilet pot/commode: • Scrub with the recommended agents and the long handle angular brush. •Outside: clean with recommended agents; use a scrubber.
Lid/ commode	Nylon scrubber and soap powder/detergent 1% Sodium Hypochlorite	• Wet and scrub with soap powder and the nylon scrubber inside and outside. •Wipe with 1% Sodium Hypochlorite
Toilet floor	Soap powder /detergent and scrubbing brush/ nylon broom 1% Sodium Hypochlorite	•Scrub floor with soap powder and the scrubbing brush • Wash with water •Use sodium hypochlorite 1% dilution
Sink	Soap powder/detergent and nylon scrubber 1% Sodium Hypochlorite	Scrub with the nylon scrubber. •Wipe with 1% sodium hypochlorite

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Showers area / Taps and fittings	Warm water Detergent powder Nylon Scrubber 1% Sodium Hypochlorite/ 70% alcohol	• Thoroughly scrub the floors/tiles with warm water and detergent • Wipe over taps and fittings with a damp cloth and detergent. • Care should be taken to clean the underside of taps and fittings. • Wipe with 1% sodium hypochlorite/ 70% alcohol
Soap dispensers	Detergent and water	• Should be cleaned daily with detergent and water and dried.

The concentration of the widely used disinfectant is 1% Sodium Hypochlorite (w/v). This paper also mentions the guidelines for the preparation of Sodium Hypochlorite.

A variety of chemicals can be used to effectively disinfect COVID-19.
Chlorine dioxide, Citric acid, Ethanol, Ethyl alcohol, Glycolic acid, Hydrochloric acid, Hydrogen peroxide, Iodine, Isopropyl alcohol, Lactic acid, Phenolic, Sodium chloride, Quaternary ammonium, Thymol.

Table 5: Preparation of 1% Sodium Hypochlorite Disinfectant [15].

Product	**Available chlorine**	**1 percent**
Sodium hypochlorite – liquid bleach	3.5%	1 part bleach to 2.5 parts of water
Sodium hypochlorite – liquid	5%	1 part bleach to 4 parts water
NaDCC(sodium-dichloroisocyanurate) powder	60%	17 grams to 1-litre water
NaDCC (1.5g/ tablet) – tablets	60%	11 tablets to 1-litre water
Chloramine – powder	25%	80 g to 1-litre water
Bleaching powder	70%	7g g to 1-litre water

2.4 Indian Advancements for run-off pandemic

Importantly, Hand hygiene is a vital principle and exercise in the prevention, control, and reduction of coronavirus disease. Indian Pharmaceutical Science Authority prepared and Herbal Hand Sanitizers which are less harmful to the skin. Table 4 shows the prepared formulation of herbal hand sanitizer showed significant results at concentrations starting from 400 µg/ml [16].

Table 6: Preparation of Herbal Sanitizer [16].

Sr. No	**Ingredients and Excipients**	**Quantity %**
1.	Deionized water	31.00
2.	Alcohol Denatured	62.00
3.	Tulsi leaves extract	01.00
4.	Nilgiri leaves extract	01.00
5.	Carbopol 940	00.50
6.	Tri Ethanol Amine	00.70
7.	Glycerin	02.30
8.	Polysorbate 20	00.50
9.	Perfume	00.50
10.	Preservative	00.50

3. DISINFECTION GATEWAY

The Ethanol treatment can be used to evaluate large collections of environmental samples for the presence of giant viruses and to provide insight into understanding their ecology. Scientists at the Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), Trivandrum have come up with a 'disinfection gateway' - a

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portable system that generates hydrogen peroxide (H_2O_2) mist and UV-based decontamination facility to fight the Covid-19 pandemic.

The SCTIMST said that the disinfectant gateway is an electronically controlled system. The hydrogen-peroxide fumes will decontaminate the body, hands, and clothes of a person whereas the purpose of the UV system will be to decontaminate the chamber attached to it. The electronically controlled system will have sensors that will detect the entry of a person in a room and generate hydrogen-peroxide mist for fumigation.
The person under the process will be required to walk through the chamber attached to its end. When the person exits, the system will shut off the hydrogen peroxide fumigation system and will turn on the UV lamp inside the chamber to decontaminate it.

The UV light will get switched off automatically after a prescribed time. The chamber will then get ready for the next person. The whole process takes just 40 seconds for disinfecting one person. The system has see-through glass panels on sidewalls for monitoring and is fitted with lights for illumination during use. The design and Know-how have been transferred to HMT Machine Tools [17].

4. DISCUSSION

Coronaviruses have been making people cough and sneeze for eons. Will it continue to escalate into an even more deadly pandemic, or will it burn itself remains to be seen? The world is still struggling with this scary virus. It has set a new field for research. The virus has changed the language of communication. This is a very different experience from an outbreak that we have been a part of. It's not clear whether ongoing scientific collaborations will help mitigate the worldwide blow from COVID-19, but many scientists welcome the way the outbreak has already changed the way they communicate. It feels like things are transforming to a completely new culture of doing research. It’s exciting.

5. CONCLUSIONS

In the wake of the novel virus pandemic, there is also an urgent need to understand the importance and judicial use of water. The problem of infected excreta from the hospital's water supply and sewage needs to be tackled. Thus, there is a super urgent need to stop manual handling of faeces. Due to increased awareness, water consumption has almost doubled its statistics than before. Wastewater from medical departments and sewage pipelines should not be mixed with regularly consumed water at any cost.

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