

# Suggestion for a long-term effective disinfection to eliminate the COVID-19 epidemic

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Omicron;

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Ozone disinfection;

Hydrogen peroxide.

## Abstract

The COVID-19 has tyrannized the world for almost 3 years and has seen no signs of decline. The mutant Omicron is more infectious and can be transmitted and spread through many channels. As long as there is any residue, the virus can quickly revive and spread if there is no intervention. In addition to targeted prevention and control and vaccination, we also need an ecologically safe and long-term effectiveness virus-eradication program to inhibit the biochemical activity of the virus and stop the spread of the epidemic until the complete elimination of COVID-19. By analyzing a number of empirical data of ozone disinfection, this paper reveals that the extensive and massive application of ozone and hydrogen peroxide disinfection technology is an effective and powerful method to eliminate COVID-19. The novel coronavirus is highly sensitive to the trace ozone in the atmosphere, and a disperse ozone of concentration  $0.6 \text{ mg/m}^3$  in the air can make COVID-19 lose infectivity. Therefore, for public places where people gather, such as subway, bus, train, airports, stations, schools, office buildings, shopping malls, hospital, etc., a long-time air disinfection by ozone through centralized air conditioner can effectively stop the human-to-human transmission of the virus. For heavily infected cities, regular aviation spraying of diffuse hydrogen peroxide to disinfect the ambient air can obviously deplete and inhibit the virus. As long as the above disinfection method is implemented for some time, the COVID-19 will be controlled until it completely disappears.

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## Introduction

Since the first case of COVID-19 patient appeared in Wuhan, Hubei Province in December 2019, the novel coronavirus has become a catastrophe for mankind for its rapid transmission, easy strain mutation and damage to the central nervous system. As of May 21, more than 500 million infections and more than 6.27 million deaths had occurred worldwide. COVID-19 has tyrannized for nearly 3 years, now the global scale has not decreased, but has a deteriorating trend, the virus variant strain Omicron has more infectious and higher antibody tolerance. In addition to human, the virus can also infect birds, poultry, dogs, mice and about 30 kinds of animal. As long as there is a little residue, in the absence of intervention, the virus will quickly resurgence, rapid spread and hardly to prevent. The prevention and control of COVID-19 have exceeded the capacity of medical resources in some countries and are out of control. How to effectively inhibit the activity of the virus for a long time, contain the spread and spread of the epidemic, and continuously deplete the virus until the complete elimination of COVID-19 is a topic that all mankind needs to study carefully. In addition to precise prevention and control as well as universal vaccination, we also need an ecologically safe and long-term effective strategy of disinfection.

A large number of clinical treatments show that COVID-19 has serious complications and sequelae. The novel coronavirus infected patients show symptoms of fever, dry cough, dyspnea, and pneumonia, as well as gastrointestinal symptoms and cardiovascular system dysfunction. In addition, patients also developed neurological and psychiatric symptoms, such as loss of taste and smell, impaired consciousness, encephalitis, and acute cerebrovascular disease [1]. An investigation published in Nature in March revealed that the novel coronavirus attaches to the central nervous system cells through synaptic glycoprotein interacting with the host ACE2 receptor, invading the central nervous system and causing brain atrophy in some patients [2]. By comparing brain images, it was found that some COVID-19 patients' brains were significantly changed, and the areas governing memory, smell and cognitive ability were reduced, and the brain volume was reduced by 0.2~2%. COVID-19 has about ten times the fatality rate in elderly patients than influenza. Therefore, the opinion of "peaceful coexistence with COVID-19" is infeasible, and we have to thoroughly eliminate the novel coronavirus.

### Epidemic prevention effect of ozone

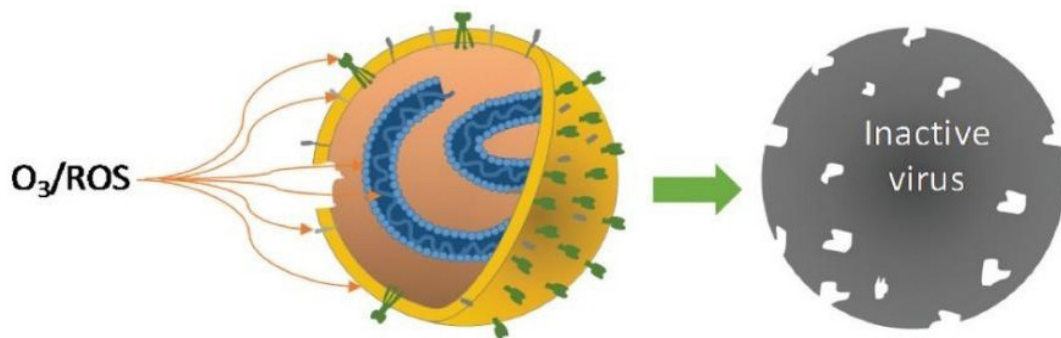
Ozone  $O_3$  is an allotrope of oxygen  $O_2$ , an unstable, fishy and light blue gas. At room temperature, the half-life of ozone in the air is 3~16 hours, which is highly related to the humidity and ozone concentration. The half-life of ozone in 20°C water is only about 16~25 minutes. Ozone is lively in chemistry, which is a wide spectrum of efficient disinfectant, and has a strong oxidation, fast reaction speed, has a very good disinfection, sterilization and deodorization effect. Ozone attacks proteins and lipids in the viral spiking synapses and envelope, disrupting viral integrity and thus inactivating the virus. Ozone chemically reacts with the bacterial cell wall and proteins therein, rapidly entering the cell after destroying and resolving the cell wall, oxidizing intracellular enzymes, RNA or DNA, thereby killing bacterium [3].

Nowadays, the technology and process of ozone production have been very mature, the industrial method to product ozone is mainly corona discharge method. Ozone generator produces ozone with dry air or oxygen as raw material, used for disinfection and purification of air, articles and water. Compared with other disinfection methods, ozone disinfection has no harmful residue and secondary pollution, air disinfection concentration distribution is uniform without dead angle, convenient and fast to use. Ozone has been widely used in indoor air disinfection, tap water disinfection, breeding farm epidemic prevention, sewage deep treatment and other occasions.

General occasions disinfection air, ozone concentration 1~2 mg/m<sup>3</sup>, relative humidity ≥60%, lasting 30~60 min, the killing rate of various bacteria can reach more than 99%. Ozone can simultaneously degrade sulfur dioxide, nitrogen oxide, volatile phenol, formaldehyde and other pollutants in the indoor air. After 30 min 0.3 mg/m<sup>3</sup> ozone disinfection, the titer of Hepatitis B Surface Antigen (HBsAg) decreased from 1:256 to 1:64. After 30 min 13.6 mg/m<sup>3</sup> ozone disinfection, the inactivation rate of HBsAg exceeded 99.99%, destroying 100% of the antigen of Hepatitis A Virus (HAAg). Ozone is sterilized about 300~600 times faster than chlorine agents.

At present, ozone disinfection has been widely used in the prevention of livestock and poultry disease, through ozone disinfection farm air and drinking water for livestock to achieve epidemic prevention effect. After more than three years of testing, [4] has verified the unique role of ozone disinfection in animal disease prevention and epidemic prevention. Ozone spreads to every corner of the pig pen and chicken coop in a short period of time, quickly kill viruses, bacteria, fungi and parasites and other diseases, effectively prevent the infection and transmission of respiratory diseases, eliminate odor and improve the environment. Ozone treatment of drinking water can reduce or eliminate the occurrence of gastrointestinal diseases in livestock and poultry, enhance livestock and poultry immunity, and can improve the feed conversion rate. Ozone disinfection has been applied in livestock and poultry farms in most provinces in China.

There are some studies on the application of ozone in COVID-19 prevention and control. [3] revealed that ozone attacks the novel coronavirus spike synapses and envelope proteins, destroying the integrity of the virus and thus inhibiting viral infection (see Figure 1). [5] shows that ozone can oxidize and inactivate the virus while stimulating the immune system in patient cells and body fluids, useful in the early COVID-19 infection stage. Ozone can improve gas exchange, reduce inflammation, as well as hypoxemia and multiple organ failure. [6] shows that drug treatment can achieve enhanced efficacy by injecting intravenous ozone water as an adjuvant treatment. [7] tested the effectiveness of ozone disinfection apparatus on disinfecting bed units in COVID-19 wards. The surfaces of bed sheets, mattresses, cores, covers, pillow cores and pillow covers used by COVID-19 patients had viral contamination. Some bed units tested positive for viral nucleic acid, and no specimens with positive novel coronavirus nucleic acid were detected after disinfection by the ozone disinfection apparatus.



**Figure 1:** Potential attack sites when viruses are inactivated by ozone.

Exploring the relationship between the epidemic spread and environmental factors helps better understanding of the characteristics of COVID-19 and develop long-term control strategies for the epidemic outbreak, [8] computed the correlation between pollutants in atmosphere and the infectivity of COVID-19 in Chinese cities. According to the air pollutant monitoring data of 1642 stations of China National Environmental Center, the relationship between the basic reproduction number  $R_0$  of COVID-19 and each type of pollutant was studied by regression analysis. From December 10, 2019 to February 29, 2020, in 154 cities the COVID-19 outbreak were detected, namely the basic reproduction number in these cities  $R_0 > 1$ , and  $R_0 \approx 2.5$  in Wuhan was the largest.

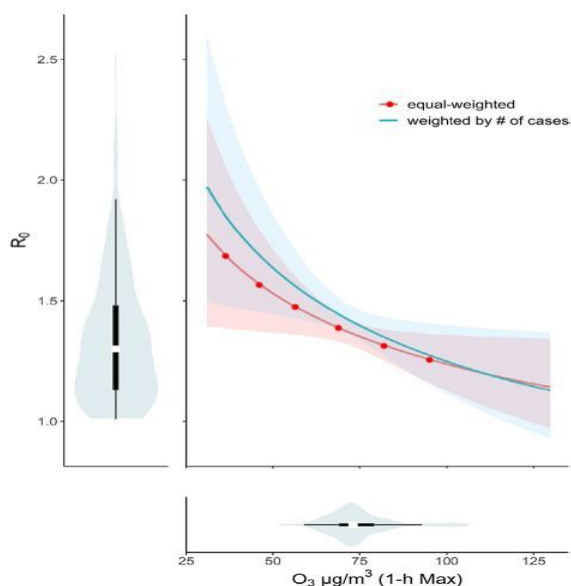
The maximum daily one hour (1h) ozone concentration in the 154 cities ranged from  $51.6 \sim 106.7 \mu\text{g}/\text{m}^3$  with an average of  $73.1 \mu\text{g}/\text{m}^3$ . Studies found a significant negative correlation between  $R_0$  of COVID-19 and the 1h maximum ozone concentration daily, but little correlation with other contaminants. Figure 2 shows that the infectivity of COVID-19 decreases rapidly as the concentration of ozone in the ambient air increases. Thus, when the environmental ozone concentration exceeds a certain critical value, the reproduction number  $R_0$  of the COVID-19 virus will decrease as an exponential function of the ozone concentration, that is, the infectivity and transmission capacity of the virus will decrease exponentially with increasing the ozone con-

centration. In fact, Nature produces ozone through lightning to purify the ecological environment. After every thunderstorm, the bacteria and viruses in the atmosphere are greatly reduced, and the air becomes particularly fresh.

### Long effective strategy in epidemic prevention

Since the outbreak of COVID-19, the virus has been mutated constantly and showing stronger and stronger momentum. The basic reproduction number has developed from  $R_0 \sim 3$  of COVID-19 to  $R_0 \sim 10$  of Omicron. It is impossible to complete eliminate the novel coronavirus in a short time. Now the spread of the virus has not encountered any barrier, it can be transmitted with air and goods, or through about 30 common animals, so it is incomplete to focus the prevention and control measures only on positive infections. Some studies believe that the novel coronavirus is transmitted by aerosols in the air within a radius of 2m [9], and other studies believe that the virus has a very short half-life, with only three hours in the air and less than 3 days on surfaces of goods [10], but the actual transmission process of the virus may be more complicated than the experimental conditions. From [11] we learn, the novel coronavirus variant Omicron was found in wastewater of several communities in November 2021, at least a week before the clinical detection of the first omicron infection in the United States on December 1. Thus, the global prevention and control situation of COVID-19 is still grim, and there are many uncertain and unknown factors, so it is difficult to thoroughly eliminate the viruses in a short term.

Ecosystems can rarely annihilate a creature in a short time, but a war of attrition. In order to control the development of the epidemic safely and long-term effectively, we need to come up with a comprehensive and systematic epidemic prevention plan. If the biological activity of COVID-19 can be suppressed, weaken its infectivity and maintain the situation of "human is stronger than the virus" for a long time, then it will only take two or three months before the virus will automatically disappear and the COVID-19 will go to end. As can be seen from Figure 2, trace amounts of ozone in the air can greatly weaken the infectivity of COVID-19 and achieve the purpose of long-time depletion of the virus. If the ozone concentration in the air is kept  $\geq 0.5 \text{ mg}/\text{m}^3$ , then COVID-19 almost lost infectivity. Therefore, ozone disinfection in public places with highly concentrated floating population, such as stations, shopping malls, buses, subways and train, will greatly reduce the risk of the spread of the epidemic. Because the ozone gas is difficult to preserve, it is impossible to use ozone to extensively disinfect the atmosphere in heavily infected cities. Hydrogen peroxide is a broad-spectrum disinfectant with similar properties of ozone, which also has the advantages of fast bactericidal effect, strong



**Figure 2:** Correlation between the reproduction numbers  $R_0$  of COVID-19 and the 1h maximum ozone concentration in the atmosphere.

bactericidal ability, small irritation, low corrosion, easy gasification, and no residual toxicity [12]. Hydrogen peroxide of high concentration is easy for production and preservation, and has been widely used in industries, environmental protection and medical production. For cities with severe infection and already out of control, regular aviation spraying of hydrogen peroxide should be an economically feasible means of disinfection.

For large-region and large-dose disinfection actions, environmental protection is a key factor to be considered, and many chemical disinfectants will pollute the environment and are unacceptable. During the outbreak in Wuhan, more than 5,000 tons of chlorine-containing disinfectant were used in urban disinfection in the first three months, polluting the water body to some extent [23]. The monitoring data of Wuhan from February to March 2020 showed that the highest value of residual chlorine in the covered water of some lakes reached 0.4 mg/L. If it occurs in cities with less water resources, the problem of water pollution will be even more serious.

Hydrogen peroxide and ozone are environmentally friendly products that are also cheap and can be obtained easily. Considering various factors, hydrogen peroxide and ozone should be the best choice for the epidemic prevention and control. The safety tolerance value of ozone concentration in the working environment is 0.3 mg/m<sup>3</sup>, and the highest ozone concentration that people can bear for long time is about 2 mg/m<sup>3</sup>.

Therefore, the ozone concentration to deplete the virus should be set as 0.6~1.0 mg/m<sup>3</sup> in public places where the crowds gather. This concentration can either effectively prevent the spread of the virus, or will not harm human health.

To disinfect the air in public places, ozone can be released through the duct of air conditioner, and the relative humidity of the air is adjusted about 70%. In this case, the disinfection effect is the best. Centralized air conditioner and ventilation system is widely used in all kinds of public places, due to its structural characteristics and health management measures, it is easy to cause air pollution and bacteria exceeding the standard. Some sampling and testing in many public places shows that many air quality of centralized air conditioners is not up to standard [13]. Therefore, the mandatory provision to install ozone disinfection apparatuses in centralized air conditioning systems will be a measure of twofold purposes: regular disinfection to ensure air quality in peacetime, and running at full capacity to nip the epidemic in the bud when an epidemic outbreak.

## Conclusions

Ozone and hydrogen peroxide are both broad-spectrum high-efficiency disinfectants and green products, and the decomposition products are oxygen and water with few residual side effects. The author once produced industrial ozone generators and also provided ozone generator of air disinfection for the breeding farm, so I knew some professional knowledge and practical application. The author has been using the small ozone generators at home. For children, such small ozone generator has a good effect on preventing influenza, inhibiting milk tinea and skin diseases. If you have just caught a cold and started sneezing, breathing the ozone air produced by the home ozone generator soon for 1 minute can prevent and heal the cold. The method may also be effective for new infections of COVID-19.

Because the novel coronavirus is a highly contagious and difficult to prevent super-virus, it is difficult for humans to wipe it out in a short term. Therefore, it is crucial to introduce a long effective inhibitive mechanism for the virus in the existing prevention and control systems. As long as the basic reproduction number  $R_0$  can be controlled less than 1/2, it is only a matter of time to completely eliminate the novel coronavirus. From the above analysis, we find that ozone disinfection is a method of long-term effectiveness to prevent and control COVID-19, and is a powerful means to reduce the infectivity and to deplete the virus. There are now many kinds of epidemic outbreaks around the world, and ozone and hydrogen peroxide are safe, powerful and economical disinfectants for almost all epidemics, therefore they deserve extensive application.

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