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Water and Air as Possible Transmission Medium for Novel Corona Virus (COVID-19), Scope for Future Research: A Review

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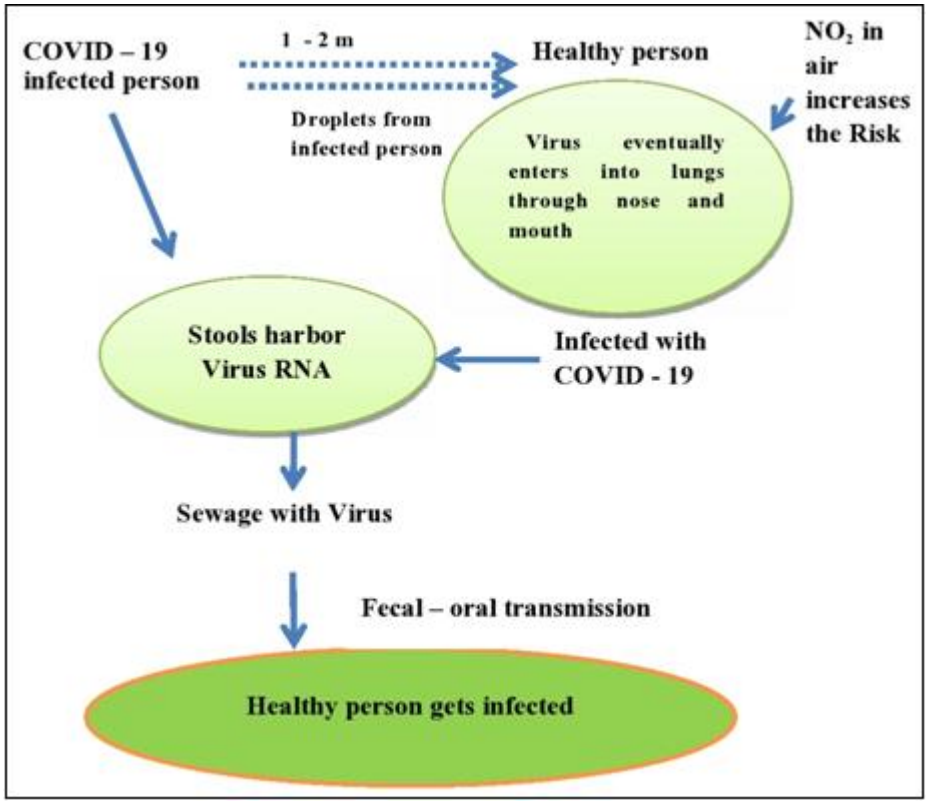
Abstract: ***The recently spread Novel coronavirus (COVID-19) belongs to RNA virus group of viruses, which is having relatively high transmission rate and it is highly contagious. Among the two strains namely S and L reported, the later one was common at the early stages of the outbreak. Mainly it is transmitted via droplets and person to person contact. But it is evident that through air and wastewater (fecal - oral) also transmission is occurring. Till now only few reports are available about the transmission of COVID-19 viruses other than droplet. This article is written after reviewing a few research outcomes published in the journals and clinical reports collected from the web sources to highlight the possible mode of transmission of this deadly virus such as air and wastewater to draw more attention to do thorough study in this area.***

Keywords: COVID-19, mode of transmission, air borne, fecal – oral



Graphical Abstract

1. Introduction

Various pandemics were observed by mankind throughout the history, where some of them were more disastrous than the others to the humans. It is reported that since the beginning of the 21stcentury, three coronaviruses have caused disastrous outbreaks of pneumonia in human beings such as severe acute respiratory syndrome coronavirus (SARS-CoV) in 2002–03 and Middle-East respiratory syndrome coronavirus (MERS-CoV) in 2012. The ongoing Corona Virus disease (COVID-19) is the third coronavirus epidemic (Sun et al., 2020)which spread from Wuhan, a city in China to the entire country and within 30 days spread to nearly 105 countries in less than three months. COVID-19 was declared a pandemic by the World Health Organization (WHO) on 12th March 2020.

As on today it is reported that except Antarctica all other countries in the globe are the victims of the deadly pandemic COVD – 19. Worldwide total death, new cases reported, total cases reported and active cases as on 29th April 2020 was 216,580, + 61, 871, 3, 121,817 and 1958, 028

respectively (bbc.com, 2020.). However, the virus is deadly and is not inactivated or killed by cold weather or snow. The COVID -19 are transmitted from one person to other via droplets when infected persons breath outs, cough or sneezes. Further, transmission is achieved through contaminated surfaces like door handles or rails. The possible mode of transmission of this virus from the infected person to others is illustrated in Figure 1.

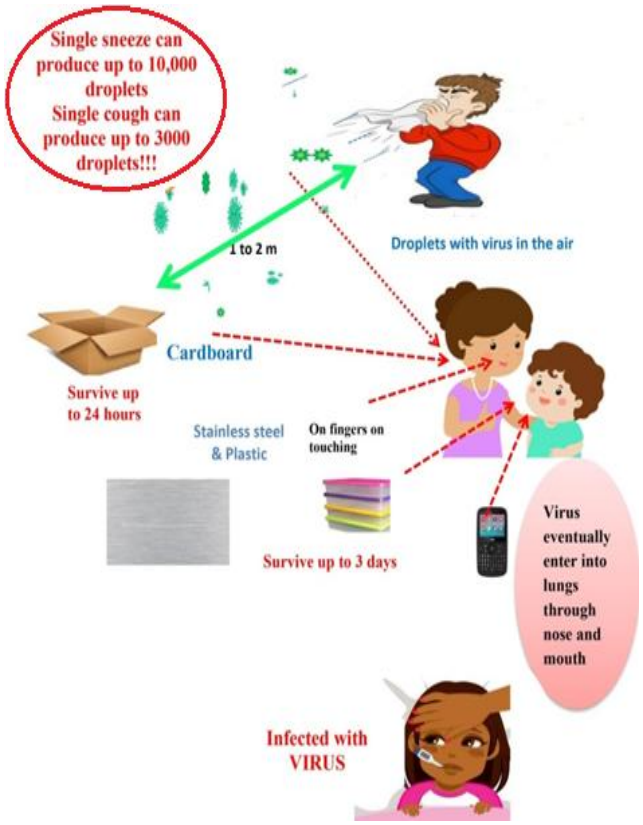


Figure 1: Illustration showing possible modes of transfer of COVID-19 from infected persons

Air pollution and COVID-19 transmissions

Transmission of respiratory infections is mainly via droplets. Most commonly, the infections are transmitted by the droplets with the diameter of 5 to 10 µm. The droplets with diameter < 5µm are known as droplet nuclei (WHO, 2014). The studies conducted in China revealed that COVID-19 is mainly transmitted via droplets and contact routes (Liu et al., 2020). Another way of respiratory infection transfer is via airborne transmission, in which the microbes are present within the droplet nuclei and withstand the air current and persist in the air for long duration. In this case, the particles or pathogens are transmitted to other persons over a distance greater than 1m. Under controlled conditions in a laboratory the viability of the aerosolized COVID-19 viruses in the air was maintained with a half -life of one hour (VanDoremalen 2020, Kampf, et al., 2020). However, in the outdoor environment they are greatly influenced by the physical factors such as temperature, Relative humidity (RH), Ultraviolet (UV) rays and inactivated within a short period (Casanova, 2010, Walker and Gwangpyo, 2007, Contini and Costabile, 2020). When 75, 465 COVID-19 infected cases were observed initially in China, the infection was predominantly transmitted through droplets and no airborne transmission was reported (Ong, et al., 2020, Cheng et al., 2020). But in European countries such as Italy, Spain, France and Germany on observing the COVID-19 infected persons and death, it was concluded that there was a correlation between the transmission of the virus and air pollution. Among the 66 Corona viruses administrated regions it was noted that 78% death occurred in the 5 regions which were highly polluted (Ogen, 2020a). The air in the regions was heavily polluted with NO_2, a major emission from the vehicles. Further, due to the weather conditions prevailed during that period there was no dispersion of the polluted air away from these regions causing more death when COVID-19 infected people were exposed to air containing NO_2(Ogen, 2020b, Conticini et al., 2020).

On long-term exposure to air pollutants such as nitrogen dioxide (NO_2) these infections get aggravated. In addition, it was proven that increased concentrations of NO_2 in the atmosphere has been associated with hypertension (Saeha et al., 2020), cardiovascular diseases (Arden et al., 2004), Chronic obstructive pulmonary disease (COPD) (Abbey et al., 1993), poor lung function and asthma in children (Avol et al., 2001) and adults especially at middle age (Bowatte et al., 2017) and diabetes (Saeha et al., 2020). The epithelial cells in the airways are inflammated on exposure to NO_2 and thereby the infected persons are susceptible to death (Persinger et al., 2002). It is clear from the results of the early studies that the vulnerable group for this COVID-19 virus epidemiology was people with prolonged smoking history (Liu et al. 2020), hypertension and heart disease (Chen et al., 2020) and old age (Wu et al., 2020)

Fecal – oral transmissions of COVID-19

When the spread of COVID-19 occurred beyond China, initially it was noticed by the clinicians that the mild gastrointestinal symptoms such as diarrhea, nausea, vomiting and abdominal pain in addition to fever, dry cough and dyspnea were expressed by the infected persons. Further, it was reported that the first case of COVID-19 infected people who has returned from Wuhan city of China, expressed stomach upset in addition to the cough and fever. At second day of admission, along with severe dry cough the symptoms such as nausea and vomiting, and loose bowl movement were expressed by the patient. On testing the sample of loose stool along with additional respiratory specimens (nasopharyngeal and oro-pharyngeal) and serum by real-time reverse-transcriptase-polymerase Chain Reaction (rRT – PCR) Assay all the samples were found to be COVID-19 positive except serum (Michael et al., 2020).

Although the gastrointestinal symptoms (GI) were expressed by a few COVD – 19 patients, the infection should be considered as a respiratory illness (Johnson, 2020). But concomitant gastrointestinal shedding in stool and saliva, and GI symptoms were observed in COVID-19 infected patients that should be also given attention (Johnson, 2020). Further, the samples from mouth, nose, throat, urine and feces obtained from 73 patients hospitalized during the first two weeks of February, 2020, were tested and found to have COVID-19 viral RNA. The presence of viral RNA was confirmed from 1 to 2 days. Also it was observed that about 23.29% (17 out of 73) of the patients' stool found to be positive for COVID-19 even after the improvement of the

respiratory symptoms (Fei et al., 2020). This might be due to the reason that the Angitensin - Converting Enzyme 2(AEC 2) a receptor for COVID-19 (Xu et al., 2020, Jia et al., 2005) was abundantly expressed in glandular cells of gastric, duodenal and rectal epithelia and attracting the entry of this virus, causing GI symptoms which was confirmed by immunoflourecent assay(Fei et al., 2020). However, some patients even with a positive stool test for COVID-19 did not experience GI symptoms and lung infection (Zhang et al., 2019, Zhang et al., 2020). Hence, a health protection is needed as there is a possibility of virus transmission through stools.

Further studies revealed that high levels of viral shedding in fecal samples from COVID-19 patients have been observed. Further, it is understood that shedding happens early in the disease's progression, well before patients show any symptoms, there's reason to suspect evidence of the virus might show up in a city's wastewater, even before the residents of that city have been tested. Traces of viral particles (COVID 19) have been reported in wastewaters of many countries including France and USA. Most of the pathogens are transmitted through fecal- oral route and causing severe health effects in humans. But the detection of COVID 19 in wastewater has not been studied thoroughly and not established well yet.

As COVID 19 is a recently transmitted viral disease a few studies have been conducted to detect the viral particles in wastewater treatment plants. The possible ways of fecal–oral transmission of COVID -19 are Shown in Figure 2.

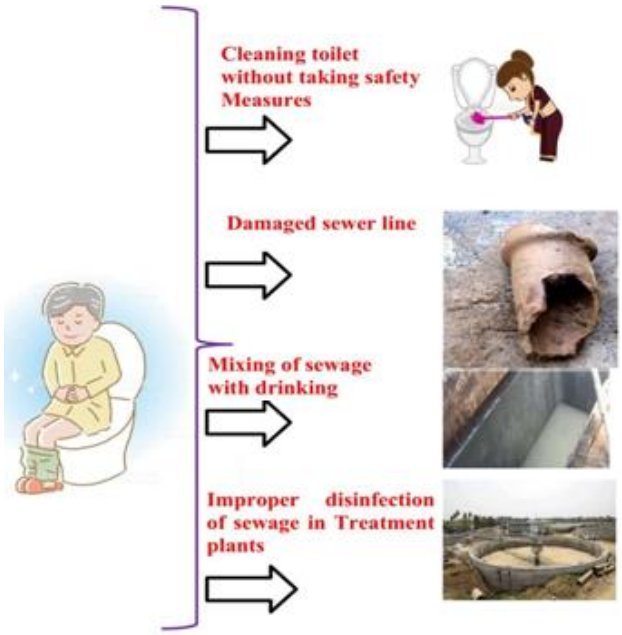


Figure 2: Illustration showing fecal- oral transmission modes of COVID-19

Water samples collected from a wastewater treatment plant in Massachusetts had higher concentration of SARS-CoV-2 particles indicated a far higher number of people likely infected with COVID-19 than the reported cases in that area (www.statnews.com). SARS-CoV-2 (COVID-19) RNA was concentrated from wastewater in a catchment in Australia and viral RNA copies were enumerated using reverse transcriptase quantitative polymerase chain reaction (RT-qPCR) resulting in two positive detections within a six day period from the same wastewater treatment plant (WWTP) (Ahmed et al., 2020,Khan et al., 2020).

The wastewater-based epidemiology (WBE) approach could provide an effective and rapid way to predict the potential spread of novel coronavirus pneumonia (COVID-19) by picking up on biomarkers in feces and urine from disease carriers that enter the sewer system. Rapid testing kits using paper-based devices could be used on-site at wastewater treatment plants to trace sources and determine whether there are potential COVID-19 carriers in local areas (Mao et al., 2020).

Research team from Massachusetts Institute of Technology (MIT) and Brigham reported that at least 440 people were likely infected with COVID-19 in the area around the treatment facility — much higher than the reported cases (Down to Earth, 16th April, 2020)

Novel corona virus in sewage samples was detected even before public health officials reported the first diagnosed case of COVID-19 in a community in Netherlands (https://www.statnews.com/2020/04/07/new-research-wastewater-community-spread-COVID-19/accessed on 1st May, 2020).

Further, it is reported that the treated wastewater effluents showed a 100 times reduction in the viral load compared to the corresponding raw wastewater samples (Wurtzer et al., 2020).

2. Conclusion

After reviewing the mode of transmission of COVID-19, the air and water (sewage) is also playing major role in the transmission of the virus. The air polluted with NO_2 levels caused was responsible for more deaths in European countries. But the focus given in this aspect is limited. So at this juncture it is essential to pay attention and studies should be elaborated further in this field. The possible transfer of the virus via air medium and the factors affected should be studied. It is a promising approach to understand the prevalence of viruses in a given wastewater treatment plant (WWTP) catchment population. The advent of severe acute respiratory syndrome and its potential environmental transmission indicates the need for more information on the survival of coronavirus in water and wastewater. Hence, in order to detect the presence of COVID - 19 particles in sewage a thorough monitoring is needed. Further, to prevent the entry of these viral particles in to the human system, a better treatment system should be established to kill the viral particles.

3. Scope for Future Research

1) The concentration of antibiotics in the water is to be given attention, because there is abundant increase in the antibiotics usage for the COVID - 19 therapies. Already the presence of antibiotics in the water is creating problems. So in this direction the research should be

elaborated to detect the types and concentrations of antibiotics in water.
2) Study should be conducted to detect the occurrence of COVID - 19 viruses in sludge.
3) The bacterial species and protozoa population in wastewater and sludge is an important factor for the various microbial processes in wastewater. Further research should be carried out to study the impact of COVID - 19 viruses on the population of bacteria, protozoa and yeast in the wastewater.
4) The impact of various antibiotics used for the COVID19 therapy on the microbial population should be studied further.
5) Developing a technology for efficient inactivation and destruction of virus in wastewater.

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