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Research Article

Air Pollutants and Viral Transmission

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Abstract: Viral infection, especially respiratory viral infection (RVI), is currently one of the infectious diseases with the highest mortality, and the hospital admissions of viral infection rises every year particularly in the developing countries. Researchers currently suspect that there is a certain correlation between levels of air pollution and the ease of viral transmission. In most cases, the hospital admissions of airborne diseases show a positive correlation with the level of air pollutant in that area. Several reasonable explanations for this association have been given based on observations, but none of these theories has yet been well justified, and more researches have to be done. The aim of this article is to discuss the correlation between level of air pollution and the ease of viral transmission, the possible causes of this association, including the physical traits of air pollutant trapping viruses, and the reduced amount of virus-killing rays in sunlight due to air pollution, to offer possible solutions to lower incidence rate of viral infections, and to attract more attentions on exploring this correlation.

Keywords: Viral infection; Airborne diseases; Air pollutants; Particulate matter; Sunlights

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1 Introduction

Viral infection is currently one of the diseases with the highest morbidity and mortality. Re-searchers now suspect the incidence rate of viral infection is related to the rising level of airborne pollutants in cities. Since airborne-transmitted viral infections like pneumonia represent one of the main causes of death in children younger than the age of five years in developing countries, and since the level of air pollution is still rising, it is important to figure out away to lower the incidence rate of RVI[1]. Thus determining the association and understanding the influence fac-tors in viral transmission with regard to air pollutants would be a great help. Although several studies have been done, this association and its causes are still largely unknown, and more data is needed for further research. The aim of this article is to focus on the association between levels of air pollution and the ease of viral transmission, the two possible causes of this relationship, and the possible methods, like monitoring air quality, combining air pollution index with hospital admission data, processing waste from factory production, taking special care of the susceptible population, to lower the incidence rate of airborne diseases, based on the knowledge of this cor-relation, and to call on more studies on this association.

2 Determining the Association

The association between air pollution and viral transmission has been studied for some time and people have not yet got a definite answer. The main air pollutants causing viral infections include carbon monoxide (CO), lead, nitrogen dioxide (NO_2), particulate matter (PM), ozone (O_3), and sulfur oxides (SOx)[2], as well as some indoor air pollutants. All of these have a possibility to af-fect the ease of viral transmission.

The types of viral infections humans get from airborne transmission are usually respiratory viral infections or a few other diseases like cerebrospinal meningitis. These diseases have shown evident

seasonalities, and the incidence rate of airborne infections is generally higher in develop-ing countries than that in the developed world. The patterns indicate a relationship between the level of pollutants and the ease of viral transmission.

Specifically, pathologists in China have found that microbes associated with human infections, such as Pseudomonas aeruginosa, have a positive correlation with pollutant concentration for both PM2.5 and PM10 samples (adjusted $P<0.05$), and Stenotrophomonas maltophilia has a positive correlation with the pollutant concentration in PM10 samples, so do most of other bacte-ria[3]. Correspondingly, the hospital admissions of RVI generally peaks in winter and early spring, when the cold and dry air and other meteorological conditions make haze happen frequently. Al-though the link with viruses is not mentioned here, it is possible that the viruses responsible for airborne viral infections also have a positive correlation with ambient pollutants. Again in the very same study, the patterns from different areas at different time periods vary, and the positive association is not always true. Long-term observations and more data need to be collected in the future to further prove this positive relationship found.

3 Seeking for the Causes

Now that an impact of pollution level on viral transmission is known to exist, and it is likely to be a positive correlation, the causes behind this relationship should be explored. There are a few possible conjectures, but none of the explanations has been proved to be true.

One explanation is that the traits of particulate matters (PMs) make them more attachable to pathogens, and thus they carry more viruses into the respiratory tract. PMs, including PM2.5 and PM10, and other pollutants from combustion of biomass rises rapidly along with the fast devel-opment of industry. This exacerbates air pollution and triggers haze, especially in the cold and dry winter days. Also, compared with the coarser particles, the fine particles named PM2.5, which has a diameter no longer than 2.5 um, are smaller in size, larger in [relative] surface area, and more easily transported, and these features make them more easily attached to toxic and harmful substances, like heavy metal particles, and pathogens[4]. Thus, PM becomes natural ve-hicle of viruses. With a higher level of PM2.5, which could penetrate deeply into the lungs, the transmission of virus becomes easier.

Another possible explanation for a promoted viral transmission in polluted areas is that haze formed by PMs blocks, absorbs, and reflects much of sunlight that could have reached the ground. Although essentially all ultraviolet C rays, which is responsible for killing pathogens, are naturally blocked by the atmosphere even in a sunny day, experiments indicate that living bacte-rial taxa that can be inactivated following changes in local abiotic conditions, and that the bacte-ricidal potential of ordinary window filtered sunlight may be similar to ultraviolet waves answers across dosages[5]. The reason of this is that the rays with a short wavelength, including ultraviolet rays, have energy strong enough to harm the nuclear acid and protein of pathogens, thus inhibit-ing their multiplication, and even killing them. Given the proved inactivation of bacteria in sunlight, a possible theory based on the same knowledge arises: the sunlight reduced in hazy days provides a chance for ambient viruses to multiply, and thus, with more viruses in the air, the likelihood of airborne transmission significantly increases. However the exact bactericidal effect of sunlight still need more testing, and the difference in eliminating bacteria and viruses with sunlight is still largely unknown.

Despite the two possible explanations for the positive correlations between levels of airborne pollutants and viral transmission, there is no enough evidence justifying they are true, especially when the studies are mostly focused on short-term effects only. There can be more than one fac-tor causing this association, too. Serious air pollution mainly happens in the developing world, and problems like haze and photochemical smog have just caught researchers' attention in recent years. More studies need to be done on this problem to draw a right conclusion.

4 Approaches to Lower the Incidence Rate

Since viral infections can cause severe morbidity and mortality, it is important to lower the incidence rate of them. Now that researchers found the ease of viral transmission may be posi-tively correlated with the levels of airborne pollutants, measures could start with the air pollution.

The association between levels of pollution and the ease of viral transmission remained unnoticed for many years, and up until today there is still not enough researches done. So more scientists and research groups need to be involved in. Experts should keep monitoring the air quality, report it to the public on various platforms, and give warnings if the level of pollutants goes high in order to remind people of the health risks. Besides, studies of short-term effects of pollutants are now being done by several research groups, but the long-term impacts of air pollution on vi-ral transmission should also be explored. Long-term monitoring of air quality could provide pre-cious and reliable data for future studies. The data used in future studies should include the pol-lution index and the hospital admission numbers, so that the association can be comprehensively understood. In the severely polluted countries, researchers could construct mathematical models based on these data collected, and perform some quantitative and qualitative analysis, in order to better determine the local epidemiological patterns and prevent the epidemics. Also, government, organizations, and companies could take measures to reduce or to purify the pollutants produced, so that the air quality will benefit. Finally, the susceptible population to viral infections, like young children, pregnant women, and elderly people, should be well protected, especially when the air quality is bad.

5 Summary

Severe air pollution mainly happens in the developing world, and it has not got enough atten-tion from the scientists. The airborne-transmitted viral infection can be fatal, so it is important to know its association with levels of air pollutants as it helps us determine the local ecological pat-tern. The majority of current studies has observed a generally positive correlation between levels of air pollution and population of pathogenic microorganisms, but exceptions are also mentioned. They indicate that the physical structure of PM or the pathogen-killing effect of short-wavelength sunlight that reaches the Earth might be the reasons behind the association, but there has not been enough evidence gathered. There are flaws in the studies, and the patterns can vary from area to area. Humans could keep monitoring the air quality, combine the epidemiological studies with pollution research, analyze the data, and build mathematical models to determine the local viral infection patterns. Warnings on days with bad air quality, approaches to cut air pollu-tion, and special care to the susceptible populations could be good ways to reduce the incidence rate of RVI.

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