Cleaner Air, Healthier Hearts

Long considered a threat primarily to pulmonary health, air pollution has been linked to adverse cardiovascular events as well. Robert D. Brook (M.D. 1995, Fellowship 2000), associate professor in the Division of Cardiovascular Medicine and chair of the American Heart Association Scientific Statement on Cardiovascular Disease and Air Pollution, co-directs one of four Environmental Protection Agency Clean Air Research Centers — a collaboration with Michigan State and Ohio State universities. Brook shares his insights on air pollutants and cardiovascular health. →

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Q: How do you define environmental cardiology? What are its origins?

A: Environmental cardiology investigates the cardiovascular effects of many types of environmental exposures, specifically their potential short- and long-term harmful effects on cardiovascular health. I think the impetus comes from two avenues that converged in the last 10-15 years. Air pollution — the largest environmental toxin impacting billions of people globally — began to be shown in the 1990s to be related to cardiovascular events. During the same time a greater appreciation was developing that these events don't simply occur randomly, that there has to be an environmental or external situational trigger.

Q: What are the source components that make up air pollution?

A: Air pollution is a complex amalgam of solid particles, or particulate matter, and gaseous pollutants like ozone. Particulate matter is the component most strongly linked to adverse cardiovascular health effects. It's a heterogeneous mixture of particles from sources that vary across the country, including elemental and organic carbon species, transition metals, and inorganic ions like sulfates and nitrates. These components form a complex, dynamic mixture of pollutants that interact with each other, the atmosphere and the meteorology. $PM_{2.5}$ — particles less than 2.5 microns in size, 40-50 of which can fit across the width of a human hair — is a regional pollutant that's produced mostly by fossil fuel combustion and can travel thousands of miles and persist for days. There are also more local point sources, such as traffic, that typically produce shorter-lived pollutants — ultra-fine particles around 20 to 100 nanometers in diameter, and nitrogen dioxides. In addition to regional fine particles derived mostly from fossil fuel combustion, recent findings suggest that traffic exposure may be one of the most robust sources for triggering cardiovascular events.

Q: How do air pollutants cause harm?

A: This is precisely what I and my colleagues have been researching. One way is that the $PM_{2.5}$ particles can be inhaled into the lungs all the way down to the very small bronchioles and alveoli. There they can activate resident cells that in response secrete many different danger signals, such as inflammatory cytokines and oxidation by-products, that seem to have remote effects on blood vessels, for example, as they leave the pulmonary milieu and spill over throughout the circulation. These inflammatory mediators are known to impact cardiac and blood vessel function, and promote a host of acute adverse effects — vasoconstriction, increases in blood pressure, instability in existing atherosclerotic plaques, arrhythmias and reductions in heart pump function.

Inhaled particles can also interact with autonomic nervous system and irritant receptors in the lung. We see, within minutes to hours of exposure, an increase in blood pressure and a triggering of relative increase in sympathetic nervous system activity, which favors arrhythmias and heart attacks.

A more theoretical pathway is that the smallest nano-sized particles, or chemical constituents within larger particulate matter, may be transported directly into the circulation and carried to the vasculature.

Q: Who is most vulnerable to air pollution?

A: People with existing cardiovascular disease appear to be most affected. Epidemiologic studies show that the elderly seem to be at greater risk, as are potentially people with diabetes. Another risk factor can be lower socioeconomic status, which may increase the likelihood of being exposed to toxic or common pollutants, or being more susceptible due to poorer health in general.

Q: Does it follow that people living in regions with higher levels of air pollution have increased risk for cardiovascular disease? Is there a correlation to longevity?

A: Yes. Those who live for long periods exposed to higher levels of pollutants

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have an increased risk for cardiovascular events. It's been estimated that air pollution exposure decreases life expectancy by between one to three years; conversely, the reduction in air pollution levels since 1980 in the U.S. has led to an average seven-month increase in life expectancy. It's a serious problem in places like China, Indonesia, the Middle East and India, where there's a growing epidemic of obesity and westernized habits, in conjunction with an ever-growing urbanization and industrialization causing worse air quality. The two are colluding and leading, we believe, to a potential public health catastrophe within the next few decades.

Q: Do EPA standards address the impact of air pollution on human health and not just the environment?

A: Absolutely, it was principally the undeniable observation of adverse health effects following extreme air pollution episodes during the 1950s and 60s that drove the formation of the first regulations. At that point it was thought that lung-related deaths were the primary problem. We know now that heart diseases are the largest cause of air pollution-related mortality. Our research at the U-M has helped support the science that underpins the veracity of the epidemiologic studies linking air pollution to cardiovascular diseases, which in turn underpin national and international air quality regulations. As a nation, we should be proud of what we've achieved since 1970 in reducing air pollution levels and improving human health. Today our air quality in the U.S. ranks among the best in the world.

Q: Risk factors for cardiovascular disease and stroke such as smoking, poor diet and sedentary lifestyle can be avoided, but air? What do we do about that, as individuals and society?

A: Citizens should be aware of and support our EPA regulations. Through advocacy and educating patients, health care providers can help inform the public of the health importance of keeping our air clean. If people look at images of the air in New York City or other major U.S. metropolitan areas just 30 or 40 years ago, they will realize what a victory we've achieved. Adopting looser air quality regulations now could have disastrous long-term effects on our public health.

Practically speaking, it's important to be aware of air quality indices and forecasts in the media, such as newspapers and websites. People at higher risk can make prudent choices that help reduce their pollution exposures — for example, choosing not to exercise or engage in activity outdoors during peak pollution times like rush hour, or at highly polluted locations like along roadways. When you're driving in traffic, setting the air filtration system to 'recycle' can dramatically reduce particle levels within your vehicle. It's critical to avoid second-hand tobacco smoke, a major source of indoor air pollution, and to reconsider voluntary travel to highly polluted countries or cities.

All you need to do is take a trip to many cities in China, India or the Middle East to see what poor air quality looks and feels like. You'll come home happier that you live where the air is much cleaner to breathe. [M]

Interview by Rick Krupinski