

compounds, beryllium, bis(chloromethyl) ether, chromium (hexavalent), formaldehyde (nasal), isopropanol (nasal sinuses), mustard gas, nickel carbonyl (nickel smelting), polycyclic aromatic hydrocarbons (coke oven emissions and diesel exhaust), secondhand tobacco smoke, silica (both mining and processing), talc (possible asbestos contamination in both mining and milling), vinyl chloride (sarcomas), wood (nasal cancer only), and uranium. Workers at risk of radiation-related lung cancer include not only those involved in mining or processing uranium but also those exposed in underground mining operations of other ores where radon daughters may be emitted from rock formations.

### ASSESSMENT OF DISABILITY

*Disability* is the term used to describe the decreased ability to work due to the effects of a medical condition. Physicians are generally able to assess physiologic dysfunction, or *impairment*, but the rating of disability for compensation of loss of income also involves nonmedical factors such as the education and employability of the individual. The disability rating scheme differs with the compensation-granting agency. For example, the U.S. Social Security Administration requires that an individual be unable to do any work (i.e., *total* disability) before he or she will receive income replacement payments. Many state workers' compensation systems allow for payments for *partial* disability. In the Social Security scheme, no determination of cause is done, whereas work-relatedness must be established in workers' compensation systems.

For respiratory impairment rating, resting pulmonary function tests (spirometry and diffusing capacity) are used as the initial assessment tool, with cardiopulmonary exercise testing (to assess maximal oxygen consumption) used if the results of the resting tests do not correlate with the patient's symptoms. Methacholine challenge (to assess airway reactivity) can also be useful in patients with asthma who have normal spirometry when evaluated. Some compensation agencies (e.g., Social Security) have proscribed disability classification schemes based on pulmonary function test results. When no specific scheme is proscribed, the *Guidelines of the American Medical Association* should be used.

### GENERAL ENVIRONMENTAL EXPOSURES

#### OUTDOOR AIR POLLUTION

In 1971, the U.S. government established national air quality standards for several pollutants believed to be responsible for excess cardiorespiratory diseases. Primary standards regulated by the U.S. Environmental Protection Agency (EPA) designed to protect the public health with an adequate margin of safety exist for sulfur dioxide, particulates matter, nitrogen dioxide, ozone, lead, and carbon monoxide. Standards for each of these pollutants are updated regularly through an extensive review process conducted by the EPA. (For details on current standards, go to <http://www.epa.gov/air/criteria.html>.)

Pollutants are generated from both stationary sources (power plants and industrial complexes) and mobile sources (motor vehicles), and none of the regulated pollutants occurs in isolation. Furthermore, pollutants may be changed by chemical reactions after being emitted. For example, sulfur dioxide and particulate matter emissions from a coal-fired power plant may react in air to produce acid sulfates and aerosols, which can be transported long distances in the atmosphere. Oxides of nitrogen and volatile organic compounds from automobile exhaust react with sunlight to produce ozone. Although originally thought to be confined to Los Angeles, photochemically derived pollution ("smog") is now known to be a problem throughout the United States and in many other countries. Both acute and chronic effects of these exposures have been documented in large population studies.

The symptoms and diseases associated with air pollution are the same as conditions commonly associated with cigarette smoking. In addition, decreased growth of lung function and asthma have been associated with chronic exposure to only modestly elevated levels of traffic-related gases and respirable particles. Multiple population-based time-series studies within cities have demonstrated excess health care utilization for asthma and other cardiopulmonary conditions as well as increased mortality rates. Cohort studies comparing cities that

have relatively high levels of particulate exposures with less polluted communities suggest excess morbidity and mortality rates from cardiopulmonary conditions in long-term residents of the former. The strong epidemiologic evidence that fine particulate matter is a risk factor for cardiovascular morbidity and mortality has prompted toxicologic investigations into the underlying mechanisms. The inhalation of fine particles from combustion sources probably generates oxidative stress followed by local injury and inflammation in the lungs that in turn lead to autonomic and systemic inflammatory responses that can induce endothelial dysfunction and/or injury. Recent research findings on the health effects of air pollutants has led to stricter U.S. ambient air quality standards for ozone, oxides of nitrogen, and particulate matter as well as greater emphasis on publicizing pollution alerts to encourage individuals with significant cardiopulmonary impairment to stay indoors during high-pollution episodes.

#### INDOOR EXPOSURES

Secondhand tobacco smoke (Chap. 470), radon gas, wood smoke, and other biologic agents generated indoors must be considered. Several studies have shown that the respirable particulate load in any household is directly proportional to the number of cigarette smokers living in that home. Increases in prevalence of respiratory illnesses, especially asthma, and reduced levels of pulmonary function measured with simple spirometry have been found in the children of smoking parents in a number of studies. Recent meta-analyses for lung cancer and cardiopulmonary diseases, combining data from multiple secondhand tobacco smoke epidemiologic studies, suggest an ~25% increase in relative risk for each condition, even after adjustment for major potential confounders.

Exposure to *radon gas* in homes is a risk factor for lung cancer. The main radon product (radon-222) is a gas that results from the decay series of uranium-238, with the immediate precursor being radium-226. The amount of radium in earth materials determines how much radon gas will be emitted. Levels associated with excess lung cancer risk may be present in as many as 10% of the houses in the United States. When smokers reside in the home, the problem is potentially greater, because the molecular size of radon particles allows them to attach readily to smoke particles that are inhaled. Fortunately, technology is available for assessing and reducing the level of exposure.

Other indoor exposures of concern are bioaerosols that contain antigenic material (fungi, cockroaches, dust mites, and pet danders) associated with an increased risk of atopy and asthma. Indoor chemical agents include strong cleaning agents (bleach, ammonia), formaldehyde, perfumes, pesticides, and oxides of nitrogen from gas appliances. Nonspecific responses associated with "tight-building syndrome," perhaps better termed "building-associated illness," in which no particular agent has been implicated, have included a wide variety of complaints, among them respiratory symptoms that are relieved only by avoiding exposure in the building in question. The degree to which "smells" and other sensory stimuli are involved in the triggering of potentially incapacitating psychological or physical responses has yet to be determined, and the long-term consequences of such environmental exposures are unknown.

#### GLOBAL CONSIDERATIONS



Indoor exposure to *biomass smoke* (wood, dung, crop residues, charcoal) is estimated to be responsible for >4% of worldwide disability-adjusted life-years (DALYs) lost, due to acute lower respiratory infections in children, COPD and lung cancer in women, and cardiovascular disease among men. This burden of disease places indoor exposure to biomass smoke as the leading environmental hazard for poor health and the third most important risk factor overall.

Almost one-half of the world's population uses biomass fuel for cooking, heating, or baking. This occurs predominantly in the rural areas of developing countries. Because many families burn biomass fuels in open stoves, which are highly inefficient, and inside homes with poor ventilation, women and young children are exposed on a daily basis to high levels of smoke. In these homes, 24-h mean levels