Bad Air Day – The Impact of Pollution on Asthma

by Ross Campbell, Gen Re, London

We inhale approximately 20,000 times each day, averaging 50 litres of air each minute while running, 25 litres walking, and almost 10 litres just sitting down. Harmful substances in the air we breathe can damage the airways and cause short-term and long-term health impacts.

Air pollution is the release of natural or man-made particles and noxious gases into the air, much of which is a result of the combustion of fossil fuels. Air pollution poses a serious threat of lung disease, including lung cancer, and it may worsen existing asthma, bronchitis and emphysema. It can cause heart and circulatory problems and is linked to increased cancer of the urinary tract and bladder.

Ambient (outdoor) pollution is estimated to cause 3.7 million premature deaths worldwide per year. The World Health Organisation (WHO) estimates that 80% of ambient pollution-related premature death results from ischaemic heart disease and stroke, that chronic obstructive pulmonary disease and acute lower respiratory infections account for 14% and lung cancer is the cause of 6%.

Air quality is typically described using particulate matter (PM) concentrations. PM is a mix of solid and liquid particles of organic and inorganic substances including sulphate, nitrates, ammonia, sodium chloride, black carbon, mineral dust, sand, pollen and water that is suspended in the air. PM varies in origin, shape, size, composition, and from place to place and time to time.

Small particles are defined as 10 microns (PM10) or 2.5 microns (PM2.5) in diameter. The smallest can lodge deep inside the lungs. Chronic exposure causes inflammation and a worsening of heart and lung diseases. It is linked to deaths from cancer, cardiovascular and respiratory disease. The health impact of small PM pollution is greater than any other pollutant even at very low concentrations — indeed no safe level exists. The WHO estimates that PM alone causes 800,000 (20%) of all pollution-related, premature deaths every year.

The other main pollutants of concern are nitrogen dioxide, ground level ozone, sulphur dioxide, carbon monoxide, hydrocarbons and lead. Nitrogen dioxide inflames the lining of the lungs, causing shortness of breath and cough, and it acts to reduce immunity to infection and bronchitis. The effect is worse on people with asthma. Nitrogen dioxide contributes to the formation of particles and reacts with hydrocarbons in the presence of sunlight to create ground-level ozone. High levels of ozone can narrow the airways and inflame the lungs. For asthmatics, ozone pollution episodes can trigger attacks or generally worsen the condition. European studies have reported a rise in daily mortality of 0.3% per 10 µg/m3 increase in
ozone exposure. Sulphur dioxide gases irritate the airways of the lungs increasing symptoms for people who have lung disease. Hospital admissions for cardiac disease and mortality increase on days with higher sulphur dioxide levels. Carbon monoxide gas impairs the uptake of oxygen by the blood and can negatively affect heart function.

The weather plays a part; harmful levels of pollution can build on calm days that are either very cold or very hot. Temperature inversion traps pollutants below a band of cooler air to form “winter smog”, exacerbating lung disease due to the combination of cold and poor air quality. A “summer smog”, when nitrogen dioxide forms a cocktail of ozone and PM, may create a pollution episode, putting asthmatics at particular risk.

Estimations of the threat to health are based on the concentration of pollutants in the air, the time spent in the polluted environment and the amount of air breathed. The long-term health effects of air pollution are thought to be the most significant. These include slowly developing conditions such as cancer, COPD and heart disease. These stem from exposure to lower pollution levels than result in short-term health effects (e.g., asthma attacks) and to which people are unwittingly exposed over time. It is unclear if air pollution is a fundamental cause of asthma but people with severe disease are likely to be affected by it because they have lower reserves of lung function. The main effect is observed in the elderly with chronic lung disease, which includes asthma. Exposure to high concentrations of small particulates (PM10 and PM2.5) is linked with increased mortality or morbidity, both daily and over time. Reduced exposure to air pollution will increase life expectancy and total years lived in a population. In the UK, for example, removing man-made PM2.5 would increase life expectancy from birth by six months, according to estimates. This net gain is similar to what would be realized if there was no more infectious or parasitic disease.

Endnotes

2 http://www.who.int/mediacentre/factsheets/fs313/en/.
3 PM2.5 is defined as the mass per cubic meter of airborne particles passing through the inlet of a size selective sampler with a transmission efficiency of 50% at an aerodynamic diameter of 2.5 μm. In practice, PM2.5 represents the mass concentration of all particles of less than 2.5 μm aerodynamic diameter.
5 http://uk-air.defra.gov.uk/air-pollution/effects.
6 Ibid.
9 http://www.comeap.org.uk/.
10 The Mortality Effects of Long-Term Exposure to Particulate Air Pollution in the United Kingdom (2010), Committee on the Medical Effects of Air Pollutants, available at www.comeap.org.uk.

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