In the Thick of Air Pollution

Particles May Contribute to Atherosclerosis

Fine particles damage more than just the lungs—the effects reach all the way to the inner lining of the arteries, report researchers from the University of Southern California's Keck School of Medicine, led by Nino Künzli [***EHP* 113:201–206**]. Their paper provides the first epidemiologic evidence linking atherosclerosis with air pollution. It also adds to the growing body of evidence linking pollutants with cardiovascular damage of many types.

To uncover this new evidence, Künzli and colleagues studied 798 men and women from the Los Angeles area. These study subjects were already participating in two clinical trials investigating other aspects of atherosclerosis, or thickening and hardening of the arteries. The selected participants were generally healthy people over 40 who showed some signs of increased risk of cardiovascular disease.

To gauge the participants' exposure to fine particles, the researchers began with year 2000 data from 23 monitoring stations in the Los Angeles basin, then interpolated the data, using a geographic information system and geostatistics, to assign long-term mean ambient particulate matter concentrations to each participant's address. According to the authors, fine particle concentrations have changed little over the past 5–10 years, and the 2000 data are representative of long-term exposure. This novel approach allowed a more accurate approximation of exposures than simply using readings from the closest monitor.

The potential effects of fine particles were assessed using data gathered previously on the thickness of the two inner layers of the carotid artery, which feeds the head and neck. This technique has become generally accepted as a reliable indicator of atherosclerosis, which happens slowly in all people and is a leading contributor to death in most countries. In their statistical analysis of the data the researchers accounted for other factors such as diet, use of vitamin supplements and hormone replacement drugs, physical activity, blood pressure, education, and income.

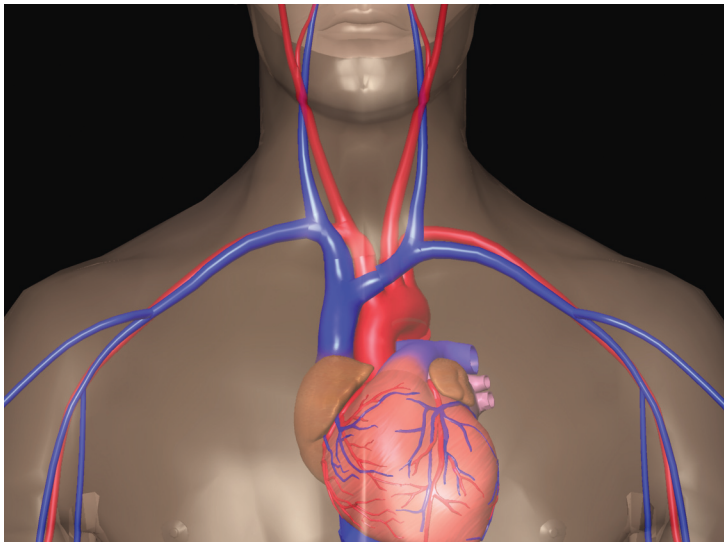
Overall, the researchers found that for each increase in fine particles of 10 micrograms per cubic meter ($\mu g/m^3$), the two inner layers of the carotid artery thickened by about 4%. For the selected monitoring stations, fine particle concentrations ranged from 5.2 to 26.9 $\mu g/m^3$. That means the most-exposed participants in this study experienced about 8% more artery thickening than the least-exposed participants.

However, not all participants were found to be equally vulnerable. Women over age 60 experienced artery thickening of about 15% for each 10-$\mu g/m^3$ increase. In general women were much more vulnerable than men, although no link was observed for women taking hormone replacement drugs. Others who were significantly more vulnerable included both male and female nonsmokers as well as men and women taking drugs to reduce cholesterol.

The researchers studied one other pollutant, ozone, and found some correlations but no significant link with atherosclerosis. However, they acknowledge some weaknesses in their ability to detect links, given their methods and available data. For example, previous studies cited by the authors indicate that outdoor ozone measurements are very weakly correlated with actual personal exposures.

Künzli and colleagues acknowledge other limitations as well, and say much more research needs to be done. For instance, the selection of participants focused on a relatively healthy population and may have excluded those at highest risk. Also, the relatively low numbers of people in each subgroup analyzed add to the possibility that the findings for these groups may not be accurate.

In addition, the projections for exposure to fine particulates measured outdoors have some small margin of error. Using just these data also excludes exposures in vehicles, workplaces, and other enclosed settings, where people generally spend the vast majority of their time. Other studies have found significant increases in indoor and in-vehicle concentrations of many pollutants, including fine particles, compared to measurements taken at nearby outdoor monitoring stations. **–Bob Weinhold**



In the thick of it. New data provide the first epidemiological evidence that exposure to fine particles can contribute to atherosclerosis—a thickening and hardening of the arteries—in generally healthy adults.

LifeART

Airborne Bacteria in CAFOs

Transfer of Resistance from Animals to Humans

Antibiotics are used in concentrated animal feeding operations (CAFOs) to treat and prevent livestock disease and to bolster animal growth and the nourishment efficiency of feed. These nontherapeutic uses involve long-term, low-level dosing that creates an appropriate environment for bacteria to develop antibiotic resistance. Several antibiotics used in animal agriculture are the same as or similar to those used in human medicine; transference of resistant microbes from animals to humans could further undermine antibiotic effectiveness against human disease. A research team including Amy Chapin of the Johns Hopkins Bloomberg School of Public Health examines one possible way that resistance may be transferred from animals to humans [***EHP* 113:137–142**].

Previous studies have examined the potential for infection with resistant microbes via animal waste–polluted water in the vicinity of a CAFO and contaminated food products. This study offers evidence for infection occurring in a way that has not been previously considered.

According to the Johns Hopkins team, inhalation of airborne bacteria could constitute another exposure pathway. It is already well documented that air within swine CAFOs can be heavily contaminated with bacteria. Several of the bacterial species are normally present in animals and humans but can sometimes cause illness. The current study is one of the first to investigate antibiotic resistance in airborne bacteria in a swine CAFO.

Working in a swine finishing CAFO in the mid-Atlantic United States, the researchers collected air samples in December 2003 and January 2004. The air samples were then conveyed to the laboratory for bacterial isolation and speciation.

Initial tests yielded 137 presumptive *Enterococcus* species isolates, and further tests confirmed that 47 were enterococci. Of the remaining 90 isolates, 44 were coagulase-negative staphylococci, 45 were viridans group streptococci, and 1 was *Micrococcus luteus*.

Each isolate then underwent testing to determine susceptibility to the antibiotics erythromycin, clindamycin, tetracycline, vancomycin, and virginiamycin. The first four of these drugs are used in human medicine; the last, virginiamycin, closely enough resembles a human drug that bacteria resistant to one will be resistant to the other. Of the five antibiotics, only vancomycin is not approved for livestock use in the United States.

All of the isolates were susceptible to vancomycin, but 121 were resistant to at least two of the antibiotics used in swine production; 115 were resistant to three. These results underscore the relationship between antibiotic use and the emergence of resistance: in the absence of use, resistance is unlikely to develop.

In some situations, the bacterial species found in CAFO air samples can cause human disease. *Enterococcus* species and coagulase-negative staphylococci are leading causes of infections in health care settings. Viridans group streptococci, normally found in the respiratory tract, are linked to life-threatening infections in immune-compromised individuals. The viridans group streptococci are also suspected reservoirs for erythromycin resistance genes, which could potentially be transferred to more pathogenic streptococci.

The researchers conclude that exposure to airborne bacteria from a CAFO presents a potential pathway for transferring antibiotic-resistant bacteria from animals to humans. CAFO workers and the people with whom they come in direct contact, as well as neighbors near the operations and areas of land where animal wastes are applied, may be especially at risk. Continuing research of the transfer of antibiotic-resistant bacteria from animals to humans needs to encompass a variety of environmental media that may serve as exposure sources. **–Julia R. Barrett**

Building and bonding. Understanding the stress-fighting effects of certain elements of the built environment may shed light on how people's surroundings affect their quality of life.

Topophilia and Quality of Life

Defining the Ultimate Restorative Environment

Mental stress is increasingly recognized as an environmental contributor to disease burden in many parts of the world. One way people try to reduce mental stress is through features of the built environment. Architects often give us "nature" in the form of water or trees to create restorative settings, while others favor complex and challenging sculpture or structures. In this month's issue, Oladele A. Ogunseitan of the University of California, Irvine, asks us to consider the study of topophilia as a source for criteria to help us judge which elements of an environment truly have a restorative effect [***EHP* 113:143–148**].

The term *topophilia* was coined by the geographer Yi-Fu Tuan of the University of Wisconsin and is defined as the affective bond with one's environment—a person's mental, emotional, and cognitive ties to a place. Topophilia is studied here as a latent construct, an abstract psychological concept similar to "attitude" or "intelligence" whose variability can only be observed indirectly through its effect on measurable responses.

Ogunseitan surveyed 379 people on the Irvine campus, asking them to rate the importance of features such as color, flowers, and complexity to an environment they consider restorative. He then compared these values with data from a World Health Organization quality of life (QOL) survey administered along with the topophilia questions.

The environmental features surveyed mapped closely onto four domains of topophilia: ecodiversity (the presence of flowers, water, and other elements of nature), synesthetic tendency (a commingling of colors, smells, and other sensory stimuli), environmental familiarity (which includes spaciousness and privacy), and cognitive challenge (which includes structural complexity and texture). Structural equation modeling showed a positive correlation between topophilia and various aspects of QOL. That is, people who had the highest topophilia ratings (who, for example, most highly valued flowers or color as important for achieving a restorative effect) tended to have the highest QOL scores. Ecodiversity had the highest correlation with overall QOL. Within this category, the presence of flowers and proximity to lakes or the ocean were most significantly correlated with QOL.

Ogunseitan notes that "complexity" and other features associated with the cognitive domain—and much loved by some architects—were not linked with higher QOL. He also was surprised that none of the synesthetic tendency qualities such as smells or sounds were associated with improved QOL, given the postulated health benefits—and obvious commercial appeal—of aromatherapy and recorded "nature" sounds.

The results would appear to buttress previous research indicating that people prefer "natural" environments to those that emphasize complex designs or artificial sensory stimulation, but Ogunseitan stresses that this study represents only an initial foray into understanding the complex relationship between quality of life and restorative environments. The current study design assumes that when people rate aspects of their environment highly, there really is a chance that those features are restorative to mental health beyond their aesthetic appeal. Although the results of such correlational research do not imply causation, Ogunseitan notes, they can offer insights to guide future research. **–Hakon Heimer**