The impact of Covid-19 pandemic on water supplies and wastewater sewer system

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Abstract. Besides other issues, the global pandemic caused by SARS CoV-2 also brought a number of water management questions which mainly concern the likelihood of virus spread through drinking water and possible contamination of wastewater. This paper reviews principal data on the virus and the recent course of the pandemics. It shows that there is no risk of the virus spread through drinking water and that drinking water disinfection is sufficiently effective. On the contrary, wastewater was observed for SARS CoV-2 RNA particles. As a result, a number of papers deal with research in the observation of the virus in wastewater, which may become an early-warning tool before an epidemic develops. The monitoring of the virus in wastewaters may also enable researchers to predict the course of Covid-19 illness rates in the future.

1. Introduction

The Covid-19 pandemic has turned our attention to viruses. Viruses are non-cellular organisms occurring in the environment, including water. They may be agents behind a number of diseases, such as influenza, cold, measles, polio, viral hepatitis and AIDS. In waters, they may contaminate drinking water and wastewater. A typical example of a drinking-water borne infection is Hepatitis A which is transmissible through water in case of low hygienic conditions, e.g. water from wells can get contaminated by faeces. However, the cases of drinking water contamination in public water mains are rare and mostly of a local character only. Few years ago, one serious case was reported in Prague’s quarter Dejvice, when drinking water got contaminated by Noroviruses. This had been caused by a broken water pipeline and sewer with infected water [1].

2. Coronavirus - SARS CoV-2

The first news on the new virus related disease appeared towards the end of 2019 in China. It caused similar health problems as influenza. It has gradually spread worldwide and has not been eradicated to date [2]. The first information on the new virus arrived from a Chinese town of Wu-chan. Although the source was not known, local health authorities pointed at a local fish market as a likely source of the infection [3].

The epidemic quickly spread into other parts of China, particularly because of people’s travels in connection with the Chinese New Year. It also started to spread in Europe and other countries. As of January 30, 2020 the spread was proclaimed a public health emergency of international concern by WHO. This organization also announced the designation of the new coronavirus disease, i.e. Covid-19. The epidemic became global and as of March 11, 2020, WHO reclassified it as pandemic.
SARS CoV-2 virus belongs among coronaviruses which have positive single-stranded genomic RNA. Their name is derived from their characteristic surface, i.e. a lipid envelope, shaped liked a solar corona. The virus particle’s diameter is approximately 120 nm - see its structure in Figure 1 below.

![Virus particle structure](image)

**Figure 1.** Virus particle structure [4].

Human coronaviruses (HCOV) are respiratory pathogens and they are primarily transmitted by human contacts. The virus spreads through respiratory droplets when infected people cough, sneeze or even breathe. Infection is also possible through direct contact with contaminated surface which may stay contagious for several hours. The virus was also observed in infected patients’ faeces. However, the transmission of the infection was confirmed only in a part of infected people [5].

Since the end of 2019, SARS CoV-2 virus has gradually spread from China worldwide. The pandemic has affected practically all countries in three waves and the world is expecting a fourth one. To date, there have been over 214 million positive-tested people worldwide, in the Czech Republic we have had 1,686 million positive-tested people [6]. The waves occurred mainly in spring and autumn. The example from the Czech Republic in Figure 2 shows the times of the 3 waves so far.

![Covid-19 illness development in the Czech Republic](image)

**Figure 2.** Covid-19 illness development in the Czech Republic 24.5. 2020 – 23.8.2021 [7].
The decisive measure to eradicate the disease is vaccination. Effective vaccines were developed timely and vaccination has advanced. So far, over 50% population have been already vaccinated in Europe and the United States.

3. Coronavirus in water
When the SARS CoV-2 epidemic developed, there were questions about possible virus spread through water. Water treatment technologies use disinfection, during which bacteria and viruses are eliminated from the final drinking water. Chlorine and its compounds and ozone are applied for chemical disinfection, and UV radiation is used for physical disinfection.

According to [8], drinking water disinfection is more effective with bacteria than viruses, except for ozone which has a very high disinfecting efficiency in viruses. In their drinking water guidelines, the World Health Organisation also state that viruses are more resistant to free chlorine than bacteria [9]. However, the current research shows that SARS CoV-2 virus is very low resistant to chlorine disinfection. It is thus possible to eliminate potential water SARS CoV-2 contamination by chlorine [10]. This is because coronavirus belongs to enveloped viruses (with a protein envelope) and the degradation of the virus’s envelope leads to the loss of the receptor. This way, the virus stops to be infectious [11].

In the Czech Republic, the National Reference Centre for Drinking Water issued a statement on the coronavirus spread through drinking water, in which they provide information for public water mains operators. The statement considers the transmission of the virus into raw water (used for drinking water treatment) as unlikely [12]. The currently applied water treatment processes, such as coagulation, filtration and disinfection, eliminate coronavirus effectively. The experience with avian flu viruses and other SARS viruses show a high disinfecting effectiveness towards these viruses. The experience with SARS CoV-2 similar. The current water management practices need not change with respect to the Covid-19 pandemic [13].

4. Coronavirus and wastewater
During the SARS epidemic of 2003 in Beijing in China, the likelihood of virus transmission through wastewater from two hospitals was investigated. The viral genome was detected in the hospital wastewater back then, but was later eliminated by disinfection [14].

Similarly, when the current pandemic evolved, it was necessary to verify whether the infection may spread through wastewater. The research shows that as many 10 % of Covid-19 patients suffer from diarrhoea, which could cause a possible virus transmission through wastewater [15]. The research by Medemy in the Netherlands proved the occurrence of SARS CoV-2 virus genome in the wastewater sewer system. However, the prevalence of the virus in the wastewater could not be determined using the method applied [16].

Still, the transmission of the virus directly from the wastewater onto the population showed as unlikely. This is due to the wastewater treatment technologies, unfavourable conditions and retention time. Considering the CoV-2 virus sensitivity and wastewater treatment processes, only non-infectious viral fragments may be found [17].

The monitoring of SARS CoV-2 RNA in municipal wastewater has been considered as an option how to observe the spread of the epidemic. Such monitoring of the occurrence of SARS CoV-2 RNA was assumed to serve as a warning tool before Covid-19 outbreak. This assumption was confirmed by an experiment in six Dutch cities. Wastewater samples were observed for SARS CoV-2 RNA. The concentration of SARS CoV-2 RNA was studied during the period of 4 weeks. Samples were drawn from wastewater inflows into the municipal wastewater treatment plants. At the same time, the cumulative prevalence of Covid-19 was observed in the cities in question. The reported concentration of SARS CoV-2 RNA in the wastewater was compared with the cumulative prevalence of Covid-19 illness rates reported on a daily basis. The results showed that the monitoring of SARS CoV-2 RNA concentrations in the municipal wastewater may serve as an early-warning tool pointing at increased circulation of the virus in the population [16].

There is a number of papers that observe the occurrence and concentrations of SARS CoV-2 RNA in wastewater [18]. In the Czech Republic, a more extensive research on the occurrence of SARS CoV-2
RNA fragments was carried out in 38 wastewater treatment plants. The size of the wastewater treatment plants was from 2 000 to 100 000 population equivalent. Three wastewater treatment plants were bigger than 100 000 inhabitants equivalent. Based on the concentrations of SARS CoV-2 RNA, the results shall serve for the creation of an early-warning system prior to epidemic outbreak [19].

Another wider research on the occurrence of SARS CoV-2 RNA was carried out in the Prague’s sewer system and lasted for 8 months. Wastewater samples were drawn at 14 points in the interval of 2 weeks. The measured values were correlated with estimated active cases of Covid-19 illness rates. The results showed a good agreement between Covid-19 infection and content of SARS CoV-2 RNA in the wastewater samples from the major public wastewater sewer system. This way, results acquired from small sewers may help identify an isolated, local occurrence of positive cases of Covid-19 infection [20].

However, an epidemiologist in [21] warned that the interpretation of virus occurrence in wastewater is not unambiguous. Only 10 % of Covid-19 patients replicate the virus in their intestines. The majority of patients do not excrete the virus into the wastewater. The virus currently occurs in the population, and its identification in the wastewater need not bring any new information. For a higher predictive power of the data, more frequent observations would be needed. In addition, we have no idea about the future behaviour of the virus [21].

The European Commission also commented on the issue of wastewater testing for SARS CoV-2 virus. They invited the member countries to introduce national sentinel systems for SARS CoV-2 in wastewater since 1 October 2021. Although the recommendation is not binding, the system should collect data on SARS CoV-2 RNA in wastewater and focus on cities with over 150 000 inhabitants [22].

5. Conclusion
A wide range of data on Coronavirus in the aqueous environment has been collected in a rather short time. We know the structure of the virus, we know and apply methods to determine SARS CoV-2 RNA in water. It shows there is no evidence on the occurrence of the virus in the drinking water resources, and thus water purification plants need not change or modify their current technologies. However, the proved occurrence of SARS CoV-2 RNA in wastewater, which has been the subject of research, serves to develop and study methods how to predict and evaluate the course of Covid-19 epidemic in people from the contents of SARS CoV-2 RNA in their wastewater.

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