Air Pollution, Heart Disease and Stroke

Exposure to air pollution contributes to the development of cardiovascular diseases (heart disease and stroke).

A person's relative risk due to air pollution is small compared with the impact of established cardiovascular risk factors such as smoking, obesity, or high blood pressure. However, this is a serious public health problem because an enormous number of people are exposed over an entire lifetime.

Background

Until May of 2004, the American Heart Association had not issued any expert reviewed statement about the short-term and long-term effects of chronic exposure to different pollutants. This was due to flaws in research design and methodology of many pollution studies. During the last decade, however, epidemiological studies conducted worldwide have shown a consistent, increased risk for cardiovascular events, including heart and stroke deaths, in relation to short- and long-term exposure to present-day concentrations of pollution, especially particulate matter.

Elderly patients, people with underlying heart or lung disease, lower socioeconomic populations and diabetics may be at particularly increased risk. More research is needed to find out the differential toxicity of various constituents of air pollution.

Components of Air Pollution

Air pollution is composed of many environmental factors. They include carbon monoxide, nitrates, sulfur dioxide, ozone, lead, secondhand tobacco smoke and particulate matter. Particulate matter, also known as particle pollution, is composed of solid and liquid particles within the air. It can be generated from vehicle emissions, tire fragmentation and road dust, power generation and industrial combustion, smelting and other metal processing, construction and demolition activities, residential wood burning, windblown soil, pollens, molds, forest fires, volcanic emissions and sea spray. These particles vary considerably in size, composition and origin.

Particulate Matter and Sulfur Dioxide

The concentrations of both particulate matter and sulfur dioxide often change in parallel. The oxidation of sulfur dioxide in the atmosphere is linked with the formation of various particulate compounds, including acid sulfates.

A 1994 report on the adverse effects of particulate air pollution, published in the *Annual Reviews of Public Health*, noted a 1 percent increase in total mortality for each 10 mg/m^3 increase in particulate matter. Respiratory mortality increased 3.4 percent and cardiovascular mortality increased 1.4 percent. More recent research suggests that one possible link between acute exposure to particulate matter and sudden death may be related to sudden increases in heart rate or changes in heart rate variability.

The Environmental Protection Agency (EPA) has declared that "tens of thousands of people die each year from breathing tiny particles in the

environment." A recent report released by the nonprofit Health Effects Institute in Cambridge, Mass., agrees with the EPA assessment. This study was reviewed by *Science* magazine and clearly shows that death rates in the 90 largest U.S. cities rise by 0.5 percent with only a tiny increase – 10 micrograms (mcg) per cubic meter -- in particles less than 10 micrometers in diameter. This finding is similar to those of other studies throughout the world. The case is stronger with this study, because it eliminated several factors that could confound the interpretation of the data, such as temperature and other pollutants.

The number of deaths due to cardiac and respiratory problems may be small when looking at individual cities with small particles in the environment. The combined long-term effect of studies in several large cities predicts 60,000 deaths each year caused by particulate matter. This is a staggering loss of life that can be eliminated by stricter emissions standards as proposed by the EPA.

Secondhand Tobacco Smoke

Secondhand smoke, also known as environmental tobacco smoke, is the single largest contributor to indoor air pollution when a smoker is present. Studies of secondhand smoke indicate that air pollution in general can affect the heart and circulatory system. Previous research has established that exposure to the secondhand smoke of just one cigarette per day accelerates the progression of atherosclerosis – thus it is plausible that even low doses of air pollution could negatively affect coronary functions.

Carbon Monoxide

Carbon monoxide (CO) is a colorless, odorless and highly poisonous gas. It's a common air pollutant associated with combustion reactions in cars and other vehicles. It's also in cigarette smoke. When the level of CO in blood increases, the level of oxygen that blood can carry decreases. That's why CO in any level is harmful to your body -- and high levels may prove deadly. Long-term, low-level exposure to carbon monoxide may lead to serious respiratory diseases. Smoking tobacco and breathing environmental tobacco smoke raise CO levels in your blood, eventually leading to disease.

Carbon monoxide levels in the blood of nonsmokers vary depending on the quality of air that they generally breathe. The levels are usually 0-8 parts per million (abbreviated ppm). The CO level of smokers is much higher, but it depends on when and how much they smoke, and how they smoke (cigar, pipe, cigarette, etc.). A person who smokes one pack of cigarettes a day has a blood CO level of 20 ppm; someone who smokes two packs a day may have a blood CO level of 40 ppm. When smoking stops, the blood CO level should return to normal in a few days. The following chart shows the level of blood CO and the response to it.

Carbon Monoxide Levels	Responses to CO levels
0-8 ppm	Nonsmoker
20 ppm	Loss of oxygen to vital organs begins
35 ppm	Legal limit of 8-hour exposure in workplace
50 ppm	Urban "Air Pollution Emergency" alert
60 ppm	Headaches, nausea, mild central nervous system dysfunction

Nicotine causes a short-term increase in blood pressure, heart rate and

blood flow from the heart. It can also cause arteries to narrow. The carbon monoxide reduces the amount of oxygen the blood can carry. When combined with nicotine's effects, this creates an imbalance between cells' increased demand for oxygen and the reduced amount of oxygen that the blood can supply.

Nitrogen Dioxide

Nitrogen dioxide (NO2) is a precursor to ozone (O3) formation. Current efforts to reduce ozone levels also target reductions in NO2 levels. In contrast to ozone, NO2 is often found at higher levels indoors compared with outdoors. Mainly this occurs in settings where gas stoves and kerosene heaters are being used.

The main sources of NO and NO2 in outdoor air are emissions from vehicles and from power plants and other fossil fuel-burning industries. NO2 levels vary with traffic density. Annual average concentrations range from 0.015-0.035 ppm. Some highly congested areas like metropolitan Los Angeles ranged from 0.020-0.056 ppm in 1990. Estimates of concentrations inside vehicles in Los Angeles ranged from 0.028-0.078 ppm, where average commuting time was about 6.5 hours per week.

People with respiratory or heart problems should avoid prolonged exposure to high-traffic areas and unventilated heating elements in their homes.

People with asthma appear to be especially vulnerable to the effects of acute NO2 exposure. Healthy people, by contrast, don't seem to show detectable changes in lung function. Exposure to high levels (20 ppm) for several weeks or longer causes emphysema-like changes in the lungs of animals.

EPA Air Quality Standards

The U.S. Environmental Protection Agency (EPA) introduced its 1997 National Ambient Air Quality Standards (NAAQS) to educate the public about daily air quality levels, including information about ozone and particulate matter levels. This daily Air Quality Index was updated in 2003 to include information on fine particle pollution. This index provides information each day for more than 150 cities along with a health alert system that reflects recommended changes in activity on days when pollution is high. These daily updates can be found on the EPA Web site at www.epa.gov/airnow and in many newspapers across the country.

The American Heart Association supports these EPA guidelines for activity restriction for people with heart disease or those who have certain cardiovascular risk factors and for people with pulmonary disease and diabetes and the elderly.

Nineteen percent of all U.S. counties with air-quality monitoring systems are presently not meeting these standards. This inadequacy soars to much higher estimates in regions such as the industrial Midwest (41 percent) and California (60 percent).

American Cancer Society Cohort Study

Recently published data from the American Cancer Society cohort suggested that long-term exposure to fine particulate air pollution at levels that occur in North America is associated with increased risk for cardiovascular mortality by 12 percent for every 10 micrometers of particulate matter within 1 cubic meter of air. Ischemic heart diseases (e.g., heart attacks) account for the largest portion of this increased mortality rate. Other causes, such as heart failure and fatal arrythmias, also increased.

Air Pollution Impact in U.S. Cities

Another study confirmed the importance of variations of pollution within a single city. Its findings suggested that a person's exposure to toxic components of air pollution may vary as much within one city as across different cities. After studying 5,000 adults for eight years, the researchers also found that exposure to traffic-related air pollutants was more highly related to mortality than were city-wide background levels. For example, those who lived near a major road were more likely to die of a cardiovascular event.

Some research has estimated that people living in the most polluted U.S. cities could lose between 1.8 and 3.1 years because of exposure to chronic air pollution. This has led some scientists to conclude that

1. Short-term exposure to elevated levels of particle pollution is associated with a higher risk of death due to a cardiovascular event.
2. Hospital admissions for several cardiovascular and pulmonary diseases rise in response to higher concentrations of particle pollution.
3. Prolonged exposure to elevated levels of particle pollution is a factor in reducing overall life expectancy by a few years.

See also:

Atherosclerosis
Chronic Obstructive Pulmonary Disease
Cigarette Smoking and Cardiovascular Diseases
Cigarette Smoking Statistics
Clean Indoor Air Laws
Environmental Tobacco Smoke
Nicotine Addiction
Nicotine Substitutes / Nicotine Replacement Therapy
Risk Factors and Coronary Heart Disease
Stroke Risk Factors
Sudden Cardiac Death