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15. Impact of Air Pollution on the Pathophysiology of COVID 19 in Indian Population: A Brief Account

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15.1 Introduction:

Air pollution is a serious issue around the world. India is no exception. Unfortunately, several cities of India are in the top list of polluted cities in the world. Major among those are Delhi, Hyderabad, Kolkata, Bangalore, Nagpur, Chennai etc[1]. Air pollution is known to cause serious health impacts on animals and human beings. Exposure to toxic air not only imposes direct health threats but also aggravates other prevailing pathological conditions in individuals. Also, exposure to toxic breathing air is found to make people more susceptible to certain diseases [2]. Children exposed to toxic air are reported to have a damaged immune system which causes early onset of adult diseases as they grow up[3].Millions of children are exposed to toxic polluted air around the world. This imposes serious health threats in them and even in some cases leads to death[3]. Air pollution effects several system of our body. The most adversely effected system by air pollution is our respiratory system as it gets maximum and direct exposure to the toxic air pollutants as we directly breathe in the polluted air from our environment[2].

Exposure to polluted air is known to damage our lungs and respiratory pathways. It causes chronic obstructive pulmonary disease (COPD), asthma, allergy and breathing difficulties in some people[4]. Air pollution is reported to causes skin problems. People with compromised pulmonary conditions are more adversely affected with air pollution. On the other hand, exposure to toxic air causes irreversible damage in the respiratory system which makes the individual more susceptible and prone to respiratory problems and diseases like, pneumonia etc. The world has recently witnessed a fatal pandemic, the COVID-19 and has not yet been able to get rid it completely. The human race is surviving with new mutant variants of the virus and is adapting gradually with drugs and vaccines somehow.

This virus primarily has been found to damage the respiratory system and millions of people around the world have succumbed to death due to respiratory failure induced by COVID - 19 infection[5, 6].

15.2 Air Pollution and India and Health Effects:

India is badly affected with air pollution. The main causes recognized are automobile exhaust, industrial emissions, construction works, crop burning etc. The country being densely populated, the human health is very badly affected in large scale due to increasing air pollution. The particulate matters in the air are the major contributors to health problems[7]. Among these, PM10 and PM 25 are found to be abundantly present in polluted air[8]. Studies reveal that in urban regions, the automobile exhausts, industrial emissions and dusts & wastes from construction works are the major contributors to air pollution. In rural areas, mainly the particulate matters are added to the air from burning the remains of crop plants after harvesting in farms. The national pollution control board and various state pollution control boards have set up monitoring stations around the country and are trying their best to keep a watch and control on the increasing air pollution in various parts of the country[9]. But, unfortunately despite of strong measures and stringent laws enacted by the central and various state governments, has been a remarkable increase in air pollution in India. Though there a decrease in the level of pollution in India and also in other parts of the world during the lockdown period due to the pandemic, yet the level of pollution has got back to their earlier pre-lockdown values after since the unlock phase. Thus air pollutions makes our immune system weak and damages our respiratory system and leaves it susceptible to other kind of pathological invasions. The different particulate matters and heavy metals and hydrocartbons and other harmful elements present in polluted air reaches our respiratory tract through breathed in air and damages the epithelial cells of the tract[10]. The most effected are the alveolar wall which remains damaged and gets worst hit by further pathogenic invasions and pathological conditions. Also, the reduced concentration of oxygen in the air, makes it difficult to get enough oxygen in breathed in air, thus effecting the oxygen saturation in individuals[11, 12].

15.3 COVID-19 and India:

India along with the entire world has seen the worst pandemic ever in the modern era. The Coronavirus disease, COVID 19 is still prevailing. It owes its origin in Wuhan, China. India has witnessed three major waves of the viral pandemic till now[13]. The second wave being the most fatal. It accounted for maximum death. The dense population of India has made the country more vulnerable for easy transmission of the infectious disease. The country has seen lockdowns since the onset of the disease. The virus effects different persons in different ways. The major symptoms of the disease are cough, fever, throat infection etc. People with earlier predisposition of respiratory disorders and diseases may often develop severe respiratory distress[14].

Currently the country is seeing again a rise in the cases of COVID 19 from different parts. Though after successful vaccination of millions of people across the country against COVID 19, the rate of death and infection have been remarkably reduced. Covishield and Covaxin are the two vaccines that have been extensively used to vaccinate people of India against the deadly Coronavirus[14].

Other vaccines like Sputnik V has also been used. Experts have opinionated about administering the booster dose of the vaccines in order to prevail the immunity against the virus[16]. The elderly population of the country is already in process of getting the booster dose of the vaccine. Also, maintaining of normal COVID protocols and precautions against the COVID 19 are still essential to combat the rapid and extensive spread of the disease.

Mankind doesn't want to see another catastrophe as the earlier waves of COVID 19.No one wants to see further lockdown leading to extreme socio-economic damages at individual, national and international level. With advanced understanding of the pathophysiology of disease and clinical experiences regarding the disease and response to drugs, it is possible to treat the patient at home with mild to moderate symptoms without hospitalization. However, severe cases of COVID 19 requires hospitalization and utmost clinical care[17].

15.4 Pathophysiology of COVID-19:

The disease COVID-19 primarily hits the respiratory system and the virus causes an extreme immune response there which is termed as "immune storm" [18] (Figure.1). The virus is a RNA virus. As it enters the epithelial cells of the respiratory tract, the virus stimulates pro-inflammatory immune responses. This is further facilitated by NF kappa bp65 and p38 MAPK T helper cells 1 and certain monocytes.

The monocytes involved are mainly the CD14+ and CD 16+. Studies reveal that a large amount of IL-6 and TNF-alpha are secreted and also granulocyte macrophage colony stimulatory factor is stimulated. All these triggers intravascular permeability, disseminated intravascular coagulation (DIC), plasma leakage and respiratory distress syndrome (RDS) [18]. Accessory cardiorespiratory failure and death in many individuals are reported following the immune storm due to invasion of respiratory immune cells by Coronavirus[19].

15.5 Air Pollution and COVID 19 in India:

A correlation between air pollution and infectious diseases has been reported. Studies have revealed a significant correlation between air pollution and COVID 19 infections. Mortality due to COVID -19 has also been found to be associated with exposure to pollution[20] [Fig.1]. Exposure to PM2.5 and nitrogen dioxide have been reported to cause enhanced complications in COVID 19 infections and mortality. PM10 has also been found to worsen COVID 19 infection though to some lesser extent. Rate of transmission of COVID -19 and mortality have also been found to be associated with exposure to air pollution.

Laboratory studies reveals that in laboratory conditions, SARS CoV 2 remains stable in ambient aerosols[21]. This may be considered a reason for air pollution to facilitate COVID-19 transmission. Both long term and short term exposure to sir pollution has been reported to worsen infections disease conditions. Studies conducted in seven countries around the world, namely Italy, Spain, Germany, France, UK, USA, Iran and China found more cases of COVID-19 in the regions which had higher concentrations of PM2.5 and nitrogen dioxide in air[22]. A study conducted considering 120 cities in China shows that there exists a significant positive association for PM2.5, PM10, NO2, and O3 with newly COVID-19 confirmed cases[23].

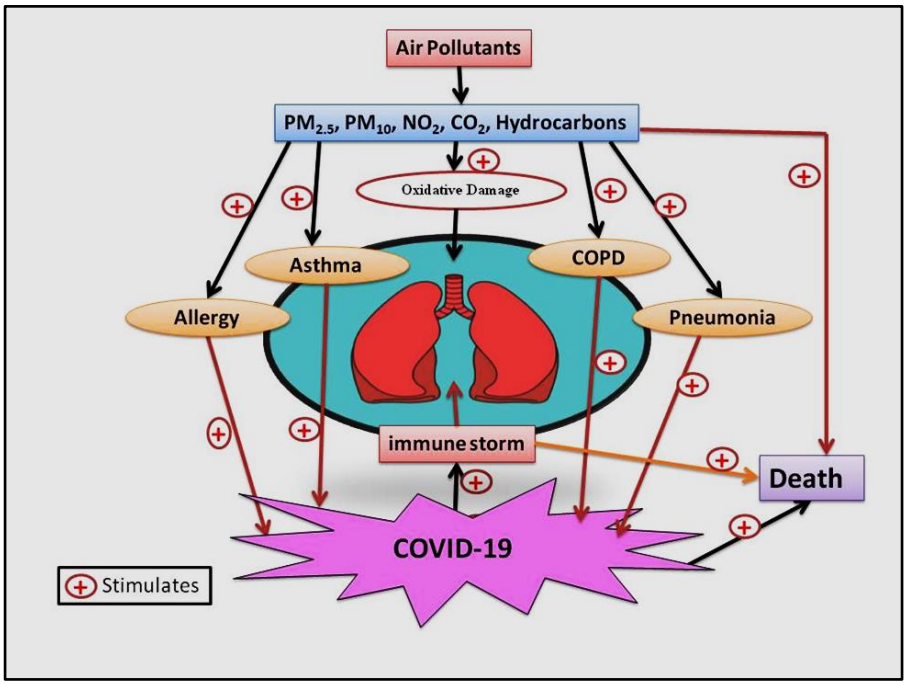

Figure 15.1: Effects of Air Pollutants on the Pathophysiology of COVID-19

A study conducted considering 110 Italian cities reveals that PM 10 is intimately associated with spread of COVID 19. It is assumed that the PM 10 may be the carrier of droplet nuclei and thus accelerating the transmission of SARS CoV 2 [24] .Studies show that the rate of spread of COVID 19 is hastened more by Contaminated and polluted air among human compared to that of human to human transmission rate. Other studies also reveal that air pollution indicators like cO2, NO2, PM 2.5, PM10 etc., are associated with rapid spread and occurrence of COVID-19[25]. Studies have reported that a rise of only 1 µg/m3 in PM2. 5 results in 8% increase in the rate of death due to COVID-19[26]. Also, air pollutions is known to weaken the immune system and thus enhances the risk of getting any infection like COVID-19. Interesting findings have been reported according to which evidence have been put forward that in certain conditions of atmospheric stability, SARS-CoV-2 RNA can be present on outdoor PM. Thus PM10 level can be considered and utilized as an indicator of epidemic recurrence[26]. Particulate matters are the prime contributors in respiratory and other health complications in humans. The extent of pathogenicity of these particulate matters depend on their size, origin, composition and ability to generate free radicals in the body[10]. These highly reactive free radicals once generated damages various physiological components and lead to a compromised health condition with time[27]. This makes the person weak with a compromised immune system and leaves him more susceptible to infectious diseases and viral infections including COVID-19. Immune compromisation has been linked to infertility in human which may be the actual underlying reason for COVID 19 induced infertility[28, 29]. Studies reveal that air pollution has a deep adverse impact on the mental health of people getting exposed to toxic pollutants. On the other hand COVID-19 has been reported to cause severe mental health consequences especially in the aged individuals. The aged population is also known to be more susceptible to morbidity and mortality due to COVID 19 infections[30].

15.6 Conclusion:

According to the World Health Organisation (WHO), 7 million premature deaths every year occur due to breathing polluted air; Also, breathing in polluted air adds on to the threat imposed by COVID-19 infection[31] [Fig.1]. Air pollution is serious concern for public health in India [32]. Raising public awareness regarding the impact of pollution on the pathophysiology of COVID -19 is extremely essential. The rate and ease of transmission and intensity of infection of COVID-19 in human can be regulated to some extent by regulating the level of air pollution. Already people are aware of the ill health effects of air pollutants and due to rising awareness among mass, air pollution is being trained to be controlled and brought down. Now if people gets aware of the possible added threats of air pollution in making the situation of CIOVID-19 more dangerous, more drastic and stringent measures may be adapted for combating increasing air pollution. Use of mask, specifically N95 or surgical mask may be effective in preventing breathing in the particulate matters from the air and also may be helpful in preventing spread of COVID-19 from one individual to another. Regular monitoring of the composition of the air is necessary and measures to lower emission of toxic pollutants also needs to be adapted. Strict implementation of laws against pollution is necessary. Use of mask need to be made compulsory by law or order in order to fight back pollution, its effects on COVID 19 and COVID -19 directly. Raising public awareness is the need of the hour.

Also, as evident from findings, various natural antioxidant rich leaves and vegetables are capable to scavenge and remove free radicals from the physiological system thus lowering oxidative damages and oxidative stress[34, 35]. This also helps to strengthen our immune system. Certain immune-modulatory components have also been reported from mushrooms which may help to strengthen our immune system[36]. Also, certain medicinal plants have been reported to possess antiviral activity[37]. Thus including these types of natural components in the daily diet, we may fight back pollution induced adverse health effects and also may fight back COVID-19 infections directly. Other purified antioxidants may also be included in the treatment regime of pollution induced pathological conditions and also in COVID-19 infections. Those are also known to remove and scavenge free radicals from the body [38]thus minimizing the risks of damaging the immune system and keeping the body strong to fight back infections and diseases. The overall impact is that these helps to make our body better and strong to fight back any kind of infections including COVID-19.

More research, investigations and detailed studies are required to unfold the exact pattern and mechanism of the association of air pollution and the pathophysiology of COVID-19.A better understanding of the fact may help to regulate the spread and severity of the COVID-19.

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