Air pollution: The invisible threat

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ABSTRACT

Air pollutants are airborne particles and gases which are present in concentrations endangering well being of organisms or disturb the orderly functioning of environment. The phenomenon of these being present in environment is called Air pollution. The World Health Organization (WHO*) estimates that urban air pollution contributes each year to approximately 800,000 deaths and 4.6 million lost life-years worldwide (WHO 2002). This burden is not equally distributed: approximately two thirds of the deaths and lost life-years occur in developing countries of Asia. Such estimates play an important role in decision making in a variety of policy contexts from setting of air quality guidelines to establishing public health priorities to international lending. Adverse response to air pollutants depends upon the exposure and the delivery of the dose of the injurious agent to the target site within respiratory tract. From size of the particle to chemical nature or solubility, all decide to what extent it will cause harm to human body. Here is a short review of the invisible toxins we inhale every day.

Key words: air pollution, clean air act, smog, green belts

INTRODUCTION

Two great revolutions have been the main contributors to anthropogenic air pollution. The first of these was the industrial revolution, started in Britain and Western Europe in 18th century and resulted in growth of cities to house the workers in the new factories. The fuel of the industrial revolution was coal and the building of towns and cities became black with sooty smoke. The first of 19th century Western Europe was noted for their winter time smoky fogs or smog. The Revolution in mobility cause the next increasing ownership of cars and motor vehicles for transportation of goods due to general prosperity and ready availability of cheap fuel was another contributor of air pollution. The London fog of 1952 which caused excess of deaths led to formation of new laws which led to change in type of pollution. In places where coal burning has been reduced, traffic has increased, so that smoke may contain less black matter and SO2 but more nitrogen oxides and other chemicals. This has also led to greater secondary pollution by the photochemical production of ozone. Now we have complex regulations that limit emissions and control concentration of key pollutants in outdoor air. The health effects of indoor air pollution are a more recent concern.[1]

General principles and concepts:

Adverse response to air pollutants depends upon the exposure and the delivery of the dose of the injurious agent to the target site within respiratory tract. Atmospheric pollutants exist in both gaseous and particulate forms. Particulate pollutants occur in nature as aerosols and their deposition depends on aerodynamics (primarily size), airway anatomy and breathing pattern. Particles more than 10 micrometer is filtered out in nose and nasopharynx which are then either coughed up or swallowed. Particles less than 10 microns may be deposited in tracheobronchial tree. Deposition in lung's alveoli is maximal for particles less than 1-2 microns. Total deposition increases as the size decreases. Removal of particles from large airways by mucocilliary apparatus is efficient and occurs within hours of deposition; clearance from the deep lung by alveolar macrophages is much slower; requiring days to months. Penetration and retention of toxic gases in the respiratory tract depends upon solubility of gas, concentration in inspired air; the rate and depth of ventilation and the extent to which the material is reactive. Water soluble gases like SO2 are completely extracted in

upper airways in healthy subjects during brief exposures at rest. The less water soluble gases (NO3 and O3) may penetrate to the airways and alveoli of the respiratory tract. Exercise augments the penetration of gases into deep lungs.[2]

Outdoor Air pollution: Exposure and Health effects

Outdoor air pollutants can be both manmade and natural. Some naturally occurring pollutants in outdoor include pollens and fungi. The manmade pollutants are expected to reach potentially hazardous levels in urban areas or near point sources such as power plants, smelters or manufacturing facilities. In USA "clean air act" classifies air pollutants as "criteria pollutants" and "toxic air pollutants". The criteria pollutants include primary combustion related pollutants (SO2, NO2, CO and particles), the Secondary pollutants O3 and lead. The toxic pollutants are predominantly carcinogens; the sources are diverse but principally comprised of industrial emissions and waste products.

All the pollutants covered below are of public health significance throughout the world. Sulphur oxides, particles nitrogen oxides and CO are generated by combustion and are typically found together in the complex air pollutant mixtures in outdoor environments. Ozone is a secondary pollutant while the pollutants are considered individually, exposure to them typically occurs in the form of inhaled mixtures.

Sulphur-di-oxide (So2)

Sulphur oxides are produced by combustion of fuels containing sulphur; such as coal and crude petroleum; smelting of ores containing sulphur. Heavy industry and coal burning power plants are predominant sources of pollutant mixtures containing sulphur oxides, nitrogen and particles. Tall smokestacks for power plants; used to control local pollutant concentration, release SO2 and NO2 high into atmospheres where residence time is prolonged. Through some of reactions acid sulphates and nitrate particles are formed which may undergo any range transport finally leading to acid rains. Inhalation of SO2 produces decrement in lung function and increased airway resistance that are sufficient to produce symptoms of dyspnoea, wheezing and chest tightness.

Nitrogen-di-oxide (No2)

The principal source of NO2 in outdoor air is motor vehicle emissions and power plants. The health effects of NO2 probably arise principally from precursor of O3. It also secondarily forms acidic nitrate particles. NO2 is an oxidant gas of low solubility that penetrates to the small airways and alveoli of the lungs. It can impair lung defences against respiratory pathogens and cause airway inflammation, with associated effects on lung function and respiratory symptoms.

Particles

Particles are suspended in air by the action of wind on crustal material and road dust. The manmade sources are diverse and include power plants, industry and motor vehicles; including diesel-powered vehicles that emit particles in the inhalable range. The man-made particles are primary i.e. emitted directly by combustion or other processes or secondary i.e. formed through chemical and physical transformation of gaseous pollutants, such as SO2 and NO2.[4]

Studies have been directed at clinical indicators, such as hospitalization or the triggering arrhythmias, MI, or sudden death. They have also examined biomarkers and electrocardiographic parameter. A review in 2004 by the American Heart Association compiled a substantial body of evidence linking particulate air pollution to adverse cardiovascular effects. Airborne particles have been shown to adversely affect persons with asthma and COPD.

Carbon monoxide (CO)

CO is an invisible gas formed by incomplete combustion of fossil fuels and other organic materials. Outdoor source is predominantly

vehicle exhaust. Its exposures can be conveniently assessed by the level of carboxyhaemoglobin as a biomarker of exposure or by measuring the concentration of CO is an end tidal breath sample, following a breath hold. Depending on ambient levels of CO, levels of activity, and lung function, the half-life of CO in the body ranges from about 2.5 to 4 hr. The rate of accumulation of ambient CO in the body above endogenous levels is affected by ambient CO concentrations, alveolar ventilation, lung diffusivity, total haemoglobin mass and COHb level. People with impaired gas exchange have compromised ability to excrete CO.

Persons with Cardiovascular diseases are considered to be at greatest risk from CO exposures. Standard exercise tests on subjects with IHD have demonstrated a decrease in time interval to the onset of angina at COHb levels from 2 to 6 %. The 1hr 35ppm and 8hr 9ppm federal standards for outdoor air were selected to prevent COHb levels from rising above 1.5%, thereby protecting persons with IHD from aggravating MI; patients with coronary artery disease have an increased frequency of arrhythmias. Fetuses and people with COPD may be harmed by CO and normal persons may have reduced O2 uptake during exercise at low levels of CO exposure.[5]

Ozone (O3)

Photochemical pollution or "Smog" is a complex oxidant mixture produced by the action of sunlight on hydrocarbons and nitrogen oxides in vehicle exhaust. O3 is invariably present in photochemical pollution, and its concentration serves as an index of the level of this mixture. O3 is also produced naturally, but the exposure of concern for health almost exclusively reflects the O3 created by human activities.[6]

Low level exposures cause damage to the small airways of experimental animals. Evidence of an inflammatory response and biochemical changes in BAL fluid has been detected 18hr after an experimental exposure to O3 at levels that are commonly formed. There is potential for chronic effects from repeated inhalation. Surprisingly, in the clinical studies; asthmatics have not been shown to have increased susceptibility to O3 compared with non asthmatics. In another study some evidence was found that O3 might contribute to the onset of asthma some time series studies have linked short-term exposure to O3 to increased risk of mortality.

Lead

Exposure to lead may occur through many environmental media, including ambient air. Children are particularly vulnerable to lead exposure. Even levels previously considered safe have been associated with adverse neurological effects, and there has been a progressive tightening of recommendations of blood lead levels by the centres for disease control and prevention.

Toxic Air Pollutants

The toxic air pollutants are predominantly carcinogens, but they demonstrate a variety of other toxicities. Approximately 200 hazardous pollutants are listed as air toxics in the 1990 clean air act amendments. Although the sources are diverse, emission releases tend to be localised, often at industrial sites, or form municipal incinerators or waste sites.

Only a small proportion of lung cancers can be attributed to air pollution, even though carcinogens are found widely in outdoor air. Polycyclic aromatic hydrocarbons (PAH), in diesel exhaust possess mutagenic and carcinogenic activity. Difficulties of measuring exposure, confounding by cigarette smoke and by other occupations, it is difficult to reach any definite conclusion on the role of diesel exhaust in causing lung cancer in the general population.[7]

Air pollution monitoring in India:

The National Air Quality Monitoring Programme, sponsored by Central Pollution Control Board (CPCB) since 1990, has generated database in 10

major Indian cities. The programme facilitates evaluation of long term air quality trends for health related criteria pollutants. The trend analysis showed that Suspended Particulate Matter (SPM) exceeds the CPCB standards in all cities most of the time throughout the year. First rain event has the maximum concentration of pollutants with low pH values and higher sulphate and nitrate contents.

The WHO has recommended the following procedures for the prevention and control of air pollution:[8]

1. Containment: it can be achieved by various engineering methods such as enclosure, ventilation and air cleaning. A major contribution to this is "arresters".
2. Replacement: replacing a technological process causing air pollution, by a new process that does not. Like using electricity, natural gas and central heating in place of coal.
3. Dilution: the establishment of "green belts" between industrial and residential areas is an attempt at dilution.
4. Legislation: Clean air acts, cover matters such as height of chimneys, power to local authority to carry out investigations, research and education concerning air pollution. Government of India have enacted "The Air (Prevention and Control
5. International action: WHO has established an international network of laboratories for monitoring and study of air pollution. It consists of two international centres at London and Washington, 3 centres at Moscow, Nagpur and Tokyo and 20 labs in various parts of the world.

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