

The Effect of Air Pollution on the Immune System

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Abstract: Air pollution has become a serious problem, the pollutant mainly came from industrial and vehicle exhaustion will harm people's bodies to a different extent, cause lots of diseases like asthma, and cardiovascular disease. The system protects us are also be damaged by pollutant entering the tissue barrier, harm to immune cells and regulate cytokine secretion. This essay is mainly focused on the particulate matter, sulfur dioxide, and nitrogen oxide effect on the immune system from the innate immunity to the acquired immunity, and how the immune system defense.

Keywords: Immune system; Air pollution; Particulate matter

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1 Introduction

The relationship between air pollution and human activity is close. If a city wants to be prosperous, it needs to improve the industrial and transportation. Therefore, in other words, the effect of causing air pollution is inevitable. An increasing number of diseases and the coronavirus start to happen this year, the system used to defense human body from foreign bacteria--the immune system is attacked by the air pollutant. So that let the human body easier to be infected^[1-2]. Air pollution causes lots of effects in several aspects of the body, main is respiratory diseases, physiological functions, and have the disease due to mucus is stimulated. it is also an important reason cause old asthma, less air breath in the lung cause less energy to get. Air pollutant comes from industrial, waste gases from factories and those

during transportation contain several toxic materials that can mutate the chronic disease to acute disease, as the concentration gets higher bring several people's life. Those smoke usually contains fine particulate matter which we know as PM and other toxic gases such as SO₂ and nitrogen oxide NO_x.

2 Main body

2.1 Fine particulate matter(PM)

Among PM the smaller diameter ones cause a more serious issue. In particular, fine particulate matter mainly comes from the combustion of coal, petrol, and others like chemical raw materials. And also the vehicle exhaustion is a source that can produce it. PM-related to so many diseases like cardiovascular disease, asthma, and autoimmune disease.

3 The innate immunity

3.1 Mucus and cilia

After PM has breath into the respiratory system. The respiratory tract is the first place PM attack. The first line of defense of our immune system--mucus and cilia will sweep PM outside the body, but that is only for the normal situation. The immune system will stop working when there is a high concentration. When the first line is defeated, PM will lower the sweeping ability for mucus and cilia, this lead to some PM will stay on the airway. Those carry toxic materials that will cause mucosal edema, Epithelial cell proliferation, and vasodilation.

3.2 Blood-brain carrier

The blood-brain carrier is the innate barrier involved in the innate immunity. PM can go into the blood through the blood-brain carrier so that they can

enter all other organs in though the body. And go to the brain by olfactory nerve transfer and blood-brain carrier osmosis lead to the inflammatory response to the central nervous system. PM can alter the permeability of BBB(blood-brain barrier), thereby damaging the function of the central nervous system is mainly following three ways. First, regulate inflammatory cytokine secretion, TNF- α increase. TNF- α is a highly inflammatory cytokine matrix, damages endothelial cells and promotes the expression of matrix metalloproteinase (MMPs). MMP is endopeptidase contain zine ions and can be activated by the calcium ions. MMPs can increase the permeability of BBB. The second is Increase brain oxidative stress level when the brain exposure to the PM. Biomembrane oxidative damage, the permeability of BBB change. Third, Direct toxic effects on capillaries, leading to small artery spasm, increased vascular patency, and thus no limit for the BBB.

3.3 Blood-fetal barrier

One of the important initial barriers of the innate immunity that prevents harmful substances from entering the fetus. After exposure, the exhaustion of the vehicle, the placental hyperemia, the probability of DNA deletion increase, affected DNA compound formation. Decrease the baby's memory and study ability, have the risk of premature birth. OHdG level increase means oxidative DNA damage, offspring gene mutation may lead to a pathological effect in later life^[3].

3.4 Alveolar macrophage(AM)

The innate immune cell the AM is the first line of defense when the foreign pathogen came into our lungs, participate in the innate immune regulation and initiate adaptive immune response. AM is the main cell which PM targets on, involved in the physiological process move away from the fine particulate matter out of the body. A high concentration of PM can lower the function and promote the death of the phagocytic cell and decrease its activity. Damage the AM to reduce the immunity of the human body.

3.5 NK cells

natural killer cells secrete multiple cytokines involved in the immune response without activating the pathogen. According to research taken by a birth

cohort, after exposure to PM, the NK cells increase 2.8%.

3.6 Dendritic cells(DC)

DC is the most potent antigen-presenting cells in the body currently know. PM can stimulate DC to improve its own antigen presentation ability, cause the local systemic immune disorder. Induce metastasis of mature dendritic cells to lymph nodes and promote proliferation and differentiation of T cells in lymph nodes.

3.7 Innate immune molecules

PM can be attacked on the immune system by promoting the secretion of cytokines. Cytokines interact with immune cells, make T-lymphocyte dysfunction, activate the immune response and trigger the inflammatory response.

4 The acquired immunity

4.1 The humoral immunity

B cell plays the main role in humoral immunity. PM can mature B cells lead them to reproduce and producing antibodies. For those highly exposures to the PM, the level of IgM、IgG、IgE is higher than normal people. Domestic coal is the main source that decreases the level of IgG.

The reason why (Serum immunoglobulin become higher) is the result of B memory cell increase during exposure. The immune system is affected by air pollution mainly on serum antibodies, haemolymphocytes, phagocytes and so on. Fine particles are involved in the development of allergic diseases such as allergic rhinitis, atopic dermatitis, and bronchial asthma. IgE can reflect the hypersensitive state and expression of the body, trigger the immune response^[4].

4.2 Cellular immunity

T cell is the main cell of a specific immune response, mainly mediate cellular immunity. Distribute the immune system by altering the proliferation and phenotype of peripheral blood lymphocytes. Metal ions contained in the PM will also affect the anti-rhythmic immune function.

4.3 Sulfur dioxide(SO₂)

The stimulation of these gases damages the mucus respiratory tract just let the same in PM, cause

the immune system overly active, cause diseases like asthma and also other disease related to it like bronchitis and pulmoniti. And inhibited the antibody formed. A study shows after 192 days of exposure to a high concentration of SO₂, the immunity in the respiratory tract and blood of mouse had all be inhibited completely.

when SO₂ is breathed into the airway it starts to do harm to the immune system, a study shows that after breathing 14 h, respiratory tract of a mouse is completely damaged.

4.4 Nitrogen oxide NOx

Similar to nitrogen dioxide, after exposure around 12h to 18h, the whole lung function and immune system of a mouse are inhibited to different extent. Systemic cellular immune function and phagocytosis were inhibited when exposure to the nitrogen dioxide. And also they can work in pairs to increase the toxic, restrain the phagocytic cells in both lung and blood as well as the function of the immune system.

5 Conclusion

Air pollution increases the risk of asthma, regulate the immune system to act abnormal, overactive. A pollutant can damage the tissue barrier, damage the immune cells, regulate the cytokines secretion to affect the immune system. The passage only focuses on the most about only one single pollutant the effect it can cause. However, in the real-life, we breathe always the component of all these air pollutants. And also these experiments that made upward all depend on the model or mouses, can not even clearly

express what will it affect the human body. To save time to avoid for others effect that for an experiment, only take high concentration to experiment, not chronic progress. After knowing the effect, people really need to increase the awareness of protection because air pollution has a close relationship with the economy development. Take the example of these days, as people back to work, the industry started, the transportation increased, the air quality decrease from good to heavy pollution. People just can do some small things to decrease the possibility of getting the immune system effected, like decrease the time of exposure plus wearing the mask. And also another thing need to be considered is that masks can not prevent all the PM go into the body, and at the same time will also decrease the oxygen level in blood. So the mask's material, operation life need to be considered.

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