Environmental Impact and Countermeasures during the Global COVID-19 Pandemic

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Keywords: COVID-19, Environmental Pollution, Wastewater Treatment, Waste Disposal.

Abstract: Outbreak of the Coronavirus Disease 2019 (COVID-19) has been sweeping the world, which both changes our lifestyle and affects the environment. In this paper, environmental effects and countermeasures of COVID-19 has been evaluated. Negative effects of COVID-19 contain potential environmental risks of medical waste, lack of targeted testing indicators, potential risks of antiviral drugs antibiotics, while positive effects include reduced air pollution and improved environmental standards. Further, refining the detecting and discharging standards of wastewater to increase testing programs of hospital wastewater and rainwater treatment for SARS-CoV-2 RNA and its activity, as well as enhancing clinical waste disposal capacity because of the exposed problem of inadequate treatment system and insufficient capacity, are raised as the countermeasures to weaken the negative effects of COVID-19.

1 INTRODUCTION

In late 2019, patients caught SARS-CoV-2 could be found around the world. Because SARS-CoV-2 is highly contagious, the number of confirmed cases increased significantly in a short term and became a major public health emergency around the world (Guan et al. 2020). According to the World Health Organization, as of August 16, 2021, there were 207, 173, 086 confirmed cases worldwide. (WHO Coronavirus (COVID-19) Dashboard 2022).

The incubation period of Coronavirus Disease 2019 (COVID-19) is about 1-14 days, and it is characterized by fever, fatigue, and dry cough. Besides, some patients are accompanied by symptoms such as nasal congestion, runny nose, sore throat and diarrhea. (Shao et al. 2020) Mild patients present with low-grade fever and mild fatigue without manifestations of pneumonia, while severe or critically ill patients present with moderate to low fever, or no pronounced fever. (S, Z et al. 2020). There are about 215 countries where COVID-19 patients have been found to date. At the end of January 2020, WHO declared the COVID-19 outbreak a Public Health Emergency of International Concern (PHEIC) and on 11 March 2020 it was declared a global epidemic. (world health organization 2019).

Physical isolation, personnel control and international travel restriction affect lives both at home and abroad. Consumption and the pattern of trade in services based on offline contacts have also led to the disruption of the global industrial chain. After the unremitting efforts of the governments and people, the rapid growth of the number of cases in several countries was quickly under control. By contrast, the PHEIC is far to end all over the world. At present, the Novel coronavirus mutant strain Delta, which is circulating in the United States and other countries, has recently affected many provinces in China. It spreads at an amazing speed and has stronger self-replication ability. COVID-19 has had enormous influence on the politics, economy, environment, and so on, of all countries in the world. Further, according to the WHO “COVID-19 Clinical Management: Living Guidance”, among the general

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Huang, Y., Gao, G., Chen, S., Guo, Y. and Duan, L.
Environmental Impact and Countermeasures during the Global COVID-19 Pandemic.
DOI: 10.5220/0011165100003444
In *Proceedings of the 2nd Conference on Artificial Intelligence and Healthcare (CAIH 2021)*, pages 58-63
ISBN: 978-989-758-594-4

treatment measures for COVID-19 patients, the treatment of antiviral drugs (α-interferon, lopinavir, ritonavir, ribavirin, chloroquine phosphate and arbidol) is an important part. To deal with the infection problem of severely ill patients, antibiotic treatment is needed as a supplement (Guan et al 2020). In addition, In the stool of COVID-19 patients, we detected the SARS-CoV-2 virus. What is mentioned above means that the sewage in the hospital is very likely to be contaminated by antiviral drugs, antibiotics and SARS-CoV-2 (Holshue et al. 2020). Therefore, it is urgent to assess the potential risks of sewage and medical waste generated by hospitals admitted during the COVID-19 epidemic. To date, more than 30,000 papers have been reviewed related to COVID-19, covering countermeasures (Vatcheva, Sifuentes, Oraby, Maldonado, Huber, Villalobos 2021, Rocklov, Sjodin, Wilder-Smith 2020), environmental impacts (Ambika, Basappa, Singh, Gonugade, Tholiya 2021, Ankit, Kumar, Jain, Deovanshi, Lepcha, Das, Bauddh, Srivastava 2021), and so on. Among these, the influence of COVID-19 on the environment must arouse our intention. Based on the current prevention and control situation of COVID-19, this paper puts forward the research focus and direction in the future.

As of the end of this article, only 6 months after reaching 100 million cases, the cumulative number of COVID-19 cases worldwide exceeded 200 million. More than 4.2 million new cases and more than 65,000 new deaths were reported, this week alone, a slight increase from the previous week. (Figure 1) (world health organization 2021).

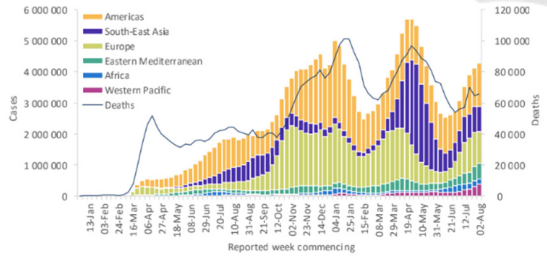

Figure 1: COVID-19 cases reported weekly by WHO Region, and global deaths, as of 8 August 2021.

2 ENVIRONMENTAL EFFECTS OF COVID-19

2.1 Negative Effects

2.1.1 Potential Environmental Risks of Medical Waste

The production of medical waste has increased dramatically, with the outbreak of COVID-19, as showed in Figure 2. At the peak of the epidemic, hospitals in Wuhan generated six times more medical waste than in the early days of the epidemic. The daily production of medical waste is roughly equivalent to the weight of an adult blue whale, which can reach 240 tons (Calma 2020). Further, as the development of the COVID-19 epidemic, the production of medical waste has increased sharply. For example, the rapid consumption of masks, gloves, goggles, insulation and protective clothing has contributed to the explosive growth of global medical waste (Yue et al. 2015). According to WHO, 76 million gloves, 89 million masks and 1.6 million goggles need to be used for COVID-19 treatment, and this growing demand has created a huge waste (Teymourian, Teymoorian, Kowsari, Ramakrishna 2021).

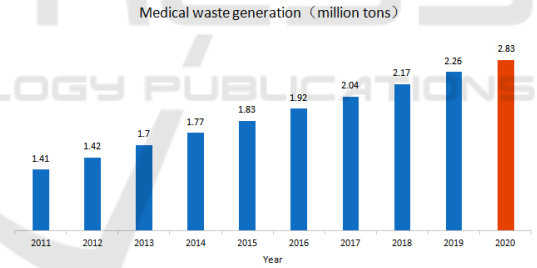

Figure 2: Medical waste generation in China.

2.1.2 Lack of Targeted Testing Indicators

There are differences in the sewage generated by various departments in the hospital. The sewage discharged from infectious wards, laboratories, operating rooms, intensive care units, intestinal outpatient clinics, medical device disinfection rooms, and disposal rooms may be contaminated by SARS-CoV-2. Hospital sewage, especially sewage from the treatment of infectious disease patients, needs to be treated strictly before discharge because it contains various microbial pathogens and viruses (Liu, Zhou, Chen, Zheng 2010). Coronavirus, however, is the most difficult of human respiratory viruses to detect, and its presence is not detectable in

most conventional virology diagnostic laboratories (Mackie 2003).

2.1.3 Potential Risks of Antiviral Drugs and Antibiotics

Antiviral drugs are mainly used to treat diseases caused by a viruses. Because they are not fully absorbed by the body, they are detected in the wastewater treatment system after a series of digestion and metabolism (Jain, Vyas, Pandit, Dalai 2013). Nevertheless, since wastewater treatment systems cannot completely remove antiviral drugs, there are certain risks to the environment, threatening ecosystems and human health. (Fick, Lindberg, Tysklind, Haemig, Waldenström, Wallensten, Olsen 2007).

Antibiotics have been widely used to protect human health and promote livestock and poultry breeding. Although the "New Corona virus Pneumonia Diagnosis and Treatment Plan (Trial Seventh Edition)" issued by the National Health and Medical Commission of China does not mention specific antibiotic treatment measures, antibiotic treatment is needed as an auxiliary when dealing with infection problems in severely ill patients. According to Zhong et al. (Guan et al 2020), 57.5% of the 1,099 COVID-19 patients studied received intravenous antibiotics. Most antibiotics are water-soluble, about 30% to 90% of antibiotics enter the environment in the form of excrement, posing a potential risk to human health and the safety of the ecosystem (Wang et al. 2016). At the same time, microbial resistance caused by antibiotics is difficult to eliminate from the environment due to its persistence and horizontal gene transfer. It has been listed by the WHO as one of the three major threats to human health (Zhu, Johnson, Su, Qiao, Guo, Stedtfeld, Hashsham, Tiedje 2013).

2.2 Positive Effects

2.2.1 Reduced Air Pollution

Over the past few months, scientists at the Royal Netherlands Meteorological Institute have been using Tropism instrument on the Copernicus Sentinel-5P satellite to monitor air pollution in Europe.

Figure 3 shows nitrogen dioxide concentrations from March 13 to April 13, 2020, compared with the average concentrations in March-April 2019. Milan and Rome fell by around 45%, while Paris saw a sharp drop of 54% - in line with strict containment measures in Europe as a whole. (ESA 2020).

The decrease in data is mainly due to strict regulations on nitrogen dioxide in the European transport and industrial and energy sectors. Excluding over large cities where human activity has not yet fully resumed, pollutant concentrations may return to near normal levels from July to August 2020(ESA 2020).

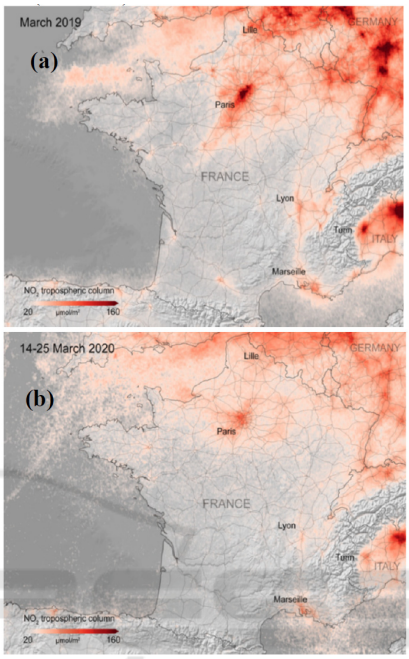

Figure 3: Nitrogen dioxide concentrations over Europe in 2019 (a) and 2020 (b) (ESA 2020).

China has imposed strict traffic restrictions and self-quarantine measures to prevent the further spread of SARS-COV-2. These measures have led to significant changes in air pollution, with nitrogen dioxide concentrations in Wuhan and China reduced by 22.8 µg/m3 and 12.9 µg/m3, respectively (Zambrano-Monserrate, Ruano, Sanchez-Alcalde 2020). Figure 4 shows NO_2 values across China from January 1-20, 2020 (before epidemic prevention) to February 10-25 (during epidemic prevention period).

According to NASA scientists, the reduction in NO_2 concentrations was particularly pronounced near Wuhan, but eventually spread across the country (NASA 2020).

2.2.2 Improved Environmental Standards

In response to deal with the tremendous growth in clinical waste generation, several international organizations, such as the World Health Organization, the Basel Convention, the European Centre for Disease Control and Prevention and the

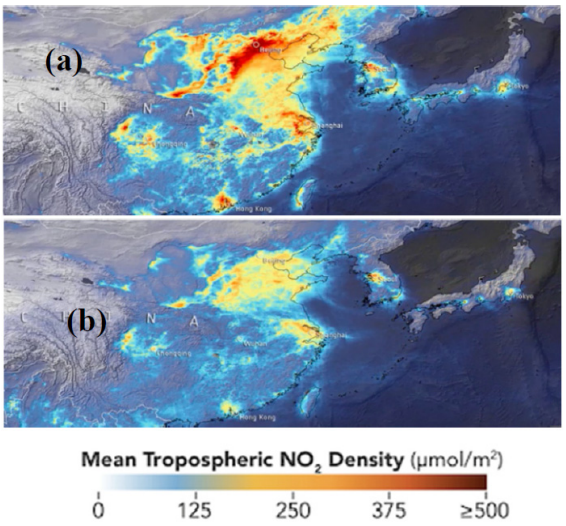

Figure 4: NO2 emissions in China before (a) and after (b) lock down(ESA 2020).

United Nations Environment Programme, have issued guidelines or reports on the proper management of medical waste and household-generated waste.

Some governments already have national legislation for medical waste. In addition, many countries immediately issued new policies, guidelines, and programs to address the outbreak of COVID-19. On February 24, 2020, China released a work plan for comprehensive treatment of medical waste, requiring every prefecture-level city in China to build at least one standard medical waste disposal factory by the end of 2020. The plan also requires that by the end of June 2022, every county in China should have established a complete system for medical waste collection, transfer and disposal, so as to completely solve the problem of insufficient medical waste disposal capacity nationwide, and finally realize smooth, safe and reliable disposal (Liang, Song, Wu, Li, Zhong, Zeng 2021).

3 COUNTERMEASURES

3.1 Refining Waste Water Testing and Discharge Standards

At present, China has formed a relatively complete hospital sewage detection and treatment system. Take Wuhan as an example, the newly built Huoshenshan Hospital and Leishenshan Hospital both have complete sewage treatment systems. Using the mode of sewage diversion discharge in contaminated and clean areas, each enters the pre-sterilizing pool independently to avoid the spread of the virus from the contaminated area to the clean area through the drainage system, the process is shown in Figure 5. Guo et al. (Guo et al. 2020) tested the air and surfaces of Huoshenshan and Leishenshan hospitals, examined the distribution of SARS-CoV-2, and found that the positive rate of SARS-CoV-2 aerosol transmission near the outlet was 35.7%, respectively, ICU medical staff shoe sole positive rate of 50%, medical staff walking back and forth resulted in the pharmacy floor positive rate of 100% and the locker room floor has 3 weak positive results. The results of this study suggest that the virus may spread outdoors through exhaust vents and the soles of medical staff, with a certain probability of entering the rainwater system.

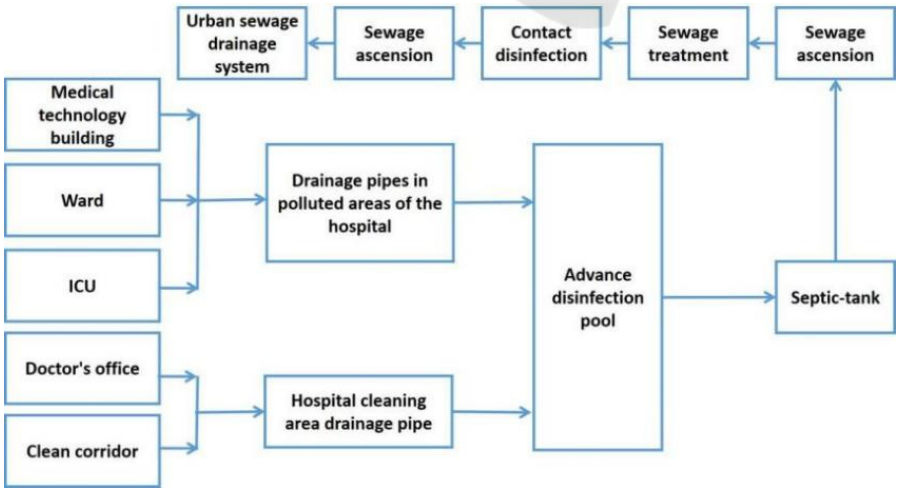

Figure 5: Waste water treatment processes of Huoshenshan Hospital and Leishenshan Hospital.

However, at present, China's medical sewage discharge implementations, including Hospital Sewage Treatment Engineering Technical Specifications (HJ 2029-2013) and Medical Institutions Water Pollutant Discharge Standards (GB 18466-2005), have not yet put forward specific requirements for anti-viral drugs and antibiotic concentrations, and need to be timely assessment and update. At a critical time for epidemic prevention and control, it is recommended to increase these testing programs before and after COVID-19 patients receive hospital sewage and rainwater treatment, especially for RNA and its activity in SARS-CoV-2. In addition, it is recommended to strengthen the disinfection of medical sewage and hospital rainwater to ensure the complete eradication of SARS-CoV-2 and its RNA.

3.2 Improving Medical Waste Disposal Capacity

When the COVID-19 broke out, the production of medical waste increased dramatically, and the city of Wuhan increased by 370%, The local medical waste disposal capacity is seriously inadequate, the relevant departments quickly work overtime to install new high-temperature steam sterilization machines and run at full capacity every 24 hours (except during maintenance), and continue to remove the medical waste stock (Klemeš, Fan, Tan, Jiang 2020). In addition, Hubei Province makes full use of medical waste disposal capacity of Wuhan's nearby cities to accelerate the disposal of excessive medical waste in Wuhan. China’s medical waste disposal facilities have been running smoothly since March 10, 2020, and can dispose the daily generated medical waste (Zhou, Chen, Li, Guo, Liu, Yang 2018).

Although strengthen regional collaboration and strict medical waste transfer processes is helpful to the medical waste disposal, it is necessary to speed up the improvement of the overall treatment capacity of medical waste in China, due to the exposed problem of inadequate treatment system and insufficient capacity. At the same time, the potential risk of virus transmission in the process of medical waste transport is worthy to pay attention. The organization, classification, packaging, registration, storage, protection, transshipment, disposal and eventual whereabouts of medical waste should be standardized management to form a long-term mechanism to reduce the environmental and occupational risks of the whole process of medical waste disposal.

4 CONCLUSIONS

Measures including closed management, establishing hospitals, restricting mass gathering are of significant value on controlling the spread of COVID-19. Both negative effects, containing potential environmental risks of medical waste, lack of targeted testing indicators, potential risks of antiviral drugs antibiotics, and positive effects, including reduced air pollution and improved environmental standards are generated from the COVID-19. Further, refining the detecting and discharging standards of waste water as well as enhancing clinical waste disposal capacity are raised as the countermeasures for further beat COVID-19.

ACKNOWLEDGEMENTS

We gratefully acknowledge the financial support from Natural Science Foundation of China (52070127), Shanghai Natural Science Foundation (20ZR1421100), Cultivation discipline fund of Shanghai Polytechnic University (XXKPY1601), Key Laboratory of Eco-geochemistry, Ministry of Natural Resources (ZSDHJJ201902).

COMPETING INTERESTS

The authors declare that they have no competing interests.

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