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Occupational and Environmental Health: Twenty-First Century Challenges and Opportunities

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Occupational and environmental health is the multidisciplinary approach to the recognition, diagnosis, treatment, and prevention of illnesses, injuries, and other adverse health conditions resulting from hazardous environmental exposures in the workplace, the home, and the community. It is a component of medical care and of public health—what we, as a society, do collectively to ensure that the conditions in which people live and work are healthy.

The twenty-first century presents many challenges and opportunities for occupational and environmental health, as illustrated by the following examples:

A 2-year-old girl, during a routine well-child checkup, is found to have an elevated blood lead level of 20 µg/dL. Could it be related to her father's work in a smelter or the water pipes in her home?

A pregnant woman works as a laboratory technician. Should she change her job because of the organic solvents to which she—and her fetus—are exposed? Is it safe for her to eat fish with elevated levels of mercury?

A middle-aged man tells his orthopedic surgeon that he is totally disabled from chronic back pain. Could it

be due to his many years of heavy lifting as a construction worker?

A long-distance truck driver has recently had a myocardial infarction. When will he be able to safely return to work, and what kinds of tasks will he be able to perform?

The board of directors of a chemical company approves its production of a carcinogenic pesticide that has recently been banned in the United States. Is it ethical for the company to export it for use in developing countries?

The wife of a former asbestos worker has developed a pleural mesothelioma, presumably as a result of having washed her husband's work clothes for many years. Can she or her family receive any compensation?

An oncologist observes an unusual cluster of bladder cancer cases in a small town. Should she ask the state health department to perform an investigation?

An elderly man suffers from emphysema due to his long history of cigarette smoking. Should he curtail his activities during air pollution alerts?

Several members of a family who live next to a hazardous waste site smell odors from the site and have

developed headaches, nausea, and other symptoms. What should they do?

An epidemiologic study has found a higher lung cancer mortality rate among workers at a chemical factory. What further research studies and preventive measures should be performed?

The vice president of a small tool and die company wants to promote health of company employees. What advice would you give her?

These are but a few of the many occupational and environmental health challenges facing health workers, all of whom need to recognize and help prevent occupational and environmental health problems.

Many hazardous exposures occur in both workplaces and the general environment, such as the following:

- Contamination of the ambient air and water near a chemical factory, where its workers are also exposed to hazardous substances
- Application by agricultural workers of pesticides that may contaminate surface and ground water
- Inadvertent transport of lead, asbestos, and other hazardous substances home on workers' clothes, shoes, skin, and hair
- Exposure of workers and community residents to hazardous wastes from an industrial facility

Whether the environment is a workplace, school, home, or community setting, the pathophysiology of specific hazards in humans is the same. However, the sociology and history of environmental health and occupational health have evolved along separate tracks, with differences of focus, scale, and the people involved.

Hippocrates recognized the importance of air quality for health, although he was concerned only with the few Greeks who were "citizens"—not for the slaves or the free workers who supported them. Pliny the Elder recognized the ill effects of lead on slaves who painted ships in the first century C.E., but the use of lead in making cookware, sweetening foods, and souring vintages persisted for more than 1,800 years. Occupational hazards were not addressed

systematically until 1700, when Bernardino Ramazzini, an Italian physician, published *De Morbis Artificum Diatriba* (*On the Diseases of Workers*). Starting in the 1920s, Alice Hamilton, a U.S. physician and colleague of the social reformer Jane Addams, pioneered occupational health as a specialty of public health and preventive medicine. In the 1960s, Rachel Carson, a U.S. biologist and ecologist, focused public attention on the wider impact of industrial pollution in her widely read book, *Silent Spring*. In the past 40 years, extraordinary developments in science, technology, legislation, public health, and social empowerment have led to much progress in occupational and environmental health.

Even though the nature of many occupational and environmental health problems is similar, workers tend to be exposed more intensively than community residents to various hazards, and, historically, have worked for many years in a given workplace—although this is less true today. As a result, the relationship between occupational exposures and adverse health effects has provided much of the information known about hazardous substances. Populations of community residents include not only workers, who are typically healthy, but also people who are very young, those who are very old, and those with chronic diseases and other health conditions that often make them vulnerable to hazardous exposures. Exposures of community residents are often continuous, although generally at lower levels than the exposures of workers. Environmental health focuses not only on hazardous substances emanating from industrial facilities but also on such fundamental issues as sanitation, safety of food and water, and control of pests.

While there are many similarities and overlapping issues between occupational health and environmental health, governmental regulatory agencies and various health and safety disciplines have evolved in ways that have separated occupational health and environmental health. For example, in the United States, there are separate federal regulatory agencies for occupational health—such as the Occupational Safety and Health Administration (OSHA) and the Mine Safety and Health Administration (MSHA)—and environmental health—such as

the Environmental Protection Agency (EPA). In addition, there are separate federal agencies for research in occupational health—the National Institute for Occupational Safety and Health (NIOSH), within the Centers for Disease Control and Prevention (CDC)—and environmental health—the National Institute for Environmental Health Sciences (NIEHS) within the National Institutes of Health (NIH), the Office of Research and Development within the EPA, and the National Center for Environmental Health (NCEH) and the Agency for Toxic Substances and Disease Registry (ATSDR) within the CDC. Similar separation exists within state and local government agencies, educational and research institutions, non-governmental organizations (NGOs), professional associations, and elsewhere.

Occupational and environmental safety and health hazards can be classified in many ways, including the following:

1. *Safety hazards*, which result in injuries through the uncontrolled transfer of energy to vulnerable recipients from sources such as electrical, thermal, kinetic, chemical, or radiation energy. Examples include unsafe playground equipment, loaded firearms in the home, motor-vehicle or bicycle crashes, unprotected electrical sources, work at heights without fall protection, work near unguarded moving machinery, and work in unshored trenches.
2. *Health hazards*, which result in environmental or occupational illnesses, including the following:
 - a. *Chemical hazards*, including heavy metals, such as lead and mercury; pesticides; organic solvents, such as benzene and trichloroethylene; and many other chemicals. There are approximately 80,000 chemicals in commercial use, 15,000 of which are frequently produced or used. Approximately 1,000 new chemicals are added to commercial use annually.
 - b. *Physical hazards*, such as excessive noise, vibration, extremes of temperature and pressure, and ionizing and nonionizing radiation.
 - c. *Biomechanical hazards*, such as heavy lifting, repetitive or awkward or forceful movements that result in musculoskeletal disorders, like carpal tunnel syndrome and low back pain.
 - d. *Biologic hazards*, such as human immunodeficiency virus (HIV), hepatitis B and hepatitis C viruses, the tubercle bacillus, and many other bacteria, viruses, and other microorganisms that may be transmitted through air, water, food, or direct contact.
 - e. *Psychosocial hazards*, such as workplaces where there is high stress due to excessive demands on, and low control by, workers; stress and hostility resulting from urban congestion, such as “road rage”; and unemployment—a major stressor.

MAGNITUDE OF PROBLEMS

Estimates have been published concerning the occurrence of occupational injuries and illnesses in the United States.¹ In 2008, a total of 5,214 workers died from occupational injuries.² Another 49,000 annual deaths are attributed to work-related diseases each year.³ In 2008, an estimated 3.7 million workers in private industry and 940,000 workers in state and local government had a nonfatal occupational injury or illness; approximately half of them were transferred, placed on work restrictions, or took time away from work.⁴ In 2007 (the most recent year for which data are available), an estimated 3.4 million workers were treated in emergency departments for occupational injuries and illnesses; approximately 94,000 of these workers were hospitalized.⁵ Work-related injuries and illnesses are costly. In 2006, employers spent almost \$87.6 billion on workers' compensation insurance payments;⁶ however, this amount represents only part of all work-related injury and illness costs borne by employers, workers, and society overall, largely because the cost of many injuries and most illnesses are shifted to other health insurance systems. In developing countries, the occurrence of occupational injuries and illnesses is much higher than in this country. On an average workday in the United States,

thousands of workers become temporarily or permanently disabled and 13 workers die from workplace injuries. The highest fatal occupational injury rates are in mining, construction, and agriculture (Chapter 36). In addition, an unknown number of workers die from occupational illnesses, which affect several organ systems (Table 1-1). Many workers are exposed to occupational health and safety hazards in the workplace as well as environmental health and safety hazards at home and elsewhere. Table 1-2 describes employed civilians in the United States by industry. There has been a declining percentage of workers in the United States in heavy industry (Figs. 1-1 and 1-2) and an increasing percentage in service industries (Fig. 1-3).

The scope of environmental health problems is broad, as reflected in the subjects of the environmental health objectives for the United States for the year 2010 (Table 1-3). (Environmental health objectives for the year 2020 were not available at the time of publication of this book. They can be accessed at <http://www.healthypeople.gov>.) Outdoor air pollution remains a widespread environmental and public health problem, causing chronic impairment of the respiratory and cardiovascular systems, cancer, and premature death (Fig. 1-4; see also Chapter 6). Approximately 113 million people in the United States reside in areas designated as “nonattainment areas” by the EPA for one or more of the six air pollutants for which the federal government has promulgated health-based standards (ozone, carbon monoxide, sulfur dioxide, lead, particulates, and nitrogen dioxide). Motor vehicles and electrical power plants account for much ambient air pollution in the

Table 1-1. Major Categories of Occupational Illness, by Organ System

Musculoskeletal disorders
Respiratory disorders
Neurologic and psychiatric disorders, including hearing impairment
Skin disorders
Reproductive and developmental disorders
Cardiovascular disorders
Hematologic disorders
Hepatic disorders
Renal and urinary tract disorders

Table 1-2. Employees on Nonfarm Payrolls by Major Industry Sector, Seasonally Adjusted (September 2009)

Industry	Size of Workforce (in millions)
Services	55.4
Professional and business services	17.6
Educational services	3.2
Health care and social assistance	16.0
Leisure and hospitality	13.1
Other services	5.5
Government	23.0
Wholesale and retail trade	21.4
Manufacturing	13.1
Financial activities	8.0
Construction	7.1
Transportation and warehousing	4.5
Information	3.0
Mining and logging	0.8
Total	113.3

Source: From the Bureau of Labor Statistics, U.S. Department of Labor. Accessed on December 5, 2009, at: <http://www.bls.gov>.

United States. Water quality continues to be a problem from both point sources, such as industrial sites, and nonpoint sources, such as agricultural runoff (Fig. 1-5; see also Chapter 8). Toxic and hazardous substances, in addition to posing health problems for exposed workers, may also cause health problems to people exposed where they live and play. Children are at increased risk for many environmental health problems, including pesticide poisoning, because of (a) the developing state of their neurological and other organ systems, (b) their higher ratio of skin surface area to body mass, and (c) pesticides and other toxic substances may be improperly stored or applied in areas that are easily accessible to children.

Many additional environmental factors can adversely affect the health of people in their homes and communities. These include poor indoor air quality (Chapter 7), lead-based paint (Fig. 1-6) and lead-containing water pipes, household cleaning products, mold, radon, and electrical and fire hazards. Over 90% of poison exposures reported by the American Association of Poison Control Centers have occurred in the home environment.

There are fewer reliable data available for the occurrence of environmentally related, than for

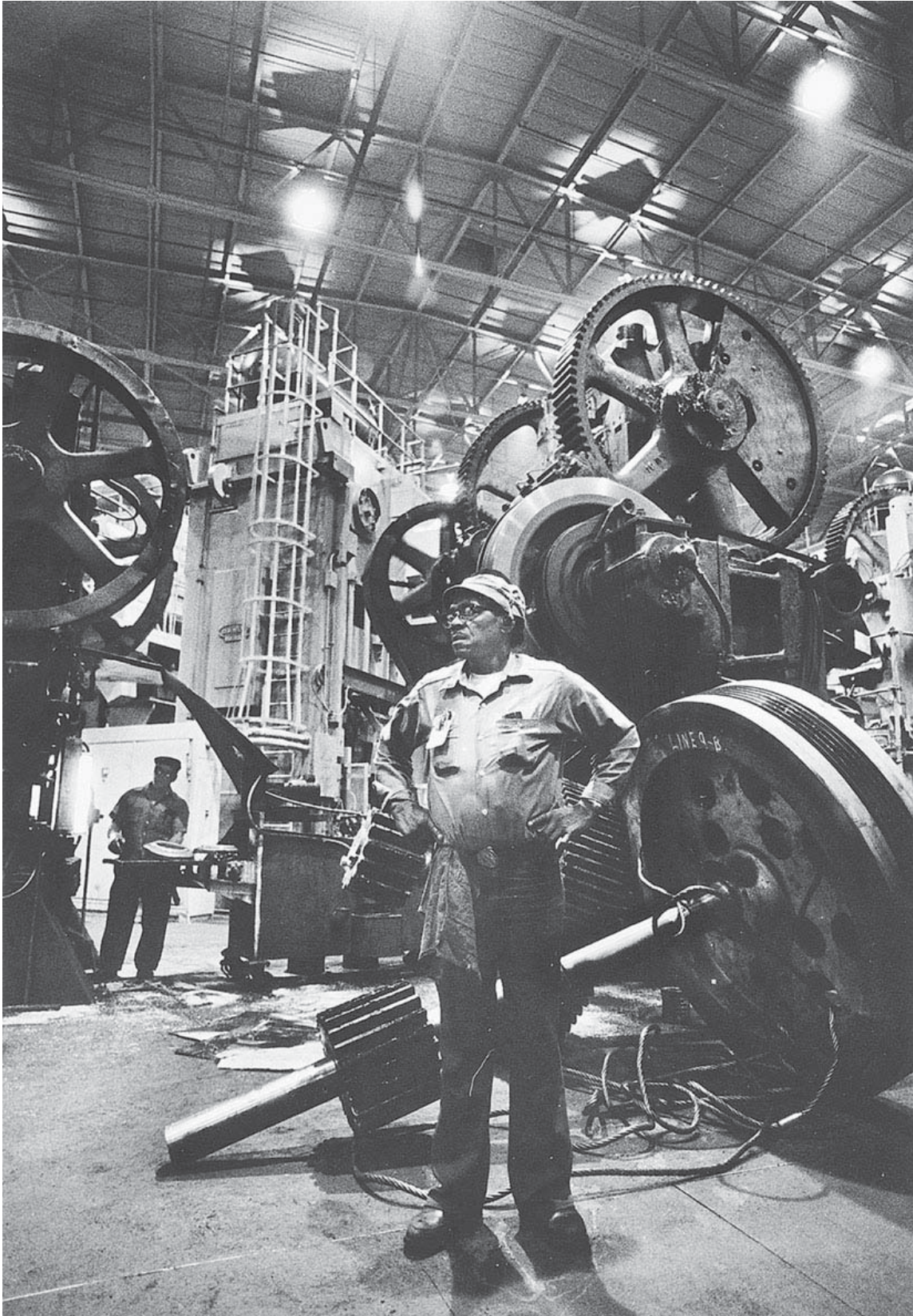


Figure 1-1. Worker at a wheel stamping plant in Michigan. Manufacturing still represents an important part of the economy and a source of many occupational health and safety hazards. (Photograph by Earl Dotter.)

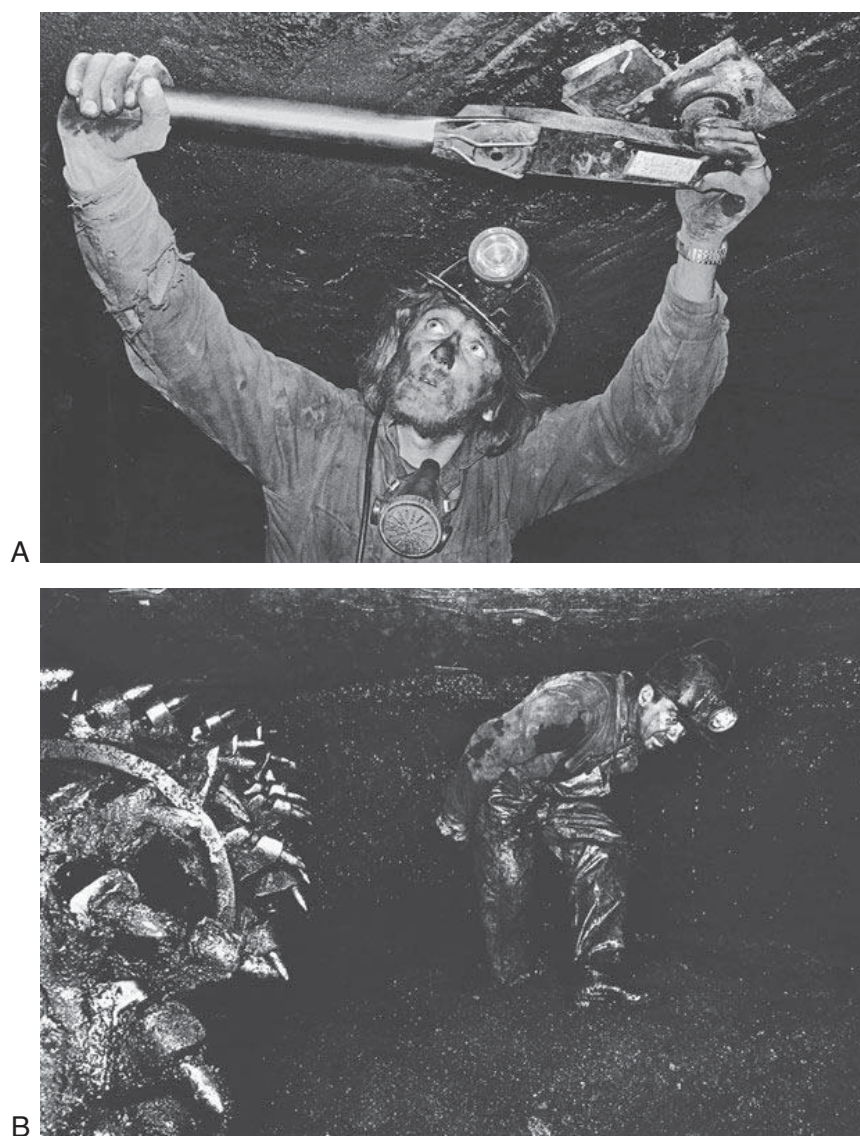


Figure 1-2. Coal miners face many occupational health and safety risks, including injuries and exposure to hazardous dusts, gases, and other substances. (A) Coal miner tests the roof support bolts in a mine. (B) Coal miner is exposed to ergonomic hazards from working in narrow mine passages. (Photographs by Earl Dotter.)

occupationally related, diseases and injuries. For some disorders, such as childhood lead poisoning, there are extensive data from screening programs, which, for example, show that 2.2% of children age 1 to 5 years had, in 2000, elevated blood lead levels (greater than 10 $\mu\text{g}/\text{dL}$). In contrast, data on pesticide poisoning are rather limited, and many cases go unreported because of the nonspecificity of symptoms. California, the state with the most extensive pesticide poisoning reporting system, found that 40% of the over 1,300 reported cases were due to

nonoccupational exposures. As another example, there are extensive data on acute injuries in the home, on the road, and in other settings from various sources, ranging from vehicles to firearms. In the United States in 2000, about 30 million people were treated for injuries in emergency departments and almost 150,000 people were hospitalized. Motor-vehicle crashes are the leading cause of injury deaths, accounting for 30%. And while there are extensive data on ambient air pollution, there are only limited data on acute and chronic morbidity and



Figure 1-3. Health care workers, including these laundry workers in New York, face a number of occupational hazards, including human immunodeficiency virus, hepatitis B, hepatitis C, and other infections associated with needlestick injuries. These laundry workers found these sharp objects in soiled bed linens over the course of a year. (Photograph by Earl Dotter.)

mortality that are due to air pollution. The prevalence of asthma for the entire U.S. population between 2005 and 2007 was estimated to be 7.7%. There are a number of environmental causes of asthma, such as air pollution, environmental tobacco smoke (see Box 7-1 in Chapter 7), and other allergens. Firearms account for approximately 30,000 deaths in the United States each year.

Many occupational and environmental health problems escape detection for a variety of reasons. The difficulty in obtaining accurate estimates of the frequency of exposure-related diseases is due to several factors, as indicated below and in Figure 1-7:

1. Many problems do not come to the attention of health professionals, employers, and others, and therefore are not included in data collection systems. A worker or community resident may not recognize a medical problem as being occupationally or environmentally related, even when the connection is known. Educating workers and community residents about hazards, such as through community and workplace right-to-know campaigns, has been helpful.
2. Many occupational and environmental medical problems that do come to the attention of physicians, employers, and others are not recognized as occupationally and environmentally related. Recognition of occupational and environmental disorders is often difficult because of the long period between initial exposure and onset of symptoms (or time of diagnosis), making cause-and-effect relationships difficult to determine. It is also difficult because of the many and varied occupational and environmental hazards to which people are exposed over many years. The training of health professionals in occupational and environmental health has begun to improve health care providers' knowledge of these factors, resulting in increased recognition of occupational and environmental diseases and injuries.
3. Some health problems recognized by health professionals, employees, or others as occupationally or environmentally related are not reported because the association with the workplace or other environments is equivocal and because reporting requirements are not strict.

Table 1-3. Subjects of Environmental Health Objectives for the Year 2010, United States

Subjects	Subtopics
Outdoor Air Quality	Harmful air pollutants Alternative modes of transportation Cleaner alternative fuels
Water Quality	Airborne toxins Safe drinking water Waterborne disease outbreaks Water conservation Surface water health risks Beach closings Fish contamination
Toxics and Waste	Elevated blood lead levels in children Risks posed by hazardous waste sites Pesticide exposures Toxic pollutants Recycled municipal solid waste
Healthy Homes and Healthy Communities	Indoor allergens Office building air quality Homes tested for radon Radon-resistant new home construction School policies to protect against environmental hazards Disaster preparedness plans and protocols Lead-based paint testing Substandard housing
Infrastructure and Surveillance	Exposure to pesticides Exposure to heavy metals and other toxic chemicals Information systems used for environmental health Monitoring environmentally related diseases Local agencies using surveillance data for vector control
Global Environmental Health	Global burden of disease Water quality in the U.S.–Mexico border region

Source: <http://www.healthypeople.gov/document/HTML/Volume1/08Environmental.htm>. Accessed on August 10, 2010.

For example, there are only a few states where reporting of pesticide poisoning by physicians is mandatory. The initiation of occupational and environmental disease and injury surveillance activities by federal and state governments has begun to address this problem (see Chapter 3).

4. Because many occupational and environmental health problems are preventable, their very persistence implies that some individual, group, or organization is legally and economically responsible for creating or perpetuating them.

CONTEXT

Occupational and environmental health problems must be understood in social, economic, political, and historical contexts. In addition, the

health and well-being of people exists in a broad ecological context. Health and safety professionals as well as many other “actors,” operating in a political, economic, and social context, become involved in the recognition, assessment, and prevention and control of occupational and environmental health problems. These include the following:

- Workers, including members of labor unions
- Employers
- Representatives of business and industry associations
- Community residents
- Members of environmental non-governmental organizations (NGOs)
- Workers in the executive, legislative, and judicial branches of government at the federal, state, and local level
- Officials of international organizations



Figure 1-4. Ambient air pollution from a coal-cleaning plant in a rural area in Pennsylvania. (Photograph by Earl Dotter.)

Educators and trainers

Researchers

Print and broadcast journalists and other representatives of the news media

Officials of charitable organizations that provide financial support to programs and projects

These “actors” play different roles, rely on different sources of power and support, have different strengths and vulnerabilities, and interact with each other in multiple ways.

Partly because the treatment of occupational and environmental disorders and those not related to occupational and environmental exposures is the same, this book focuses on the recognition and prevention of these problems. Recognition focuses not only on detecting occupational and environmental illnesses and injuries in symptomatic and asymptomatic individuals (Chapter 2) but also on applying the principles of public health surveillance for detecting individual cases and overall trends of disease and injury occurrence in populations (Chapter 3).



Figure 1-5. Although nonpoint sources account for increasing amounts of water pollution in the United States, stationary point sources still account for a substantial amount of water pollution, such as with dioxin, a by-product of the manufacture of bleached white paper at this Mississippi plant. (Photograph by Earl Dotter.)



Figure 1-6. Lead-based paint in many older homes still represents a serious health hazard to many young children. This photograph depicts a lead abatement worker with personal protective equipment. Workers performing lead abatement must be trained and certified, and they must carefully adhere to safe practice standards. (Photograph by Earl Dotter.)

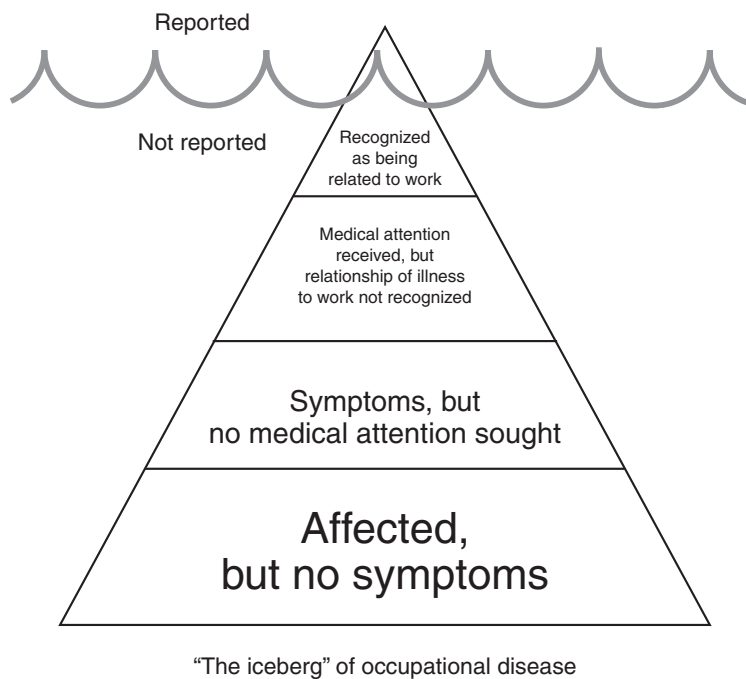


Figure 1-7. Most occupational and environmental disease is below the surface, as illustrated by the iceberg effect in this figure.

Public health principles have been applied to occupational and environmental health in preventing and controlling these adverse health effects (Chapter 2). *Primary prevention* focuses on diseases or injuries before they occur. *Secondary prevention* focuses on early identification and treatment of diseases to cure them or halt

their progression. And *tertiary prevention* focuses on treatment and rehabilitation of individuals who have already developed diseases or injuries.

Another useful perspective on identifying opportunities for prevention and designing and implementing preventive measures is the traditional public health model of host, agent,

and environment. Many preventive measures focus on the host, such as the individual worker or community resident. These include education and labeling, screening programs, and, where other measures cannot be implemented, use of appropriate personal protective equipment. Other preventive measures focus more on the agent, such as insulation containing asbestos, and control measures are focused on restricting or banning production or use of the agent, or reducing human exposure to acceptable levels of risk. And some preventive measures focus on the environment. For example, designing and implementing engineering measures, such as local exhaust ventilation, can remove airborne hazards in the workplace, or installing sound-barrier walls alongside highways can reduce noise levels in adjacent residential neighborhoods. Other examples include urban planning to design more green space or bicycle routes.

ILLUSTRATIVE OCCUPATIONAL AND ENVIRONMENTAL HEALTH ISSUES

Legislation, social activism, educational activities, and other developments have contributed to increased interest in occupational and environmental health problems in recent years. Some of these developments are summarized next.

Changing Nature of Work and the Workforce

Enormous changes in work structure have taken place in recent decades, including mergers and, paradoxically, downsizing and outsourcing. For example, the production, packing, and distribution of meat in the United States is radically different now than it was 40 years ago. The number of poultry, beef, and pork producers has decreased while the size of the producers has grown. Family farms have given way to concentrated animal production operations, with large-scale production and mechanized processes, which have led to concerns about exploitation of workers, animal welfare, environmental contamination from concentrated waste, and production of greenhouse gases. Meat packaging and poultry processing plants have relocated

near to large producers, and their workforce has been transformed from relatively highly paid, unionized, mostly white workers to one that is heavily comprised of immigrant Latino workers, who have low membership in labor unions, extremely high turnover, poor working conditions, and low pay (Fig. 1-8). In addition, one-third of those working in meat processing plants are contingent workers who work for subcontracting agencies and perform such tasks as cleaning and maintenance. Although these tasks often involve great hazard, workers' compensation and OSHA requirements often fail to adequately address these contingent workers' needs. The hazards faced by undocumented immigrant workers who find themselves in informal work arrangements or day-labor settings have resulted in mortality rates for foreign-born Latino workers that are one-third higher than those of native-born citizens. Reliance on contingent and outsourced labor takes place throughout the economy, from health care to manufacturing to information technology. Other changes in the workforce over the past four decades include the integration of women into the workforce—although not in all work sectors—and the aging of the U.S. population as a whole as the “baby-boom” generation (born between 1946 and 1964) gets older. (See Chapter 4.)

Specific issues raised by these phenomena include the needs (*a*) to address the integration of family health with work schedules (Chapter 38), recognizing that work-related stresses extend into the home environment; and (*b*) to accommodate workers who have significant skills, but, for example, reduced physical capacity or visual acuity. In addition, advances in health care have increased the numbers of workers with severe impairments who nevertheless have the ability to contribute to society and the right to work, now recognized through the Americans with Disabilities Act. The careful development and implementation of redesigned community, home, and work spaces benefits all of us, in the same way that curb access has improved the lives of mobility-impaired individuals along with, for example, those of parents pushing strollers (see Chapter 39). All of these challenges can be met through concerted prevention activities, including development and implementation of employment policies, public health measures,



Figure 1-8. Workers processing chickens on an assembly line. Minority workers and women are overrepresented in entry-level jobs like this one, in which safety and health hazards are prevalent. Twenty-five workers in a similar chicken-processing plant died in 1991, when few workers were able to escape a fire that swept through the plant because the employer had locked most of the exit doors. (Photograph by Earl Dotter.)

engineering research, safety and health training, legislation and regulation, and the practice of clinical medicine.

Governmental Role

With the passage of the Federal Coal Mine Safety and Health Act in 1969 and legislation to establish OSHA and the EPA in 1970, the federal government began taking a more active role in the creation and enforcement of standards for a safe and healthful workplace and a safe and healthy ambient environment (Chapter 30). In addition, the passage of the Occupational Safety and Health Act in 1970 also established NIOSH, which (a) has greatly expanded epidemiologic and laboratory research into the causes of occupational diseases and injuries and the methods of preventing them; and (b) has strengthened the education and training of occupational health and safety professionals. In 1969, NIEHS was established as part of NIH, greatly expanding the funding for environmental health research, with an initial focus on toxicologic and etiologic work, which has expanded into

community-based participatory research addressing environmental justice and other issues. The role of the U.S. government in funding scientific research, especially in the biomedical sciences, has remained strong over time. A similar sustained program to develop and implement public health measures, including surveillance tools and interventions, has never fully materialized, although interest has increased in the wake of the 9/11 terrorist attacks, the flooding following Hurricane Katrina, the emergence of the novel H1N1 influenza pandemic, numerous episodes of widespread food contamination and toy contamination, and other national public-health emergencies. Such a program would require strengthening of state and local government capacities through increased federal coordination and funding.

The roles of the federal government to set and enforce health and safety standards—for occupational or environmental contaminants, food safety, consumer protection, and many public health concerns—vary and remain controversial. After the initial attempts in 1969–1970 to bring standardization to all parts of the country

and to enact an initial series of environmental and occupational health laws—followed by promulgation of related standards, intense legal and political challenges slowed the setting of new standards to a crawl and Congressional budget cuts hampered enforcement of existing standards. Cooperative programs and educational outreach were given higher priority during an era of government downsizing and deregulation. The promotion of free trade without easing restrictions on the migration of workers caused increased immigration and growth in the undocumented and informal workforce that removed financial incentives for improved safety and health. Identifying and establishing an appropriate role for government in occupational and environmental health is a responsibility that all health and safety workers share.

Green Jobs and Green Production

Green jobs help improve the environment. Traditional jobs have changed, and new kinds of occupations have been created by energy efficiency and practices that are more environmentally friendly. However, with increased attention to green jobs and technological advances in industry, worker safety and health must not be overlooked.

Green production reduces toxic emissions by utilizing substances and processes that are more friendly to the environment. Some of these efforts have been facilitated by increasing concerns over the production of greenhouse gases and climate change. Others have been facilitated by concerns for environmental sustainability and reducing air, water, and soil pollution and improving workplace health and safety. However, the terms *green production* and *environmental protection* have been used so much that individuals and organizations need to confirm that these concepts are actually being implemented as products are produced and services provided. (See Box 2-1 in Chapter 2.)

Social and Ethical Questions

Serious social and ethical problems have arisen over such subjects as the allegiance of occupational and environmental physicians who are employed by management, worker and community “right

to know” about occupational and environmental hazards, confidentiality of workers’ medical records kept by employers, and the restriction of female workers of childbearing age from certain jobs. Some of the controversies on these subjects may eventually be settled by labor–management and community–company negotiations and by the deliberations of government—courts, legislatures, and executive bodies. For example, the U.S. Supreme Court has upheld a worker’s right to refuse hazardous work, stating that a worker cannot be discharged or discriminated against for exercising a right not to work under conditions reasonably believed to be very dangerous (*Whirlpool Corp. v. Marshall*, 445 U.S. 1 [6th Cir. 1980]). (See also http://www.cwa-union.org/pages/Right_to_Refuse_Unsafe_Work.)

Environmental Justice

Disparities in environmental exposures between high-income and low-income communities partially account for differences in health status between those communities. The environmental justice movement is a network of people and organizations in low-income and minority communities who are fighting against placement in their communities of hazardous waste sites and polluting facilities. This movement has transformed the environmental movement from one supported primarily by the middle class and focused on ecological issues, to a grassroots struggle of poor and working-class communities who are concerned primarily with preserving the health of their families. Many environmental health professionals work with teams of urban sociologists, economists, community activists, and others to develop multidisciplinary prevention programs to decrease environmental health factors that contribute to health disparities. (See Chapters 4 and 33.)

Security and Terrorism Preparedness

The terrorist attack on the World Trade Center in 2001 followed by anthrax-tainted mail to Congressional offices and media companies led to increased awareness of the need for public health preparedness, which became a national priority. All of this highlighted the important role of occupational and environmental health.

Environmental contamination from the collapse of the World Trade Center caused respiratory and other disorders among community residents and rescue and recovery workers. Twenty-three people developed anthrax, five of whom died, as a result of their exposure to the contaminated mail. Environmental and occupational health workers played key roles in both of these situations—in identifying and measuring contaminants and in developing screening, treatment, and prevention programs. Subsequent investigations identified key vulnerabilities for potential future terrorist attacks, including the security of the food supply and chemical manufacturing facilities near heavily populated areas. These concerns are likely to continue to have an impact on the training and future roles of environmental and occupational health workers. (See Chapter 37.)

Liability

Some workers, barred from suing their employers under workers' compensation laws, have turned to "third-party," or product-liability, lawsuits as a means of redress for occupational disease; some community residents exposed to environmental hazards have also done so (Chapter 31). Fear of lawsuits has driven many employers to focus on preventive activities. Such lawsuits play an important role in directing attention to prevention of some diseases, although this approach can be cumbersome and outcomes may not be equitable. (In some jurisdictions, some of the most egregious health and safety offenders have been criminally prosecuted.) In recent years, plaintiffs and their attorneys have found it increasingly difficult to recover damages in such lawsuits for a variety of reasons, including federal and state court decisions that have disqualified testimony of experts.

Advances in Technology

Advances in technology continue to facilitate identification of workplace hazards and potential hazards, including increasing use of *in vitro* assays to determine the mutagenicity of substances—and therefore their possible carcinogenicity, improvements in ways of determining the presence and measuring the levels of hazardous

exposures, and new methods of monitoring concentrations of hazardous substances in body fluids and the physiologic impairments they cause. In addition, technological breakthroughs have introduced new hazards into the workplace and ambient environment (see Box 26-2 in Chapter 26). The huge oil spill in the Gulf of Mexico in 2010 is an example of how advances in technology may introduce new hazards.

Promoting a Healthy Workforce

The overall health of the population is influenced by factors both inside and outside the workplace. Not only do workers experience stress and physical and chemical exposures at work and in the community, but these factors can also influence health behaviors such as diet, exercise, smoking, and alcohol use. The effects of these many factors cannot be artificially divided between "at work" and "non-work." Workplace conditions can affect health and well-being at home and in the community; exposures, activities, and conditions outside of working hours can substantially determine health, productivity, and responses to exposures during work. Recognizing this complexity, new health behavior theories have developed that incorporate the importance of both contextual environmental factors and personal and community empowerment in achieving and maintaining good health.

Careful study and understanding is required to evaluate health interventions to demonstrate which aspects succeed and which do not. These processes are often more time-consuming and expensive than traditional approaches that, for example, might rely on a pamphlet to encourage people to eat more fruits and vegetables. Instead, community-based participatory research has identified structural issues, such as the absence of stores selling fruits and vegetables in a given neighborhood, and personal and cultural factors, such as traditional cooking methods and tastes. Identification of these structural issues has led to projects that engage community members to develop, implement, and assess change. Similar projects addressing lead poisoning, triggers of asthma in the home and the community, and exercise recommendations for low-income populations are being implemented. Similarly, workers are providing input into development

of preventive measures to reduce work-related injuries. And integrative approaches that address both personal habits and occupational hazards are making smoking cessation programs for blue-collar workers more effective. (See Chapter 38.)

Economic Globalization

The growth of multinational corporations, reduction in trade barriers, and development of regional treaty arrangements, such as the North American Free Trade Agreement (NAFTA), and global organizations, such as the World Trade Organization (WTO), are often adversely impacting occupational and environmental health. In many developing countries, multinational corporations have exploited workers by employing them in jobs that have low wages and few benefits, offer little or no training or upward mobility, and exposure to serious health and safety hazards. (See Chapter 4.)

Additional Challenges in Developing Countries

In addition, developing countries—which comprise two-thirds of all countries and include the

vast majority of people worldwide—face other challenges, which will be described next.

Export of Hazards

Developed countries often export their most hazardous industries, as well as hazardous materials (such as banned or restricted pesticides) and hazardous wastes, to developing countries, where laws and regulations concerning these substances are more lax or nonexistent and people may be less aware of these hazards (Fig. 1-9; See Box 4-4 in Chapter 4 and Box 20-1 in Chapter 20).

Inadequate Infrastructure and Human Resources

In developing countries, there are far fewer adequately trained personnel to recognize, diagnose, treat, and prevent and control occupational and environmental health problems. Governments and other sectors of society have fewer resources to devote to occupational and environmental health; and labor unions, facing other challenges such as low wages and high unemployment, often give little attention to occupational health and safety.



Figure 1-9. Agricultural workers are at high risk of poisoning from pesticides. (Photograph by Earl Dotter.)

Transnational Problems

Occupational and environmental health problems in developing countries often involve multiple countries in the same region, requiring transnational or regional approaches to problems, such as development and implementation of transnational standards.

Relationship between the Workplace and the Home Environment

In developing countries, where so many people work in or near their homes, the distinction between the workplace and the home environment is blurred. As a result, family members may often be exposed to workplace hazards.

Economic Development

Governments of developing countries often give high priority to economic development, sometimes even over the health of their people. In the context of economic development and accompanying rapid industrialization and urbanization, there is often pressure to overlook occupational and environmental health issues, given limited resources and the fear that attention to these issues may drive away potential investors or employers. Similarly, workers

desperate for jobs in economies with high unemployment rates are unlikely to complain about occupational and environmental health and safety hazards once they are employed. In addition, many children are forced to leave school in order to work, often in hazardous jobs. (See Figs. 1-10 and 1-11 and Chapter 4.)

Occupational and Environmental Health Services and Primary Health Care

Given limited resources and infrastructure, many developing countries are exploring ways to integrate occupational and environmental health services with primary medical care and with a broader range of public health services. Although some successes have been achieved with this approach, there remains much untapped potential in fully achieving this kind of integration.

DISCIPLINES AND CAREERS IN OCCUPATIONAL AND ENVIRONMENTAL HEALTH SCIENCES

Identification and remediation of threats to the environment is a stewardship responsibility for

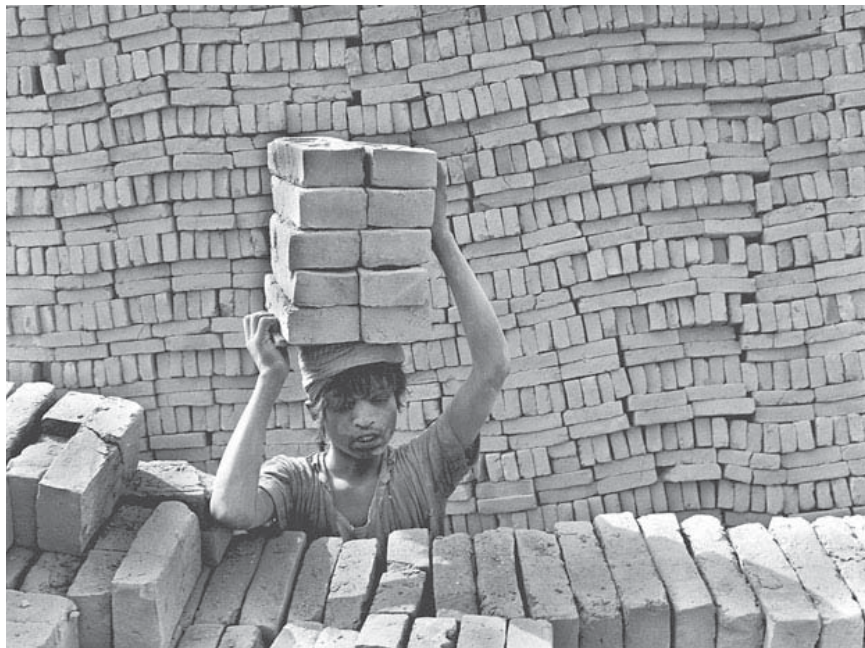


Figure 1-10. Young boy hauling fired bricks for storage in Nepal, 1993. Thousands of children are forced to work in brick kilns, rock quarries, or mines. (Photograph by David L. Parker.)



Figure 1-11. Migrant workers picking cotton. These workers face many challenges because of their minority status, poverty, inadequate education, and lack of information and control over the agrochemicals to which they are exposed. (Photograph by Earl Dotter.)

us all. For those who work in medical care or public health, there are a wide range of career options that span the physical, biologic, and social sciences as well as communications, policy making, and other fields. One of the most important challenges we face is the ability to communicate effectively across disciplines to develop the collaborative approaches needed to create safe, healthy, and sustainable environments for future generations.

Almost all health care providers encounter occupational and environmental health issues. The American College of Graduate Medical Education recognizes the specialty of preventive medicine, which includes three areas of expertise: public health and general preventive medicine, occupational medicine, and aerospace medicine. Physicians who choose to specialize in any of these areas may wish to become certified by the American Board of Preventive Medicine. (For criteria for certification, please access the American Board of Preventive Medicine Web site, <http://www.abpm.org>.) The American College of Occupational and Environmental

Medicine is a primary professional association for physicians engaged in the practice of occupational and environmental medicine.

The field of nursing is similarly integrated with communication and prevention—key aspects of environmental and occupational health practice. For those who wish to specialize in the application of the science of occupational and environmental health in nursing practice, advanced practice degrees in nurse-practitioner programs and advanced master of science in nursing and doctoral programs are available. The American Association of Occupational Health Nurses is the primary professional association for occupational health nurses and represents nurses across the spectrum of practice.

Physicians' assistants are midlevel practice professionals who are trained typically in an applied master of science degree program. They have formed the practice core for several large occupational health programs in industry and in the Veterans Administration health system.

Other health care professions important to the field of environmental and occupational

health include audiology, physical therapy and rehabilitation, clinical psychology, clinical social work, and optometry.

A wide range of environmental health science programs are available at levels ranging from community colleges to postgraduate doctoral programs, with credentialing based on education, experience, and certifying examinations available for registered environmental health specialists, sanitarians, environmental health technicians, food-safety professionals, hazardous-substance professionals, and others.

Engineering and public health programs overlap in the training of industrial hygienists and environmental engineers, who provide primary prevention through exposure assessment as well as design and implementation of interventions. Radiation physicists and biologists address a specific aspect of environmental and occupational exposure assessment and prevention.

Safety professionals have education in engineering disciplines, often with additional management training. Bachelor, master, and doctoral programs are available. Public health practitioners are also trained through a variety of programs, although the core public health sciences—epidemiology, biostatistics, environmental health, health services administration, and health education/behavioral sciences—form the basis of the core professional degree, the Master of Public Health.

Occupational health psychologists apply psychology to improving the quality of work life and to protecting and promoting the safety, health, and well-being of workers.

Research into any of the occupational and environmental health sciences can form the basis for a doctoral program, which focuses on advancement of scientific knowledge. These sciences include toxicology, the study of the effects of foreign substances on living organisms; epidemiology, the science of the distribution and determinants of disease in populations; environmental chemistry, concerned with the fate and transport of pollutants in the environment; systems engineering, the study of processes and their improvement; and sociology, psychology, and anthropology, all of which are critical to the understanding of human behavior in relation to the environment. Communications science, including social marketing and

journalism, represents an important related area of study and practice. Environmental law, economics, policy, urban planning, and environmental management are other important areas of work. Finally, the many fields of ecology, agronomy, chemistry, physics, and geology that do not directly address the human health impacts, but are nevertheless critical to our understanding of the external environment and our impact on it, provide additional career opportunities in occupational and environmental health.

CONCLUSION

Many health professionals will eventually work on occupational and environmental health and safety issues, and some will become occupational and environmental health and safety specialists. But almost all health professionals—in one way or another—will be involved with the recognition, diagnosis, treatment, or prevention and control of occupational and environmental illnesses and injuries.

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FURTHER READING

Selected Books

- Ashford NA, Caldart CC. Environmental law, policy and economics: reclaiming the environmental agenda. Cambridge, MA: MIT Press, 2008.
A detailed discussion of the important issues, tracing their development over the past few decades through an examination of environmental law cases and commentaries by leading scholars.
- Aw TC, Gardiner K, Harrington MM. Pocket consultant: occupational health. Oxford, England: Blackwell Publishing, 2007.
A clinical guide for physicians, nurses, occupational hygienists, safety officers, and others.
- Burgess W. Recognition of health hazards in industry: a review of materials and processes (2nd ed.). New York: John Wiley & Sons, 1995.
An excellent summary of industrial hazards, updated, made more comprehensive, and well illustrated with photographs, drawings, and graphs in this second edition.
- Environmental Health Criteria Series, Environmental Program. Geneva, Switzerland: World Health Organization.
A collection of monographs that provide succinct and comprehensive critical reviews on the effects of chemicals or combinations of chemicals and physical and biological agents on human health and the environment.
- Hamilton A. Exploring the dangerous trades: an autobiography. Boston: Little, Brown, 1943.
(Also published by OEM Press in 1995.)
A classic historical reference.
- Hathaway GJ, Proctor NH, Hughes JP. Proctor and Hughes' chemical hazards of the workplace (5th ed.). Hoboken, NJ: John Wiley & Sons, 2004.
Brief summaries of many chemical hazards, including basic information about their chemical, physical, and toxicologic characteristics; diagnostic criteria, including special tests; and treatment and medical control measures.
- LaDou J (ed.). Current occupational and environmental medicine (4th ed.). New York: McGraw-Hill Medical, 2007.
A clinically focused guide on common occupational and environmental illnesses.
- Levy BS, Wagner GR, Rest KM, Weeks JL (eds.). Preventing occupational disease and injury (2nd ed.). Washington, DC: American Public Health Association, 2005.
A systematically organized handbook designed for primary care clinicians and public health workers that covers the occurrence, causes, pathophysiology, and prevention of more than 100 occupational diseases and injuries.
- Lippmann M, Cohen BS, Schlesinger RB (eds.). Environmental health science: recognition, evaluation, and control of chemical and physical health hazards. New York: Oxford University Press, 2003.
A textbook that provides a broad, in-depth introduction to environmental health.
- McCunney RJ, Levinson JL, Rountree PP, et al. (eds.). A practical approach to occupational and environmental medicine (3rd ed.). Philadelphia: Wolters Kluwer/Lippincott Williams & Wilkins, 2003.
A practical guide on occupational medical services, occupational disorders, evaluation of hazards and the work environment, and environmental medicine.
- Rom WN, Markowitz SB (eds.). Environmental & occupational medicine (4th ed.). Philadelphia: Wolters Kluwer/Lippincott Williams & Wilkins, 2007.
An excellent, comprehensive in-depth reference on occupational and environmental medicine.
- Rosenstock L, Cullen MR, Brodtkin CA, Redlich CA (eds.). Textbook of clinical occupational and environmental medicine (2nd ed.). Philadelphia: Elsevier Saunders, 2005.
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- Stellman JM (ed.). Encyclopaedia of occupational health and safety (4th ed.). Geneva, Switzerland: International Labor Office, 1998.
A four-volume, comprehensive review of occupational hazards as well as occupational diseases and injuries.
- Wald PH, Stave GM (eds.). Physical and biological hazards of the workplace (2nd ed.). Hoboken, NJ: John Wiley & Sons, 2002.
A practical reference on the diagnosis, treatment, and control of these hazards.
- Waldron HA, Edling C (eds.). Occupational health practice (4th ed.). Oxford, England: Butterworth-Heinemann, 1998.
A general overview of occupational disease and health services with a British orientation.
- Wallace RB (ed.). Maxcy-Rosenau-Last public health and preventive medicine (15th ed.). New York: McGraw-Hill, 2007.
A standard text on preventive medicine, with chapters covering many occupational and environmental hazards.

Selected Periodical Publications

Occupational and Environmental Health

American Journal of Industrial Medicine, published monthly by Wiley-Liss, Inc.

American Journal of Public Health, published monthly by the American Public Health Association.

Environmental Health Perspectives, published monthly by the National Institute of Environmental Health Sciences.

International Journal of Occupational and Environmental Health, published quarterly by Hamilton Hardy Publishing, Inc.

Journal of Occupational and Environmental Medicine, the journal of the American College of Occupational and Environmental Medicine, published monthly by Wolters Kluwer Health/Lippincott Williams & Wilkins.

New Solutions: A Journal of Occupational and Environmental Health Policy, published quarterly by the Baywood Publishing Company, Inc.

Occupational and Environmental Medicine, the journal of the Faculty of Occupational Medicine of the Royal College of Physicians of London, published monthly by the BMJ Publishing Group, Ltd.

Scandinavian Journal of Work, Environment & Health, published every other month by the Finnish Institute of Occupational Health, the Danish National Research Centre for the Working Environment, and the Norwegian National Institute of Occupational Health.

Occupational Health Nursing

American Association of Occupational Health Nurses Journal, published monthly by the American Association of Occupational Health Nurses.

Occupational and Environmental Hygiene

Journal of Occupational and Environmental Hygiene, published monthly by the American Industrial Hygiene Association and the American Conference of Governmental Industrial Hygienists.

The Annals of Occupational Hygiene, the journal of the British Occupational Hygiene Society, published every other month by Oxford University Press.

Occupational Safety

Professional Safety, published monthly by the American Society of Safety Engineers.

Safety + Health, published monthly by the National Safety Council.

Occupational Ergonomics

Applied Ergonomics: Human Factors in Technology and Society, published every other month by Elsevier.

Ergonomics, the journal of the Ergonomics Society, published monthly by Taylor & Francis, Ltd.

Human Factors, published quarterly by the Human Factors and Ergonomics Society.

International Journal of Industrial Ergonomics, published monthly by Elsevier.

Occupational Health Psychology

Journal of Occupational Health Psychology, published quarterly by the American Psychological Association.

Health Promotion

Global Health Promotion, published quarterly by the International Union for Health Promotion and Education.

General News and Scientific Updates

BNA Occupational Safety & Health Reporter, published weekly by the Bureau of National Affairs.

The findings and conclusions in this chapter are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.