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Review Article

Carcinogenicity of Petroleum to the Aero Digestive Tract

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Abstract

The rapid urbanization and industrialization has brought about remarkable changes in our world but on the other hand this has drastically affected human health. The incidence of numerous diseases, including cancers have grown manifold in the last few decades itself, and the occurrences of aero digestive cancers have also shown a surge. This can be linked directly to the deteriorating air quality. The petroleum refining industry and the combustion of petrochemical fuels is the largest contributor to this increasing urban ambient air pollution and is now known to be carcinogenic. Chronic exposures to the various carcinogenic pollutants, from outdoor and indoor air pollution have diverse effects on the delicate epithelium of aero digestive tract and have been strongly linked to aero digestive tract cancers. With the revelation of these facts, more emphasis must be paid to curbing the problem of air pollution while also promoting the use of renewable energy and clean energy sources.

Keywords: Aero digestive Cancers; Carcinogens; Petroleum; Pollution

Introduction

Humans, like every other species, are an integral part of the ecosystem. It is a well- known fact that we have been responsible for drastic changes in the climate and environment, and that these changes have had far reaching effects on our health [1,2]. Human health has paid a heavy price for growing industrialization and urbanization. It was in the 1950s that saw a massive increase in the production and consumption of many petroleum based fuel products like gasoline and diesel fuel [3]. This was also the same time when an ongoing epidemic of lung cancer in Western Europe and United States was observed which led to the researchers to draw a direct link between outdoor air pollution and cancers of the aero digestive tracts. Although ultimately, cigarette smoking was identified as a culprit in this surge the incidence of lung cancers, a lot of research was directed to the possible carcinogenic role of petroleum products and outdoor air pollution on humans [4,5]. This concern, that air pollution can cause lung cancer has persisted till date and is only fortified by the growing levels of pollution from industrial sources and motor vehicles, particulate matter in the urban ambient air and also the growing knowledge indicating the various carcinogenic and mutagenic effects of these pollutants [6]. It was much later in 2013, that the World Health Organization (WHO), for the first time announced that outdoor air pollution is carcinogenic to humans. Aero digestive cancers include the cancers of lip, tongue, major salivary glands, gums and adjacent oral cavity tissues, floor of the mouth, tonsils, oropharynx, naso pharynx, hypo pharynx and other oral regions, nasal cavity, accessory sinuses, middle ear, and larynx and they constitute about 4% of all reported malignancies [7].

Although, aero-digestive tract cancer is a multidimensional problem, a number of risk factors have been attributed to the global increase in aero digestive cancers. These include exposure to tobacco and alcohol, inadequate nutrition, human papilloma virus, chronic trauma to oral mucosa, poor oral hygiene and even chronic exposure to carcinogenic chemicals in the ambient urban air [8]. In

fact, outdoor air pollution and Particulate Matter (PM), was officially classified as IARC Group 1 carcinogens by the International Agency for Research on Cancer (IARC) [9]. With this revelation, more policies should be directed towards reducing air pollution by petroleum derivatives while also paying more attention to occupational hazards.

Petroleum and Air Pollution

- The Global Urban Ambient Air Pollution Database released by WHO revealed that air pollution levels in cities across the globe rose by 8 per cent, even with small improvements in certain developed regions. The troubling fact being that over 80 per cent of city dwellers are exposed to air quality that fails to meet the minimum safety levels with the high-risk groups being low- and middle-income cities across the globe. It also exposed that major Asian cities such as Delhi, Beijing, Mumbai, Dhaka and Kolkata are heavily polluted and that this urban air pollution which continues to rise at an alarming rate is wreaking havoc on human health [10].
- The rapid urbanization and industrialization is definitely to blame for this deterioration of urban ambient air quality. The process of converting petroleum into petrochemical products is known as petroleum refining and this industry is a major contributor to environmental pollution worldwide [11]. These industries release a wide variety of chemicals like benzene, ethyl benzene, xylenes, 1,1,1-trichloroethane, trichloroethylene, tetrachloroethylene, carbon tetrachloride, chloroform which are toxic and carcinogenic to humans [12,13].
- The second biggest source of environmental pollution from petroleum is from products released from vehicular exhausts. These exhaust gases are well known to contain a variety of carcinogenic and mutagenic pollutants like Polycyclic Aromatic Hydrocarbons (PAHs), alkylated PAHs, alkyl benzenes and alkanoic acids [14]Benzene, butadiene, toluene, ethyl benzene, Xylene, trimethyl pentane, Methyl Tert-Butyl Ether (MTBE) and many other chemicals are found in gasoline [15]. These chemicals have shown evidence of increased risk of leukemia and cancers of kidney, liver, brain, pancreas, aero digestive tract and even prostate cancers [15]. Kurt Straif, head of International Agency for Research on Cancer (IARC)'s department that ranks carcinogens expressed in 2013 that, depending on the level of exposure to pollution in different parts of the world, the risk of cancers was found to be similar to that of breathing in second-hand tobacco smoke [9].

Indoor Air Pollution

- Along with the rise in outdoor pollution there is component of indoor air pollution which tends to be over looked by the developed countries but is a major health hazard in the developing cities and comparatively poorer towns. With the increase in fuel requirements, there has been a significant increase in the use of indoor fuels such as coal and wood. Even today, it is estimated that half of the global population and almost 90% of rural population in developing countries rely on coal and biomass in the form of wood, dung and crop residues to meet their domestic energy requirements. Other petroleum based fuels like kerosene are also sometimes utilized to meet household energy requirements [16].
- What actually worsens the situation is that these fuels are typically burnt in simple stoves and often result in incomplete combustion. This leads to people in developing countries being exposed to very high levels of pollution for an average of 3-7 hours daily over many years and this tends to increase to almost 24-hour periods in the cold and mountainous regions of the world [17,18]. Tobacco and cigarette smoke also attributes to indoor air pollution and is extremely detrimental not only to the smoker's health, but also to all those around him. Today although, the connection of tobacco smoke to aero digestive cancers is well established, there is also definitive evidence to support that indoor air pollution increases the risk of chronic obstructive pulmonary disease and of acute respiratory infections in childhood, which happen to be some of the most important cause of death among children under 5 years of age in developing countries [17,19,20].
- The inhaled pollutants also have an association with low birth weight, increased infant and perinatal mortality, pulmonary tuberculosis, cataract etc. They are also closely linked to increased incidence of various aero digestive cancers like nasopharyngeal and laryngeal cancer especially hypo pharyngeal cancer and lung cancer [21].
- Tobacco smoke is known to be packed with a number of carcinogens like benzo[a] pyrene, formaldehyde, acetaldehyde, croton aldehyde and Tobacco-specific nitrosamines [22].Thus, it is estimated that exposure to indoor air pollutants may be responsible for nearly 2 million excess deaths in developing countries

Aero digestive Cancers

- The aero digestive tract consists of the combined organs and tissues of the respiratory tract and the upper part of the digestive tract (including the lips, mouth, tongue, nose, throat, vocal cords, and part of the esophagus and wind pipe) [23]. Oral cancer accounts for the highest incidence, among the various aero digestive cancers although the incidence is high worldwide; Asia has a particularly high incidence of oral cancers which has a direct link to the widespread use of smoked and smokeless tobacco [24].
- Petroleum contains a number of chemicals detrimental to human health like benzene, butadiene, toluene, ethyl benzene, Xylene, trimethyl pentane, Methyl Tert Butyl Ether (MTBE) etc. of which, benzene is a known human carcinogen [15].

Chronic exposure of the delicate Squamous epithelium of the aero digestive to various carcinogenic chemicals, whether derived from ambient air pollution, occupational expose to petroleum or tobacco smoke has farfetched effects [25]. The actual mechanism of action of these carcinogens is varied and difficult to decipher. However, the possible mechanism is that, on inhalation the pollutants get deposited on the mucosal lining of the aero digestive tract. The delicate balance of the mucous membranes and special sensory organs of these passages and the mucociliary activity makes the mucosa susceptible to local and recruited immune responses, rapid uptake of chemicals increasing the carcinogenic potential of pollutants to these delicate barrier epitheliums [25].

- On longstanding and chronic exposure, these carcinogenic chemicals may evoke a cellular response resulting in pulmonary oxidative stress. This can ultimately result in a pro-inflammatory response from the tissue and concluding into genotoxicity. A number of studies have proven this relationship between pollution and cancer. In a multi-center, urban study that consisted of 8111 subjects showed, that fine particulates including sulfates that cause air pollution, were positively associated with lung cancer mortality [26]. Another study that consisted of a 15-year follow-up consisting of 6,338 non-smoking adults in California showed that increased risk of developing lung cancer was associated with air pollution, especially with the levels of Sulphur dioxide, ozone, and Particulate Matter 10 (PM10) [27]. A few animal studies conducted on laboratory mice have also shown conclusive evidence to support the opinion that exposure to polluted air leads to DNA mutations [28,29]. DNA and protein damage has been linked to higher risks of developing aero digestive cancers [30]. A study carried out recently presented that environmental and occupational exposures to carcinogenic PAHs and benzo pyrene was associated with higher plasma levels of p53 and p21 proteins, which were different from the controls [31].

Conclusion

According to the data presented by the International Agency for Research on Cancer (IARC) in 2010, air pollution contributed significantly to over 223,000 deaths from lung cancer worldwide and is also known to increase the risk of bladder cancer. Although the exact mechanism in which the exposure of the aero digestive tract causes malignant transformation is not understood, the presence of a definitive link between the two is well established. It is established that urban ambient air contains a number of carcinogenic chemicals, more research should be directed towards eliminating these carcinogens from the environment and to come up with alternative industrial processes and promoting the use of clean energy. Finally, stakeholders and policy makers must establish ameliorative policies to regulate release of polluted air into the atmosphere and implement preventive strategies.

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