
Air pollution: A new challenge for anaesthesiologists!

BACKGROUND

Air pollution is an environmental problem of worldwide urbanisation. With the increasing amount of air pollution, more than half of Indians are exposed to it, especially in Northern India.^[1] The poor air quality during the winter creates a public health crisis, killing nearly 1.2 million Indians.^[2] Air quality is quantified by the concentration of fine particulate matter (PM₁₀ and PM_{2.5}, i.e., particles lesser than 10 and 2.5 μ , respectively).^[3] As per the Central Pollution Control Board, air quality index of over 150 $\mu\text{g}/\text{m}^3$ or

ppm (part spermillion) is considered unhealthy and more than 300 $\mu\text{g}/\text{m}^3$ is considered as hazardous.^[4]

The impact of air pollution on public health has increased perioperative morbidity and mortality. However, literature regarding challenges in anaesthesia due to air pollution is sparse. The aim of this article is to focus on various concerns related to air pollutants, its effect on different organ systems, and their perioperative anaesthetic implications.

Air pollution: Impact on humans

The spectrum of health problems related to air pollution ranges from milder symptoms, such as watery eyes, sore throat to serious cardiovascular, neurological, and dermatological complications. Patients with pre-existing respiratory disease are

prone to develop severe, life-threatening deterioration of their baseline breathing problems. A recent study based on multiple-path particle deposition model has shown total deposited mass rate for PM_{10} and $PM_{2.5}$ are 942 ng/min, 345 ng/min, during a winter season.^[4] By using Grimm aerosol spectrometer, they have demonstrated maximum deposition of PM_{10} in the head and neck region, caused by nasal breathing.^[4] On the contrary, oral breathing leads to higher deposition of $PM_{2.5}$ and PM_1 in the tracheobronchial tree.^[4]

Exposure of high concentrations of PM and other toxic gases induce oxidative stress leading to formation of free radicals especially in the respiratory tract. This elicits inflammatory response in the body by release of cytokines, chemokines, and adhesion molecules. This effect elicits the similar response comparable with cigarette smoking and may be equivalent to smoking three packs per day.^[5] Another study has predicted, if the ambient ozone level increases three parts per billion (ppb) over 10 years, it is equivalent to smoking a pack of cigarette daily for 29 years.^[6]

Vulnerable population

The air pollution has long-term impact on all humans. However, impact of air pollution has greater concerns on special group of population, such as children, elderly, pregnant, etc., This lead to more challenges for perioperative management.

Paediatric population

Children are prone to have higher exposure to air pollutants than in adults due to higher minute ventilation and outdoor activities. School children living in the polluted area has impact on immunological and systemic inflammatory response.^[7] Traffic-related air pollution (TRAP) exposure is associated with childhood asthma and wheezing phenotypes.^[7,8] Early childhood (from the early postnatal period to 3 years of age) exposure to TRAP affects lung development, microvascular maturation, and causes substantial structural remodeling of lung parenchyma.^[7,8] Additionally due to immature immune system they are prone to develop respiratory infections.

Geriatric population

Elderly individuals are prone to develop airway obstruction and exercise limitation due to progressive decline in pulmonary function, decreased chest wall/lung compliance, and immuno senescence.^[9] These effects of aging are further exaggerated on exposure to air pollution.^[10] Also other

age-related factors, such as decrease cardiorespiratory reserves, cognitive dysfunction are further affected by chronic exposure to air pollution.

Pregnancy

Pregnant females have variable effect on the fetus due to exposure to air pollution with increased morbidity and mortality.^[11] Exposure to air pollution leads to increased risk of intrauterine growth retardation, prematurity, low-birth weight, premature delivery, congenital anomalies, and intrauterine or perinatal death.^[10,11] Also, pregnant females have increased risk of preeclampsia due to air pollution.^[12]

Individuals with pre-existing chronic diseases

Exposure to air pollution affects persons of all ages and its impact is further exaggerated in persons with pre-existing diseases, such as asthma, chronic obstructive pulmonary disease (COPD), ischemic heart diseases, diabetes, hypertension, and collagen vascular diseases.

Effects on respiratory system

The exposure to PM and other inhalational pollutants leads to adverse clinical effect on both upper and lower respiratory tract function.^[12] It has been reported that acute exposure to raised CO and SO₂ concentration is associated with reduction in FVC and FEV₁ with 1 day lag effect.^[13] Acute lower respiratory tract infection is a major cause of mortality in children below 5 years of age. COPD patients remain at more risk of acute exacerbations and deteriorating lung function on exposure to air pollution.^[14] Air pollution with increased level of particulate matter specially PM_{10} levels has been reported to increases the rate of hospital is ations for COPD.^[15]

Effects on cardiovascular system

Acute exposure to air pollution leads to increase in myocardial ischemia, arrhythmia, and heart failure, especially in elderly or patients with pre-existing comorbidities. Air pollution exaggerates atherosclerosis and its progression.^[16,17] A recent meta-analysis has shown temporal association between air pollution and heart failure.^[16] Experimental studies have shown the pathophysiological mechanisms leading to ischemia due to exposure to air pollutants are endothelial dysfunction, atherosclerosis, platelet activation, and increased coagulation.^[17]

Effects on nervous system

Exposure to particulate matter can cause poor age-related cognitive performance. Exposure of higher level of air pollutants has been related to increased neuro inflammatory markers and neurodegenerative conditions such as Alzheimer’s disease.^[18] Air pollutants are also significantly associated with ischemic stroke mortality.^[19]

Anaesthetic implication of air pollution

Even short-term exposure to PM_{2.5}, nitrous oxide and ozone is associated with not only lower lung dysfunction but also increase upper and lower respiratory infections.^[20,21] It also poses increased risk of unexplained bronchospasm, new onset hypertension, and cognitive dysfunctions [Table 1]. The increased incidence of active upper airway tract infection or acute exacerbation of wheezing makes the day-care surgical procedures challenging.

The most common reason for patient-related late cancellation of the surgery is acute illness. Cancellations on day of surgery are not a practical approach in the current scenario and have huge emotional and economic burden. Assessment of the suitability for elective surgery is multifactorial and depends upon the age and presenting symptoms, urgency and type of the surgical procedure, and presence of comorbidities and not just systemic manifestations due to air pollution. The decision to postpone or proceed with surgery should be made on

an individual basis by considering the risk factors and the anaesthetist’s expertise.

A recent meta-analysis has shown 7 days of deep breathing exercise significantly improves postoperative pulmonary function in patients with chronic airflow limitation. Incentive spirometry has been reported as an effective modality for improving spirometric values.^[22] Seven days of deep breathing exercise in patients with chronic airflow limitation is found to be very effective in improving pulmonary function.^[23] Preoperative nebulisation of salbutamol (2.5–5 mg) 10–20 min prior to induction of anaesthesia have been shown to be beneficial for reducing adverse perioperative respiratory events.^[24]

A recent systemic review has suggested that the key to provide safe anaesthesia is to minimise secretions and to limit stimulation of a potentially irritable airway, preferably under deep anaesthesia.^[25] Adequate hydration, use of humidifier is beneficial for clearing secretion and mucus plugging. Propofol and sevoflurane are associated with lower incidence of adverse respiratory events. Intravenous or inhalation techniques may be used to maintain anaesthesia provided anaesthesia is sufficiently deep. Tracheal intubation should be avoided if possible. Use of supraglottic airway device (SAD) or face mask is preferable alternatives for children less than 5 years. Lubricating the SADs with lignocaine gel may reduce the incidence of airway complications. An awake

Table 1: The air pollution and its effect on human body systems^[1,2,6,7,9,10]

Air pollutant	Air quality standards	Organ system	Mechanism	Acute effect	Long-term effect
PM 2.5	60 µg/m ³ Over 24 h	Respiratory system	Oxidative stress	Hyperactive airway	Asthma
PM 10	100 µg/m ³ Over 24 h	Respiratory system Cardiovascular system	Inflammation Oxidative stress, Platelet aggregation, inflammation	↑ Airway resistance ↓ Oxygen uptake, Vasoconstriction, Impaired aerobic work capacity	Bronchitis, COPD Atherosclerosis, hypertension, Angina
Ozone	100 µg/m ³ over 8 h	Respiratory system	Oxidative Stress, inflammation	↓ maximal oxygen uptake, Hyper active airway	Asthma
Carbon monoxide	2 mg/m ³ over 8 h	Respiratory system Cardiovascular system	Hypoxia Cell death	↑ Ventilation ↑ Submaximal heart rate, Impaired aerobic work capacity	Angina, arrhythmia
Nitrogen dioxide (NO ₂)		Central nervous system	Cell death	Impaired cognition	Functional loss
		Respiratory system	Alters immune system, direct irritation, inflammation	↑ Airway resistance	Cough, asthma respiratory tract infections
Sulfur dioxide (SO ₂)		Cardiovascular system	Inflammation alters immune system	↑ Heart rate	Worsen existing heart diseases
		Respiratory system Cardiovascular system	Inflammation Inflammation	↑ Airway resistance ↑ Heart rate	Cough, asthma Worsen existing heart diseases

extubation is preferable for enabling the patient to clear secretions and better protection of the airway.

The role of air purifier in combating air pollution is controversial. Similarly, air conditioning has not been proven effective as indoor air quality directly depends on the quality of outdoor air.^[26] On the contrary, exposure to cold dry air for long periods induces rhinitis, bronchospasm even in the absence of the usual triggering allergy. A study has found that nonair conditioner users have better pulmonary function in comparison to air conditioner users.^[27]

However, literature regarding impact of air pollution on perioperative care is sparse. Thus, further studies in this context are the need of the hour. However in view, of increased air pollution, subacute effects may be missed on clinical examination and routine investigations. Careful assessment for exposure to air pollution and its subclinical effects may be elicited in preoperative anaesthesia assessment.

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Conflicts of interest

There are no conflicts of interest.

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