SPREADING OF COVID'19 THROUGH WASTEWATER IN UNDERPRIVILEGED SOCIETIES - AN OVERVIEW

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Abstract- The prospective spread of unique human coronavirus by means of contaminated food and water and by aerosols-borne itineraries are turning up to be a major up challenge for all. All over the globe, every country is, at the moment, trying to overcome defies imposed by this disease. There is a need to comprehend the destiny of the virus in the environment. In this literature research, different modes of disease transmission with special focus on the wastewater management are emphasized. The literature up till now indicates that, in addition to direct person to person transmission (which is the most common form of transmission), the virus can also be transmitted through air born droplets, and also through feco-oral rout through contaminated food and water. As there is a knowledge gap indicating no evidence about transmission of coronavirus through the untreated potable water, questions regarding the consequences of non-availability or poor wastewater management strategies, increasing population rate, and failing economy of many countries, need to be addressed. It is concluded that more research is needed to estimate the future of coronavirus and form strategies for its eradication.

Keywords- Waste water, Sewage associated, SARS-CoV-2, Virus-containing aerosols, ARDS, water management.

1 INTRODUCTION

The current epidemic circumstances of coronavirus have a constant state of panic and fear for every country of the world and it is promptly changing with worldwide distribution [1]. SARS-CoV-2 (Severe acute respiratory syndrome coronavirus 2) also known as COVID-19 (coronavirus disease of 2019) is a member of the Coronaviridae family of viruses that can cause humble form of mild flu or can lead to life threatening situation like severe acute respiratory disease that can lead to death]2-4]. The very first case of SARS-CoV-2 was reported in 2019 hence was named as coronavirus disease-2019 or COVID-19 [5]. This virus has shown to be highly contagious, and can spread directly from person to person by direct contact and by respiratory droplets/ aerosols, thus leading to a pandemic that has involved the whole globe rather too quickly [6]. Recently the virus has shown evidence of transmission by oral route through contaminated water supply apart from being transmitted through the inhalational route [7, 8]. The understanding of the spread of the virus took a turn when the ribonucleic acid (RNA) of the virus was identified in the coronavirus infected patient's stool, suggesting the spread by fecal-oral route [9-11]. With this revelation, the prospect of gastrointestinal infection by coronavirus is deliberated by studying the angiotensin-converting enzyme 2 receptor, on which the virus acts, and viral nucleocapsid and GIT (gastrointestinal tract) tissue by staining of gastrointestinal tissues. It is suggested that the transmission of the virus via feco-oral route is much greater because the viral RNA had been found in samples taken from almost every part of the GITract [13, 14]. Even though coronavirus has not regarded as an airborne virus, but the virus utilizes air for its transportation by its adsorption of dust or particulate matter (PM) principally if these particles cart humidity. This is also liked with the phenomenon of virus-laden-aerosols conduction. It is recently studied in Italy that if air pollution of any city exceeds the set limit from that of PM10, there is higher infection rate of COVID-19 in that city [15]. It is proposed that the infection rate is directly related with the amount and the number of days of air pollution and the wind dynamics in a particular city or area. The areas with high pollution have a greater infection rate. A study conducted in Lombardy and Emilia Romagna, Italy where the virus showed maximum lethality as compared with rest of world, making the conclusion that the quality of air in the city is correlated with the higher infectivity of SARS-CoV-2 [16]. Another study conducted in New York City concluded that the face coverage is highly beneficent because of high virulence of the virus transmission through the air born route [17].

In neglected societies, the environmental condition favors the persistence of SARS-CoV-2 and also its lethality, making it a huge challenge for the community. This is because of the fact that poor sanitary and health care facilities making the spread of the virus in less time [18]. This places a lot of pressure on the WWTPs (waste water treatment plants) for the treatment of the wastewater having virus-contamination. Many neglected societies do not have well equipped systems for wastewater treatment that can remove viruses. These have not been prepared with the essential equipment to eliminate viruses efficiently. For instance, in developing countries like Pakistan, there is no wastewater treatment plant (WWTP) that is functioning in the entire region of different cities; rather e.g. there are some stabilization pools in Faisalabad to treat wastewater of the city. Likewise, in many areas of Nigeria, such as Benue, Kogi, Kwara, Niger, and Plateau, there are non-functional wastewater treatment conveniences whereas in other states like Akwalbom, Abia, Anambra, Imo, Ondo and Bayelsa, there is no facility for wastewater [19-21]. Currently in many parts of world, the wastewater has been discharged unswervingly in native streams and rivers with no or partial treatment [22, 23]. In this work, different pathways taken by the virus are briefly discussed along with wastewater managements and its perspectives are reviewed for the betterment of common people. The fundamental goal of this study is to highlight the strategies for the disease control and to suggest the points which need focus in the where improvement can be suggested and investigated in future. For this to take place commendably, this collected literature research is conducted by the collaboration from perspectives of engineering (wastewater) and medical (microbiology) point of view. Figure 1 demonstrates different transmission paths of coronavirus from improper waste management and aerosols formation.

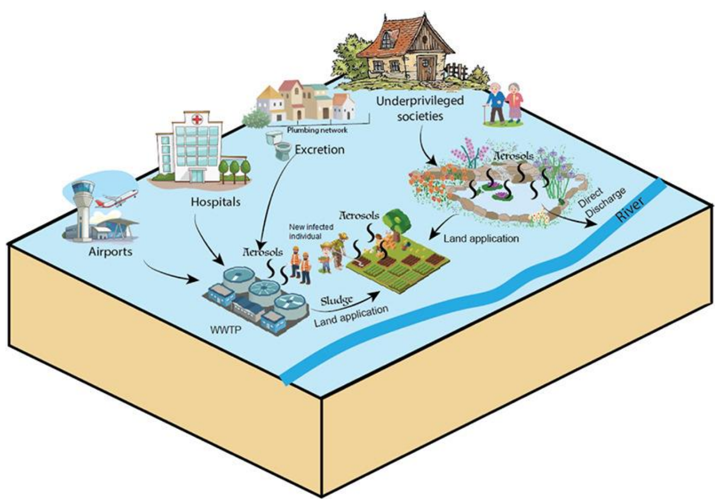

Figure 1: Different route of transmission of SARS-CoV-2 virus from improper waste management and formation of aerosols [24].

2 GIT TRANSMISSION

The GIT involvement of the virus was emphasized by finding the traces of viral RNA in almost every tissue of the gut lining [13, 14].The GIT route orthodoxly trails 5-Fs pathways like fingers, fomite, fluids, flies, and field (Figure 2). Up till now regarding COVID-19, there is very limited know-how on spread of disease via fluids and fields. On the other hand, the involvement of fomites (e.g., surfaces and clothes), flies, and fingers (direct contact) has been debated [1, 25]. It is proposed that SARS-CoV-2 has characteristic similarity with that of SARS-CoV-1 on the basis of morphology and structure and genetics [26]. On this basis like other coronaviruses its transmission could be liked with that of feco-oral route. In Hong Kong during the eruption of the coronavirus in 2003, insufficient drainage systems were acknowledged as the chief source of fecal-oral transmission [1, 27]. After entering the sewerage, the virus forms aerosols spread when it is mixed with fecal particles [28]. These droplets/aerosols initiating from virus-rich excreta were out broke with strong upward air flows, non-functional derisory traps, and water seals. The airborne spread path was further supported with the extract ventilation system of bathroom. This eventually drew air within the area of apartment, therefore facilitating extended-range human-to-human spread through movement of air. As a whole, within one 50 storied apartment building, many confirmed individuals (342) and 42 demises had been reported. Later on, the findings were verified by studying the cross-contamination mechanisms. In past, other viruses had also been spread by fecal–oral path like gastroenteritis virus. Though, no solid evidence occurs for the transmission of COVID'19, such aspects are significant to be considered for understanding the SARS-CoV-2 future.

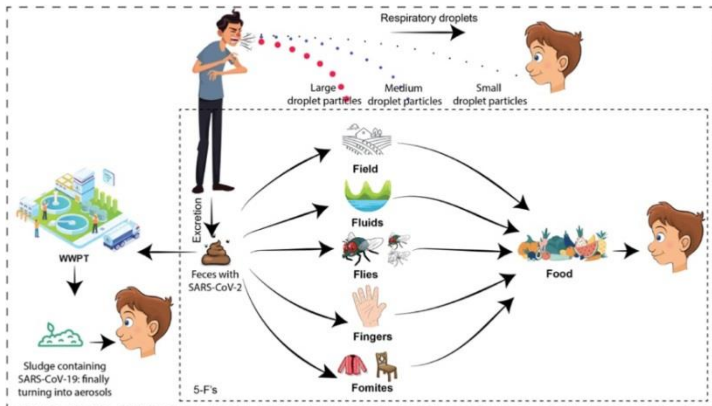

Figure 2: Pathway illustration of coronavirus spread by means of fecal-oral path [24].

3 AEROSOLS/ DROPLET–BORNE TRANSMISSION

The COVID-19 virus is also assumed to be associated with air conditioner [29]. In the early stage of pandemic, in a restaurant of Guangzhou city in China, three families had a get to gather at lunch and later on developed symptoms of coronavirus in a successive way. On day 1, only one individual had symptoms, but later on, 9 more family members got infected. As in a closed space and strong air flow of the air conditioner the droplets are propagated further as the human atomize the virus loaded particles by sneezing, coughing, or even usual breathing via an infected individual. The bigger respirational droplets (of >5 μm size) stay for a short period of time in the air and settle down at around < 1 m distance. On the other hand, small aerosolized droplets (of <5 μm size) can persist for a longer period of time in the air and could go > 1 m distances. The fine aerosols (i.e. PM2.5) might penetrate acutely in respirational tract, ultimately affecting the other important organs of the body [14]. Keeping in focus the transmission of the respiratory droplets there is a requirement for the development of necessary strategies during the construction of new buildings and the installment of the ventilation system in order to minimize the risk of indoor transmission of the disease. The engineering control of the ventilation system should be done as to include maximum ventilation, installment of air filters and purifiers, and avoidance of air recirculation and overcrowding. These measures can easily implemented and are cost effective if the strategies are implemented at appropriate time. It is believed that these engineering control measures of buildings along with the other control measures like wearing face mask, maintain a safe distance, proper hand hygiene, isolation and quarantine could have additional benefits in minimizing the transmission of the disease in public places like hospitals, schools, restaurants and offices. The detection of COVID 19 in the indoor air samples of hospitals raised many questions regarding the viability of the virus and the concentration of the virus and the relation of infectious dose. It has been observed that the virus remains viable in the air and the viability depends upon the condition of the environment like humidity and temperature etc. To assess the viability of virus in the laboratory setting, the stability and characteristics of coronavirus and other air born viruses like the MERS (Middle East respiratory syndrome) coronavirus were compared [30]. MERS-CoV virus had been found in air specimens, taken from hospitals of South Korea. This virus caused 186 infected cases as well as 36 demises, resulting in the closure of hospitals temporarily. For measuring spread of coronavirus by aerosols, SARS-CoV-1 and SARS-CoV-2 were assessed for their stability on lab-generated aerosols. It was recounted that the later one could remain up to 3 h in the aerosols in the humid environment of around 65%. It is advised to further evaluate the behaviour of the virus at different humidity levels. The detection of viable samples of virus prompt the question of safe exposure levels. Even though a decrease in infectious titer had been experienced with the passage of time, i.e. half-lives were comparable for both SARS-CoV-1 and SARS-CoV-2 and TCID50 (fifty-percent tissue culture infective dose) decreased from 103.5 to 102.7/L of air. In recent time, SARS-CoV-2 with285–1130 copies/m^3 was detected in aerosols taken from the environment of hospital [14]. This leads to the opinion that there might be a viral spillage due to the production of respiratory droplets or aerosols produced by the infected patients. In Hong Kong, in the course of the past occurrence of virus outbreak, the SARS-CoV-1 was capable of entering the separate buildings and homes. Another question arises here that what might be the impact of ambient temperature on the SARS-CoV-2 survival in the air. For answering the question, a study was conducted on coronavirus infections in China (122 cities) during period of Jan-Feb 2020 [31]. No decrease was found in infection rate due to hot environment. This finding is in contrast to the observations made about poor existence of SARS-CoV-1 at lower and high temperatures, aiding the wide spread and infections [32].

4 WASTEWATER HAVING SARS-COV-2

The general signs of COVID 19 include fever, cough, diarrhea and difficulty in breathing and the RNA of the virus are found in the feces of asymptomatic as well as the symptomatic patients [14]. According to this scenario the municipal wastewater of the effected community could contain viruses. By default the plumbing system harbors many microorganisms including viruses like coronavirus [33]. In 2003, a report was published by World Health Organization (WHO) after coming across a different scenario when the housing facility in Hong Kong was affected by SARS virus and there were 342 confirmed cases in a 50 story building with 42 deaths due to SARS virus. The transmission cause was recognized as the defected wastewater plumbing system which facilitated the virus louden vapor partials through the fittings in the bathrooms. The interconnected plumbing system can lead to spread and super spread of the disease. This is a matter of concern in the high risk facilities like hospitals and community centers or other healthcare buildings. As the virus is shredded in the stool the presence of virus (RNA, messenger RNA or capsid) could be used for evaluation. The existence of coronaviruses in WWTPs is determined via numerous factors like the occurrence of oxidants and carbon-based matter; variations in pH and temperature; and copiousness of antagonistic bacteria [1, 34]. Firstly, suspended solids and organic matter in wastewater could offer shield to viruses which has adsorption capability to such particles, decreasing the deactivation effectiveness [34]. The persistence of coronaviruses depends upon multiple factors, and in treated sewage and pure water, it lives up to many days [35]. The existence of oxidants can affect the viral envelope integrity (a very fragile structure) [36]. In the past, SARS-CoV-1 virus had been incapacitated in wastewater in the presence of strong oxidants, for example, free chlorine [34]. The WHO recommended dose of free chlorine near chlorination (i.e. at pH < 8.0, ≥ 0.5 mg/L after contact time of at least 30 minutes) may not be adequate enough to treat the current coronavirus having high viral load [37]. In a study, the septic tank having wastewater of a hospital had viral RNA. This had been disinfected with dose of 800 g/m^3 sodium hypochlorite (one and a half contact time and >6.5 mg/L free chlorine). In general, the existence of coronaviruses may be related to the temperature. For instance, SARS-CoV-1 at 20 °C could live up to 48 hours in the dechlorinated tap water, hospital wastewater, and domestic sewage. But, this duration was extended to 2.5 weeks when existing in the urine and 72 hours when present in organic matter (feces). SARS-CoV-1 had been further capable of its existence at lower temperatures (4 °C) up to > 2.5 weeks in urine or feces and 2 weeks in the wastewater [38]. The existence of antagonistic microorganisms can also have an effect as they enhance the degree of inactivation. The phenomenon is studied in detail at waste water treatment plants in which membrane-bioreactors are available. In the presence of these membrane bioreactors, the inactivation of viruses is done through enzymatic breakdown and predation [39]. The degree of deactivation auxiliary enhances in the sludge (i.e. solid state) in comparison to liquid state. This can be due to highly dense predators and enzymes in solid state [40]. Many of these outcomes are verified for enveloped viruses containing Coronaviridae family members. In short, more research on SARS-CoV-2 is necessary to make further related assumptions.

5 IMPENDING THREATS FOR NEGLECTED SOCIETIES

In many parts of the world majority of population do not have adequate facilities like clean water, toiletries and other healthcare facilities. Furthermore due to space constraints and over-crowding in most areas the physical distancing and self-quarantine seems impractical and difficult so have influence in the rapid spread of the disease. In the neglected societies there are no proper waste management facilities and the WWTPs produce a huge quantities of solid-state sludge. As it is well known that the sludge carry's many microorganisms including many bacteria and viruses including SARS-CoV-2 [41, 42]. The early detection of RNA in the fecal matter can have beneficial effect in the detection of the viral content and its vulnerability for the community. The virus load is very high on solid particles in the viral shedding period. The amount of viral RNA load in principal municipal sewage slush may perhaps be up to many times greater as per their corresponding quantities in raw wastewater [9]. The microorganism especially viruses can survive for a long period of time under appropriate circumstances [43]. For instance, after 17 months of dumping, human enteric viruses had been found in the residues taken from Atlantic Ocean (i.e. sewage slush disposed location) [44]. Though, few societies do treatment of their sewage sludge for decreasing the microorganism's existence by dewatering, thickening, composting processes or digesting, it is yet not known if such practices can adequately inactivate/remove the coronavirus. The recent know-how of the adsorption abilities of virus on particles of sludge endorses suitable treatment before discharging/disposing into environment. In addition, deprived communities could not bear expenses to buy the disinfection chemicals which can aid to deactivate the viruses. For example, in regions like Tunisia India, and Egypt, no treatment of wastewater is done beyond secondary phase [20]. The hazard linked with the existence of coronavirus in the runoff water seems insignificant; nonetheless, this condition for underdeveloped countries may be different because of poor waste management practices and improper sanitation. The other apprehension in underdeveloped countries is the cross-transmission of the systems of potable water with inappropriate wastewater management. Though, no recent indication confirms the existence of human SARS-CoV-2 in ground or runoff water [36]. Additionally, the timing and intensity of preventive actions should be made with care in deprived communities as the death rate may increase in these areas because of poor wastewater management, health care, and overpopulation. During spread of Spanish flu in 20th century, around 30% deaths were observed in India only because of the recurrent spreads [45]. In addition, modeled outcomes have concluded that coronavirus has the capability of making a substantial spread irrespective of establishment time. At most, detail wastewaters monitoring in deprived communities should have topmost urgency unless majority of the inhabitants is vaccinated. A big challenge in such communities is to have economical screening systems for easy detection at early age so as to have control situation.

6 CONCLUSION

In this work, different pathways taken by the virus are briefly discussed along with wastewater managements and its perspectives are reviewed for the betterment of common people. The fundamental goal of this study is to highlight the strategies for the disease control and to suggest the points which need focus in the where improvement can be suggested and investigated in future. For this to happen effectively, this literature research is made collaboratively from perspectives of engineering (wastewater) and medical (microbiology). Following conclusions can be drawn from the conducted literature research:

- The SARS-CoV-2 could be transmitted through fecal-oral contamination and also air born-virus-laden aerosols/droplet routes. However, there may be a difference in the outcome in different regions according to the different circumstances such as the level of control measures, the cultural norms, hygienic habits of the people, and the treatment facilities.
- The rate of pollution has a direct relation with the rate of infection of COVID-19, the higher the rate of pollution in a specific area the greater is the infection rate
- The wastewater treatment and recycling depends on the knowledge regarding the treatment options and the available resources, so detail investigation should be made to interpret the virus fortune in different environments.
- Since many underdeveloped regions are deficient of basic infrastructure to eliminate such viruses from whole water cycle, this condition can cause numerous spreads as were seen in the past.

The chain of transmission of SARS-CoV-2 could be broken or slowed down by proper wastewater management and good hygiene practices. Also wearing a facemask could decrease the infection rate. A successful health program depends upon the formation of proper strategies which require accurate knowledge regarding the proper disposal of waste and the reutilization of different products in order to minimize the spread of the disease. To address this issue further research is required based on thorough on-field testing and analyses.

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